

# LEKARZ WOJSKOWY

MILITARY PHYSICIAN



2025  
NR 4 VOL. 103  
ISSN 0024-0745

- The role of dentistry in maintaining the health of soldiers: prevention, diagnosis, and treatment in the context of military service
- Assessment of preparedness of intern physicians in Mazowieckie Voivodeship for civil-military cooperation in the event of a potential armed conflict
- Nephrological problems in children with tuberous sclerosis complex – a single-center experience
- Assessment of the prevalence of cardiovascular risk factors and associated health threats among soldiers of NATO member states



**WOJSKOWY  
INSTYTUT MEDYCZNY  
PAŃSTWOWY INSTYTUT BADAWCZY**

## Informacje dla autorów

### Informacje ogólne

„Lekarz Wojskowy” jest czasopismem ukazującym się nieprzerwanie od 1920 r., obecnie jako kwartalnik wydawany przez Wojskowy Instytut Medyczny w Warszawie.

1. „Lekarz Wojskowy” zamieszcza prace oryginalne (doświadczalne i kliniczne), prace poglądowe, doniesienia dotyczące zagadnień wojskowych, opracowania deontologiczne, opracowania ciekawych przypadków klinicznych, artykuły z historii medycyny, prace dotyczące aspektów prawa medycznego, opisy wyników racjonalizatorskich, wspomnienia pośmiertne, listy do Redakcji, oceny książek, streszczenia (przeglądy) artykułów z czasopism zagranicznych, szczególnie dotyczących wojskowej służby zdrowia, sprawozdania ze zjazdów i konferencji naukowych, komunikaty o zjazdach. Publikacja oryginalna może mieć także formę krótkiego doniesienia wstępnego.
2. Każda praca przed przyjęciem do druku jest oceniana przez dwóch niezależnych recenzentów, z zachowaniem anonimowości. Czas na odpowiedź na zaproszenie do recenzji wynosi 7 dni, czas na recenzję 30 dni, czas na recenzję poprawionej pracy 14 dni.
3. Przesyłając pracę kliniczną, należy zadbać o jej zgodność z wymogami Deklaracji Helsińskiej, w szczególności o podanie w rozdziale „Materiał i metody” informacji o zgodzie Komisji Bioetycznej, jak również o świadomej zgodzie chorych na udział w badaniu. W przypadku wykorzystania wyników badań z innych ośrodków należy to zaznaczyć w tekście lub podziękowaniu.
4. Autorzy badań klinicznych dotyczących leków (nazwa międzynarodowa) i procedur medycznych powinni przedstawić opis finansowania badań i wpływu sponsora na treść publikacji.
5. Autor ma obowiązek dostarczyć Redakcji zgodę właściciela ilustracji na ich użycie w artykule.
6. Prace należy nadsyłać przez Editorial System.
7. Redakcja zwraca się z prośbą do wszystkich autorów pragnących zamieścić swe prace na łamach „Lekarza Wojskowego” o dokładne zapoznanie się z niniejszymi zasadami i ścisłe ich przestrzeganie. Niestosowanie się do wymagań Redakcji utrudnia redagowanie, zwiększa koszty i opóźnia ukazywanie się prac. Prace napisane niezgodnie z niniejszymi zasadami nie będą publikowane, a przygotowane niewłaściwie, będą zwracane autorom w celu ich ponownego opracowania.

### Maszynopis wydawniczy

1. Artykuły należy przygotować w edytorze tekstu WORD i przesłać przez Editorial System. Tekst musi być napisany czcionką Times New Roman 12 pkt, z podwójnym odstępem między wierszami (dotyczy to też piśmiennictwa, tabel, podpisów itd.). Nowy akapit zaczyna się od lewego marginesu, bez wcięcia akapitowego. Nie wstawia się pustych wierszy między akapitami lub wycięziami.
2. Liczba stron maszynopisu (łącznie z tabelami, rycinami i piśmiennictwem) nie może przekraczać w przypadku prac oryginalnych – 30, poglądowych – 20, kazuistycznych – 10, z historii medycyny – 20, racjonalizatorskich – 15 stron. Streszczenia ze zjazdów, kongresów itp. powinny być zwięzłe (do 5 stron) i zawierać tylko istotne informacje. W każdym przypadku piśmiennictwo nie powinno zawierać więcej niż 35 pozycji.
3. Tekst główny (z piśmiennictwem) umieszcza się w odrębnym pliku. Prace oryginalne powinny być przygotowane zgodnie z układem: wstęp, cel pracy, materiał i metody, wyniki, omówienie, wnioski, piśmiennictwo; prace kazuistyczne: wstęp, opis przypadku, omówienie, podsumowanie (wnioski), piśmiennictwo. Skróty i akronimy powinny być objaśnione w tekście przy pierwszym użyciu, a potem konsekwentnie stosowane.
4. W tekście głównym należy zaznaczyć miejsca wstawiania rycin i tabel, np.: „na rycinie 1”, „(tab. 1)”.
5. Tabele, ryciny i zdjęcia załącza się w osobnych plikach. Liczba tabel należy ograniczyć do minimum. Zdjęcia cyfrowe powinny mieć min. rozdzielczość 300 dpi.
6. Prace powinny być przygotowane starannie i zgodnie z zasadami pisowni polskiej, ze szczególną dbałością o komunikatywność i polskie mianownictwo medyczne. Teksty niespełniające tych kryteriów będą odsyłane do poprawy.
7. Informacje afiliacyjne: imię i nazwisko autora lub autorów (maks. 10 osób), z tytułami naukowymi, pełną nazwą zakładu (zakładów) pracy umieszcza się w programie Editorial System. Należy wskazać także autora do korespondencji. Nie należy zamieszczać tych informacji bezpośrednio w wysłanym manuskrypcie.
8. Streszczenie (do 250 słów) w języku polskim lub angielskim, ze słowami kluczowymi w języku polskim i angielskim, także należy załączyć w programie Editorial System. Nie należy umieszczać streszczenia dodatkowo w pliku manuskryptu.
9. Piśmiennictwo powinno być ułożone zgodnie z kolejnością pojawiania się odsyłaczy w tekście. Jeśli artykuł ma nie więcej niż czterech autorów, należy podać nazwiska wszystkich; jeśli autorów jest więcej – trzech pierwszych, z dopiskiem „et al.” Numerację piśmiennictwa należy wprowadzać z klawiatury, nie korzystając z możliwości automatycznego numerowania. Przykłady cytowań:  
Artykuły z czasopism:  
Calpin C, Macarthur C, Stephens D, et al. Effectiveness of prophylactic inhaled steroids in childhood asthma: a systematic review of the literature. *J Allergy Clin Immunol*, 1997; 100: 452–457. doi: 10.1016/s0091-6749(97)70134-9  
Książki:  
Rudziński E. *Alergia na leki: z uwzględnieniem odczynów anafaktycznych i idiosynkrazji*. Lublin, Wydawnictwo Czelej, 2002  
Rozdziały książki:  
Wantz GE. Groin hernia. In: Cameron JJ, ed. *Current surgical therapy*. St Louis, Mosby, 1998: 557–561  
W wykazie piśmiennictwa należy uwzględnić tylko te prace, z których autor korzystał, a ich liczbę należy ograniczyć do 35. W tekście artykułu należy się powołać na wszystkie wykorzystane pozycje piśmiennictwa, a numer piśmiennictwa umieścić w nawiasie kwadratowym. Tytuły należy kopiować z medycznych baz danych w celu uniknięcia pomyłek.
10. Przesłany artykuł musi spełniać kryteria zgody na publikację zgodnie z zasadami przyjętymi w jednostce afiliacyjnej autora. Do pracy należy dołączyć: oświadczenie, że praca nie została wcześniej opublikowana i nie jest złożona do innego czasopisma, oświadczenie o konflikcie interesów oraz ewentualne podziękowanie.
11. Redakcja zastrzega sobie prawo poprawienia mianownictwa i usterek stylistycznych oraz dokonanie skrótów bez uzgodnienia z autorem.
12. W przypadku nieprzyjęcia pracy do publikacji Redakcja poinformuje autora pisemnie o takiej decyzji.

## Zasady etyki publikacyjnej

1. Czasopismo „Lekarz Wojskowy” stosuje zasady etyki publikacyjnej mającej na celu przeciwdziałanie nieuczciwym praktykom.
2. Materiały zgłoszone Redakcji „Lekarza Wojskowego” do publikacji są weryfikowane pod kątem zgodności z zasadami etyki wydawniczej, opisanymi m.in. w następujących dokumentach:
  - 1) wytyczne Komitetu ds. Etyki Publikacyjnej (Committee on Publication Ethics – COPE), „Kodeks etyki pracownika naukowego” (opracowany przez Komisję ds. Etyki w Nauce, wydanie drugie, PAN, Warszawa 2017);
  - 2) „Dobre praktyki w procedurach recenzyjnych w nauce” (opracowane przez Zespół ds. Etyki w Nauce, który doradzał Ministrowi Nauki i Szkolnictwa Wyższego w latach 2009–2010);
  - 3) „Rzetelność w badaniach naukowych oraz poszanowanie własności intelektualnej” (Warszawa, 2012, MNIŚW).
3. Redakcja „Lekarza Wojskowego” w szczególności:
  - 1) przeciwdziała zjawiskom ghostwritingu oraz guest authorshipu, które są przejawem nierzetelności naukowej;
  - 2) przestrzega przepisów prawa autorskiego zgodnie z ustawą z dnia 4 lutego 1994 r. o prawie autorskim i prawach pokrewnych (Dz. U. z 2021 r. poz. 1062, z późn. zm.);
  - 3) dokłada należytej staranności, by zapobiegać plagiatom i autoplagiatom poprzez zastosowanie systemu autoplagiatorowego Crossref Similarity Check, przy użyciu oprogramowania iThenticate;
  - 4) ma prawo wycofać tekst (nawet po opublikowaniu), jeśli istnieją dowody świadczące o braku wiarygodności wyników badań i/lub fałszowaniu danych i/lub praca nosi znamiona plagiatu albo narusza zasady etyki wydawniczej;
  - 5) z chwilą wykrzyka nieuczciwych praktyk jest zobowiązana:
    - a) skierować sprawę do Rzecznika Dyscyplinarnego WIM, jeśli dotyczy utworu pracownika naukowego;
    - b) w uzasadnionych przypadkach niezwłocznie informować o tych praktykach stosowne instytucje naukowe, jak również odpowiednie organy ścigania;
  - 6) zapewnia profesjonalny proces wydawniczy;
  - 7) zapewnia poufność i bezpieczeństwo przetwarzania danych osobowych zgodnie z obowiązującymi przepisami (m.in. RODC).

## Information for the authors

### General information

“Military Physician” has been published continuously since 1920, currently as a quarterly of the Military Institute of Medicine in Warsaw, Poland.

1. “Military Physician” publishes original (experimental and clinical) articles, reviews, reports on military issues, deontological papers, interesting case reports, articles on the history of medicine, descriptions of rationalisation results, posthumous memoirs, letters to the editor, book reviews, article (reviews) summaries from international journals particularly on military health service, reports on meetings and scientific conferences, and announcements of events. An original publication may also have the form of a short temporary report.
2. Before publication, each article is reviewed by 2 independent reviewers while maintaining anonymity. The time to respond to a review invitation is 7 days, the time to complete a review is 30 days, and the time to complete the review of a corrected article is 14 days.
3. A clinical article for submission should be in accordance with the requirements of the Declaration of Helsinki, and the “Material and methods” section should contain both information on the approval of the Editorial Committee and the patients’ informed consent to participate in the study. In the case of using the results of studies conducted by other centres, such information should appear either in the text or in the acknowledgements.
4. Authors of clinical studies on medications (international name) and medical procedures should provide a description of the research funding and the influence of the sponsor on the content of the publication.
5. The author must provide the editorial board with the consent of the owner of an image to use the image in an article.
6. Please submit your article using the Editorial System.
7. All authors who wish to publish their papers in Military Physician are asked to carefully read and strictly follow the guidelines listed below. Failure to follow the requirements of the Editorial Board makes editing more difficult, increases costs and delays publication. Manuscripts not meeting the requirements will not be published, and those considered inadequately prepared will be returned to the authors for revision.

### Manuscript

1. Articles should be in MS Word and sent by Editorial System. The text must be written in Times New Roman 12 point font, double spaced (this also applies to references, tables, captions, etc.). A new paragraph should be started from the left margin without paragraph indentation. Please do not insert blank lines between paragraphs or enumerations.
  2. The number of pages of the manuscript (including tables, figures and references) cannot exceed 30 pages for original articles, 20 for review articles, 10 for reports, 20 for articles on the history of medicine and 15 for rationalisation articles. Reports on meetings and conferences should be concise (up to 5 pages) and discuss only significant issues. The number of references should never exceed 35.
  3. Text (with references) should be uploaded as a separate file. Original articles should be prepared according to the following structure: introduction, aim, material and methods, results, discussion, conclusions, references; case reports: introduction, case description, discussion, summary (conclusions), and references. Abbreviations and acronyms should be defined when first mentioned in the text and consequently used in the paper.
  4. Figures and tables should be referenced in the body of the text as follows: “in Figure 1”, “(Tab. 1)”.
  5. Tables, figures and images should be saved in a separate file. The number of tables should be reduced to a minimum. Digital images should have a resolution of 300 dpi.
  6. Papers should be prepared carefully, in accordance with Polish spelling and with special attention to communicativeness and Polish medical nomenclature. Manuscripts that do not meet the criteria will be sent back to the authors for revision.
  7. Affiliation information: author’s or authors’ (max. 10 people) first and last names, including academic degrees, full name of affiliated institute (institutes) should be introduced in the Editorial System. Please indicate the corresponding author. Please do not include this information directly in the manuscript.
  8. An abstract (up to 250 words) in Polish or English with keywords in Polish and English should also be saved in the Editorial system. Please do not also include the abstract in the manuscript.
  9. References should be presented according to the order in which they appear in the text. If the article has up to four authors then all of them should be named, while if there are more, then name only the first three, followed by “et al.”. References should be numbered using the keyboard, please do not use automatic numbering.
- Examples of citations:
- Journal articles:  
Calpin C, Macarthur C, Stephens D, et al. Effectiveness of prophylactic inhaled steroids in childhood asthma: a systematic review of the literature. *J Allergy Clin Immunol*, 1997; 100: 452–457. doi: 10.1016/s0091-6749(97)70134-9
- Books:  
Rudziński E. *Alergia na leki: z uwzględnieniem odczynów anafaktycznych i idiosynkrazji*. Lublin, Wydawnictwo Czelej, 2002
- Chapter of a book:  
Wantz GE. Groin hernia. In: Cameron JJ, ed. *Current surgical therapy*. St Louis, Mosby, 1998: 557–561
- The list of references should include only those publications that were used by the author and should be reduced to 35. All references should be cited in the text and the numbers of references should be put in square brackets. In order to avoid errors, titles should be copied from medical databases.
10. The submitted article must comply with the criteria for consent to publication adopted in the author’s institution. The paper should be accompanied by: a declaration that the article has not been published before or simultaneously submitted to any other journal, Declaration of Conflict of Interest and acknowledgements, if applicable.
  11. The Editorial Board reserves the right to correct nomenclature and stylistic errors as well as to introduce abbreviations without consultation with the author.
  12. If the manuscript is not accepted for publication, the Editorial Board will inform the author in writing about the decision.

## Principles of publication ethics

1. The journal “Lekarz Wojskowy” applies principles of publication ethics aimed at preventing unfair publication practices.
2. Materials submitted to the editorial board of “Lekarz Wojskowy” for publication are reviewed for compliance with the principles of publication ethics described in the following documents:
  - 1) the guidelines of the Committee on Publication Ethics (COPE), the “Code of Ethics for a Scientific Employee” (developed by the Commission on Ethics in Science, second edition, PAN, Warsaw 2017);
  - 2) “Good practices in review procedures in science” (developed by the Team for Ethics in Science, which advised the Minister of Science and Higher Education in 2009–2010);
  - 3) “Reliability in scientific research and respect for intellectual property” (Warsaw, 2012, Ministry of Science and Higher Education).
3. The editorial board of “Lekarz Wojskowy” in particular:
  - 1) counteracts the phenomena of ghostwriting and guest authorship, which are manifestations of scientific unreliability;
  - 2) observes the provisions of copyright law in accordance with the Act of 4 February 1994 on Copyright and Related Rights (Journal of Laws of 2021, item 1062, as amended);
  - 3) exercises due diligence to prevent plagiarism and self-plagiarism through the use of the Crossref Similarity Check anti-plagiarism system using the iThenticate software;
  - 4) has the right to withdraw a text (even after publication) if there is evidence of unreliability of research results and/or falsification of data and/or the work shows signs of plagiarism or breaches the rules of publishing ethics;
  - 5) as soon as it discovers unfair practices, it is obliged to:
    - a) refer the matter to the Disciplinary Ombudsman of the WIM, if it concerns the work of a researcher;
    - b) in justified cases, immediately inform the relevant scientific institutions, as well as the appropriate law enforcement authorities about these practices;
  - 6) ensure a professional publishing process;
  - 7) ensure confidentiality and security of personal data processing in accordance with applicable regulations (including GDPR).



## ■ Letter from the Editor-in-Chief

Dear Readers!

We present another issue of *Military Physician*, which integrates clinical, military, and scientific perspectives. We are pleased that each issue of the journal reflects the broad spectrum of topics addressed in your research and analyses.

This issue addresses, among other topics, cardiovascular risk factors within the military populations of NATO countries and the role of dentistry in maintaining soldier readiness for deployment. Contemporary challenges in terms of medical readiness are illustrated by a study assessing the level of preparedness of young physicians in the field of civil–military cooperation and their knowledge of Tactical Combat Casualty Care guidelines. The findings should serve as a basis for discussion on the need to improve education in tactical medicine, particularly in the current geopolitical context.

The work devoted to the health service during the Polish campaign of 1939 is of significant historical value. The synthesis of experiences and the analysis of the health service's capabilities from that period constitute not only valuable historical material but also a source of reflection on the development of military medicine over subsequent decades.

As we conclude 2025, it is worth emphasizing that the essence of medicine lies not only in procedures, structures, or statistics, but fundamentally in people. I wish you Christmas filled with peace, joy, and the company of loved ones, as well as the strength to undertake new professional challenges. May the New Year 2026 bring prosperity, health, and professional fulfilment.

I also thank you for another year of collaboration, inspiration, and the exchange of experiences.

With best regards

Prof. Bolesław Kalicki, MD, PhD

The editorial office of *Military Physician* would like to express gratitude to the reviewers listed below for their work, commitment, reliability, conscientiousness, and effort during the evaluation of manuscripts submitted in 2025:

Lt. Gen. Prof. Grzegorz Gielera, MD, PhD; Prof. Stanisław Niemczyk, MD, PhD; Prof. Jan K. Podgórski, MD, PhD; Prof. Grzegorz Zieliński, MD, PhD; Prof. Adam Stepień, MD, PhD; Prof. Krzysztof Korzeniewski, MD, PhD; Prof. Włodzimierz Baranowski, MD, PhD; Prof. Krzysztof Paśnik, MD, PhD; Prof. Arkadiusz Lubas, MD, PhD; Prof. Paweł Kamiński, MD, PhD; Prof. Renata Duchnowska, MD, PhD; Prof. Anna Kotlarska-Michalska, PhD (Sociology); Prof. Marek Saracyn, MD, PhD; Prof. Piotr Rzepecki, MD, PhD; Prof. Maciej Gonciarz, MD, PhD; Prof. Rafał Stec, MD, PhD; Prof. Dariusz Peter, PhD; Prof. Andrzej Chciałowski, MD, PhD; Prof. Paweł Krzesiński, MD, PhD; Prof. Mansur Rahnama-Hezavak, MD, PhD; Prof. Michał Janik, MD, PhD; Prof. Dariusz Jurkiewicz, MD, PhD; Assoc. Prof. Jacek Staszewski, MD, PhD; Assoc. Prof. Tomasz Kubiś, MD, PhD; Assoc. Prof. Katarzyna Jobs, MD, PhD; Assoc. Prof. Elżbieta Kramarz, MD, PhD; Assoc. Prof. Marek Kiliński, MD, PhD; Assoc. Prof. Dariusz Tomaszewski, MD, PhD; Assoc. Prof. Maciej Wałędzia, MD, PhD; Assoc. Prof. Tomasz Żąbkowski, MD, PhD; Aleksandra Juszkiewicz, MD, PhD; Anna Olczak-Pieńkowska, MD, PhD; Katarzyna Piotrowicz, MD, PhD; Tomasz Syryło, MD, PhD; Aleksander Rutkiewicz, MD, PhD; Zbigniew Kopociński, MD, PhD; Arkadiusz Zegadło, MD, PhD; Marta Pudło-Kania, MD, PhD; Anna Olczak-Pieńkowska, MD, PhD; Justyna Towarek, MD, PhD; Krzysztof Zarzycki, MD, PhD; Janusz Dadok, MD, PhD; Piotr Cieślak, MD, PhD; Barbara Betiuk, MD, PhD; Piotr Furga, MD, PhD; Artur Szewczyk, MD, PhD; Aldona Chloupek, MD, PhD; Katarzyna Gniadek-Olejniczak, MD, PhD; Justyna Chałubińska-Fendler, MD, PhD; Justyna Sabela, MD.



Beata Uziębło-Życzkowska, MD, PhD  
Jacek Staszewski, MD, PhD  
Col. Prof. Marek Saracyn, MD, PhD  
Col. Prof. Arkadiusz Lubas, MD, PhD  
Andrzej Kwiatkowski, MD, PhD  
Lt. Col. Kornel Szczygielski, MD, PhD  
Bartosz Rustecki, MD, PhD  
Col. Radosław Tworus, MD, PhD  
Katarzyna Czarnek, PhD in Biology  
Robert Zdanowski, PhD in Biology  
Wawrzyniec Kowalski, PhD in Law

#### Scientific Committee

##### Head:

Lt. Gen. Prof. Grzegorz Gielerak, MD, PhD

##### Honorary Members:

Prof. Teofan Domżał, MD, PhD  
Prof. Eugeniusz Dziuk, MD, PhD  
Stanisław Ilnicki, MD, PhD  
Prof. Anna Jung-Hauska, MD, PhD  
Prof. Jerzy Kruszewski, MD, PhD  
Jacek Siewiera, MD, PhD  
Prof. Edward Stanowski, MD, PhD  
Prof. Zofia Wańkiewicz, MD, PhD

##### Polish Members:

Prof. Andrzej Chciałowski, MD, PhD  
Prof. Renata Duchnowska, MD, PhD  
Prof. Mirosław Dziuk, MD, PhD  
Prof. Maciej Gonciarz, MD, PhD  
Prof. Wiesław W. Jędrzejczak, MD, PhD  
Prof. Karina Jahnz-Różyk, MD, PhD  
Prof. Kuba Jałoszyński, MD, PhD  
Prof. Dariusz Jurkiewicz, MD, PhD  
Prof. Grzegorz Kamiński, MD, PhD  
Jolanta Korsak, MD, PhD  
Col. Prof. Paweł Krzesiński, MD, PhD  
Łukasz Młynarkiewicz, PhD in Law  
Prof. Stanisław Niemczyk, MD, PhD  
Col. Prof. Witold Owczarek, MD, PhD  
Prof. Robert Rejdak, MD, PhD  
Col. Prof. Marek Rękas, MD, PhD  
Prof. Piotr Rzepecki, MD, PhD  
Prof. Adam Stępień, MD, PhD  
Prof. Witold Tłustochowicz, MD, PhD  
Prof. Barbara Wróblewska, MD, PhD  
Prof. Piotr Zaborowski, MD, PhD  
Col. Prof. Grzegorz Zieliński, MD, PhD

##### Editor-in-Chief:

Prof. Bolesław Kalicki, MD, PhD

##### Deputy Editors-in-Chief:

Prof. Krzysztof Korzeniewski, MD, PhD  
Lt. Col. Agata Będzichowska, MD, PhD

##### Editorial Assistant:

Ewa Jędrzejczak, MA

##### Subject Editors:

*field: cardiology, internal medicine*  
*field: neurology, medical rehabilitation*  
*field: endocrinology, nephrology, internal medicine*  
*field: nephrology, biostatistics, internal medicine*  
*field: general surgery, surgical oncology*  
*field: otorhinolaryngology, general surgery*  
*field: anaesthesiology and intensive care, emergency medicine*  
*field: psychiatry, psychology*  
*field: biology, basic research*  
*field: basic sciences*  
*field: basic sciences*



##### Foreign Members:

Massimo Barozzi (Italy)  
Elspeth Cameron Ritchie (USA)  
Nihad El-Ghoul (Palestine)  
Claudia E. Frey (Germany)  
Anselm Jünemann (Germany)  
Paweł Kaliński (USA)  
Małgorzata Kloc (USA)  
Frederic C. Lough (USA)  
Marc Morillon (Belgium)  
Arnon Nagler (Israel)  
Tomasz Rozmystowicz (USA)  
Marek Rudnicki (USA)  
Valerii Savatskyi (Ukraine)  
Daniel Schneditz (Austria)  
Eugeny Tischchenko (Belarus)  
Mario Damiano Toro (Italy)  
Brenda Widerhold (USA)

##### Technical Editing:

Managing Editor:  
Zuzanna Leszczuk, MA  
Editing and proofreading:  
Medical Communications,  
Aleksandra Kwiatkowska-  
-Przybysz, MA  
English translation and proofreading:  
Lingua Line Translation Agency  
Cover design:  
Krzysztof Gontarski MSc, Eng  
Typography:  
Krzysztof Gontarski MSc, Eng  
DTP:  
Medical Communications,  
Marcin Haze

##### Editorial address:

Military Institute of Medicine –  
National Research Institute  
128 Szaserów St. 04-141 Warsaw  
telephone +48 261 817 380  
e-mail: lekarzwojskowy@wim.mil.pl  
lekarzwojskowy.wim.mil.pl

© Copyright by WIM-PIB

## TABLE OF CONTENTS

<b>LETTER FROM THE EDITOR-IN-CHIEF</b> . . . . .	<b>.259</b>
Bolesław Kalicki	

### REVIEW ARTICLES

<b>GLUCOCORTICOIDS IN RHEUMATIC DISEASES. PART II</b> . . . . .	<b>.263</b>
Glikokortykosteroidy w leczeniu chorób reumatycznych. Część II	
Rafał Bilski, Robert Kruszewski, Marta Jaworska, Katarzyna Rendaszka, Natalia Kostecka, Witold Tłustochowicz	

<b>ASSESSMENT OF THE PREVALENCE OF CARDIOVASCULAR RISK FACTORS AND ASSOCIATED HEALTH THREATS AMONG SOLDIERS OF NATO MEMBER STATES.</b> . . . . .	<b>.271</b>
Ocena rozpowszechnienia czynników ryzyka sercowo-naczyniowego i związanych z nimi zagrożeń zdrowotnych wśród żołnierzy państw Sojuszu Północnoatlantyckiego	
Bartłomiej Marek Gawron, Grzegorz Gielerak	

<b>THE ROLE OF DENTISTRY IN MAINTAINING THE HEALTH OF SOLDIERS: PREVENTION, DIAGNOSIS, AND TREATMENT IN THE CONTEXT OF MILITARY SERVICE</b> . . . . .	<b>.277</b>
Rola stomatologii w utrzymaniu zdrowia żołnierzy: prewencja, diagnostyka i leczenie w kontekście służby wojskowej	
Adrianna Gliszczyńska, Adam Łuczak, Agata Tuczyńska	

<b>AN INTERNATIONAL APPROACH TO HOMELESSNESS. PART I: THE CASE OF INDIA</b> . . . . .	<b>.283</b>
Międzynarodowe podejście do problemu bezdomności: Część I: Przypadek Indii	
Pranit Lanjewar, Jarosław Richard Romaniuk	

<b>PHEOCHROMOCYTOMA AND PARAGANGLIOMA IN CHILDREN AND ADOLESCENTS</b> . . . . .	<b>.292</b>
Guzy chromochłonne i przyzwojaki u dzieci i młodzieży	
Piotr Skrzypczyk, Aneta Michalczevska, Urszula Ambroziak	

### ORIGINAL ARTICLE

<b>ASSESSMENT OF PREPAREDNESS OF INTERN PHYSICIANS IN MAZOWIECKIE VOIVODESHIP FOR CIVIL-MILITARY COOPERATION IN THE EVENT OF A POTENTIAL ARMED CONFLICT</b> . . . . .	<b>.301</b>
Ocena poziomu przygotowania lekarzy stażystów województwa mazowieckiego z zakresu współpracy cywilno-wojskowej na wypadek ewentualnego konfliktu zbrojnego	
Sławomir Piotr Paszek, Marcin Rabijewski, Anna Kurek, Hubert Goetz, Zofia Czaplńska-Paszek	

<b>NEPHROLOGICAL PROBLEMS IN CHILDREN WITH TUBEROUS SCLEROSIS COMPLEX – A SINGLE-CENTER EXPERIENCE</b> . . . . .	<b>.306</b>
Problemy nefrologiczne u dzieci chorujących na stwardnienie guzowate – doświadczenie jednego ośrodka	
Anna Maria Wabik, Wiktoria Suszek, Agnieszka Piróg, Mariusz I. Furmanek, Piotr Skrzypczyk	

**MEDICAL SERVICES IN THE POLISH CAMPAIGN OF 1939 – A SYNTHESIS.  
PART I: MEDICAL SERVICE CAPACITY . . . . . 314**

Służba zdrowia w kampanii polskiej 1939 roku – synteza. Część I:  
Potencjał służby zdrowia

Aleksander Rutkiewicz

**EXPANDING .308 WINCHESTER CALIBRE AMMUNITION  
AND SOFT TISSUE INJURY . . . . . 327**

Amunicja ekspandująca kalibru .308 Winchester a obrażenia w tkance miękkiej

Grzegorz Motrycz

**CASE REPORTS**

**METASTASIS OF RENAL CELL CARCINOMA TO THE CHEEK  
IN A 73-YEAR-OLD MAN . . . . . 334**

Przerzut raka jasnokomórkowego nerki do skóry policzka u 73-letniego mężczyzny

Krzysztof Stanisław Winiarz

**PERSONALIZED TEMPOROMANDIBULAR JOINT  
ENDOPROSTHESES – OWN EXPERIENCE . . . . . 337**

Spersonalizowane endoprotezy stawu skroniowo-żuchwowego – własne doświadczenia

Iwona Niedzielska, Julia Maślanka, Jakub Fiegler-Rudol, Daria Wziętek-Kuczmik

**REPORTS**

**REPORT FROM THE 4TH SCIENTIFIC AND TRAINING CONFERENCE  
“TRAVEL MEDICINE IN MEDICAL PRACTICE” . . . . . 345**

Sprawozdanie z IV Konferencji Naukowo-Szkoleniowej  
„Medycyna podróży w praktyce lekarskiej”

Krzysztof Korzeniewski

**REPORT FROM THE 15TH CONGRESS OF THE POLISH SOCIETY OF NEPHROLOGY . . . . 347**

Sprawozdanie z XV Zjazdu Polskiego Towarzystwa Nefrologicznego

Katarzyna Romejko, Elżbieta Głuch, Anna Grzywacz, Magdalena Markowska, Mateusz Nowak,  
Dorota Górską-Michałek, Magdalena Wiśniewska









## GLUCOCORTICOIDS IN RHEUMATIC DISEASES. PART II

Glikokortykosteroidy w leczeniu chorób reumatycznych. Część II



Rafał Bilski, Robert Kruszewski, Marta Jaworska, Katarzyna Rendaszka, Natalia Kostecka, Witold Tłustochowicz

*Military Institute of Medicine – National Research Institute, Department of Internal Medicine and Rheumatology, Poland*

Rafał Bilski –  0009-0004-1580-3807  
 Robert Kruszewski –  0000-0003-4214-2982  
 Marta Jaworska –  0000-0003-4131-2281  
 Katarzyna Rendaszka –  0009-0003-0807-897X  
 Natalia Kostecka –  0009-0009-6090-7484  
 Witold Tłustochowicz –  0000-0002-7750-2901

### Abstract

Glucocorticoids are an effective and relatively rapid-acting treatment for conditions with a severe, sudden course, which until recently led to significant disability and mortality. Vasculitis, in which the treatment timing and intensity strongly determine its outcomes, as well as chronic diseases, in which the action taken significantly affects the patient's quality of life, are of particular importance. The first part of this review outlined the general principles of glucocorticoid therapy in vasculitis based on detailed expert recommendations and guidelines of recognised rheumatology societies. For very rare diseases, the experience of researchers and generally accepted clinical practice are presented. The second part of the publication discusses the place and role of glucocorticoids in the subsequent lines of therapy for both common and rare conditions of rheumatic origin. This paper summarizes current and structured knowledge of the use of glucocorticoids in the treatment of vasculitis and other rheumatic diseases.

### Streszczenie

Glikokortykosteroidy umożliwiają skuteczne i stosunkowo szybkie opanowanie chorób o ciężkim, nagłym przebiegu, które do niedawna prowadziły do znacznej niepełnosprawności lub śmierci. Szczególnie istotne są przypadki zapalenia naczyń, w których czas rozpoczęcia i intensywność terapii silnie determinują jej efektywność, oraz stany przewlekłe, w których podjęte odpowiednie działanie znacznie wpływa na komfort życia pacjenta. W pierwszej części pracy omówiono ogólne zasady wykorzystania glikokortykosteroidów w leczeniu zapalenia naczyń, oparte na szczegółowych rekomendacjach ekspertów oraz wytycznych uznanych organizacji reumatologicznych. W przypadku rzadkich chorób przedstawiono doświadczenia badaczy oraz ogólnie przyjętą praktykę kliniczną. Druga część pracy prezentuje miejsce i rolę glikokortykosteroidów w kolejnych rzutach terapii innych chorób o podłożu reumatycznym, zarówno tych powszechnie występujących, jak i rzadkich. Niniejsze opracowanie podsumowuje aktualną, usystematyzowaną wiedzę na temat wykorzystania glikokortykosteroidów w terapii zapalenia naczyń oraz różnych chorób reumatycznych.

**Keywords:** rheumatic diseases; pharmacotherapy; glucocorticoids; vasculitis

**Słowa kluczowe:** choroby reumatyczne; farmakoterapia; glikokortykosteroidy; zapalenia naczyń

DOI 10.53301/lw/203012

Received: 24.01.2025

Accepted: 17.03.2025

Published: 30.12.2025

### Corresponding author:

Robert Kruszewski  
 Military Institute of Medicine –  
 National Research Institute,  
 Department of Internal Medicine and Rheumatology,  
 128 Szaserów, 04-141 Warsaw, Poland  
 e-mail: rkruszewski@wim.mil.pl

## Introduction

Glucocorticoids (GCs) remain one of the most widely used anti-inflammatory therapies. Their use spans several decades, and extensive scientific evidence has confirmed their efficacy in the treatment of many disorders. Due to the complex mechanisms underlying their action, these drugs exert diverse effects across multiple systems and organs. In clinical practice, modulation of immune cells and other components involved in the inflammatory response remains their most extensively utilized action.

Since limiting the effects of inflammation is particularly important in the treatment of rheumatic diseases, GCs have become widely used in rheumatology, providing rapid improvement in conditions previously considered incurable. Unfortunately, during prolonged therapy, the beneficial effects of GCs may be counterbalanced by adverse events that negatively affect the cardiovascular system, glucose and lipid metabolism, the skeletal system, the eyes, and other organs. For this reason, recommended GC dosing regimens are continually revised to incorporate emerging evidence on safety and efficacy.

The previous part of this paper outlined the current guidelines for the use of GCs in arthritis and systemic connective tissue diseases. This part discusses recommendations for GC therapy in vasculitis and other rheumatic disorders. Clinical entities in which inflammation does not constitute the predominant pathological mechanism are also included. The presented management principles are based on recommendations from scientific societies, expert group opinions, and researcher experience in rare diseases.

### The role of GCs in the treatment of vasculitis

Current treatment guidelines for anti-neutrophil cytoplasmic antibody (ANCA)-associated vasculitis (AAV) include an induction phase, typically lasting 3–4 months, followed by maintenance therapy with low-dose GCs for at least 18–24 months in combination with immunosuppressants. Importantly, it is suggested to include prophylaxis against *Pneumocystis jirovecii* during the period of treatment with high doses of GCs in these clinical entities [1, 2]. GCs are used as induction treatment for granulomatosis with polyangiitis (GPA) and microscopic polyangiitis (MPA). The choice and intensity of the treatment regimen depend on the activity and extent of the disease process; notably, ANCA antibody levels should not serve as the primary determinant of therapy [2]. In severe cases with life-threatening organ involvement, first-line treatment consists of high-dose GCs combined with a potent immunosuppressant, such as rituximab or cyclophosphamide [1]. The recommended initial daily dose of prednisolone is 50–75 mg [1] or 1 mg/kg (up to 80 mg) [2]. In the most severe cases, such as pulmonary alveolar haemorrhage or rapidly progressive renal impairment, intravenous methylprednisolone at 0.5–1.0 g/day for 3–5 days, followed by oral therapy, is an alternative approach. Rapid GC tapering, compared with earlier treatment regimens, can reduce the overall corticosteroid exposure by approximately half, thereby directly improving the safety profile of the therapy. As an example of this approach the PEXIVAS regimen optimizes dosing

in patients with severe disease, which is presented in the table. It consists of three-day pulses of methylprednisolone at a cumulative dose of 3 g, followed by intensive, gradually tapered corticosteroid therapy [2]. Low-dose GCs may be used as maintenance therapy in combination with an immunosuppressant; however, there is no clear evidence to establish the optimal duration of such treatment. GC discontinuation appears to be associated with a higher risk of disease exacerbation. According to expert opinion [1], therapeutic decisions should therefore be individualized and based on an assessment of disease activity and relapse tendency. In selected cases, topical GCs may also be employed. Intranasal preparations may be beneficial in patients with active lesions in the paranasal sinuses. However, individuals with long-standing, fibrotic subglottic or endobronchial stenoses unresponsive to standard therapy may require local GC injections administered during endoscopic intervention [2].

For mild eosinophilic granulomatosis with polyangiitis (EGPA), and in the absence of additional risk factors, GC monotherapy [1] or in combination with a disease-modifying drug [2] is sufficient. When selecting the appropriate therapeutic approach, it is recommended to use the Five-Factor Score, which incorporates predictors of poor prognosis, including age >65 years; cardiac, gastrointestinal, or renal involvement, as well as the absence of nasal, aural, or pharyngeal lesions. The induction phase includes prednisolone at 1 mg/kg/day for 2–3 weeks. As in other AAVs, intravenous methylprednisolone at 7.5–15 mg/kg/day may be considered [3]. However, due to the lack of evidence for the superiority of intravenous (IV) therapy over intensive oral therapy, methylprednisolone pulses should be reserved solely for life-threatening situations [2, 3]. The optimal GC tapering regimen has not yet been established due to limited clinical evidence. Proposed protocols suggest gradual dose reduction to 0.3 mg/kg/day after 3 months and to 0.15 mg/kg/day after 6 months, until discontinuation or achievement of the minimum effective dose [3]. Therapeutic recommendations largely follow the regimens and procedures used in GPA and MPA. Accordingly, topical GCs may be considered in patients

**Table.** Glucocorticoid dose reduction in ANCA-associated drivers. Based on: Hellmich et al. [1]

Week	Daily prednisone dose (mg)		
	<50 kg	50–75 kg	>75 kg
1	50	60	75
2	25	30	40
3–4	20	25	30
5–6	15	20	25
7–8	12,5	15	20
9–10	10	12,5	15
11–12	7,5	10	12,5
13–14	6	7,5	10
15–18	5	5	7,5
19–52	5	5	5
>52	Dose adjusted to the patient's current health status		

with EGPA and paranasal sinus involvement. The duration of therapy should be individualized based on the patient clinical status. According to some authors, the maintenance dose of prednisolone should not exceed 7.5 mg/day, provided that remission can be sustained at this level [3]. The use of mepolizumab (a monoclonal antibody targeting interleukin-5) as a steroid-sparing agent is recommended in relapsed or refractory EGPA with a non-life-threatening course or with organ involvement, such as persistent GC-related bronchial asthma [1].

GCs are the cornerstone of treatment for giant cell arteritis (GCA), producing significant clinical improvement within a few days (often as early as 2–3 days) after treatment onset. Prompt initiation of therapy markedly reduces the risk of permanent vision loss, which underscores the importance of starting treatment even before the diagnostic workup is fully completed. The induction phase involves prednisone at a daily dose of 40–60 mg [4] or 1 mg/kg (up to a maximum of 80 mg) [5], and, according to some authors, even up to 100 mg. This regimen should be maintained until normalization of clinical and laboratory parameters, typically over 2–4 weeks [6]. In cases of milder GCA, therapy with medium-dose GCs (0.5 mg/kg/day of prednisone) may be considered [5]. Sudden visual deterioration, blindness, or neurological complications are indications for intravenous pulses of methylprednisolone at 0.25–1 g/day for up to 3 days [4]. The use of additional immunosuppressants, such as tocilizumab or methotrexate, may help reduce the cumulative GC exposure, particularly in refractory or relapsing disease. Once disease is controlled, the prednisone dose should be gradually tapered. The target dose is 15–20 mg/day within 2–3 months, followed by  $\leq 5$  mg/day after one year [4]. At each stage, the patient's current clinical status should be reassessed, and caution is warranted if relapse risk factors are present, also when considering more rapid tapering protocols. Alternating therapy, in which the drug is dosed every other day, increases the risk of relapse and is therefore not recommended [5]. Expert experience indicates that maintenance therapy in GCA is most often continued for approximately 2 years [4], although it may extend longer (even beyond 5 years) in some patients [6]. Relapses may occur in up to 75% of patients and most commonly arise when prednisone is tapered below 20 mg/day [6]. In cases of severe exacerbation, an increase in GC dose is recommended, following the approach used for newly diagnosed disease. In milder cases, it is possible to resume the last effective dose or to increase the dose by 5–15 mg [4]. In patients with active disease who require vascular surgery, high-dose corticosteroids are recommended during the perioperative period [5].

The management of Takayasu's disease is similar to the approach described above for GCA. Treatment should be initiated as early as possible, as prompt therapy improves efficacy and reduces the risk of vascular complications. According to the recommendations of the European Alliance of Associations for Rheumatology (EULAR) [4], all patients with Takayasu's disease should receive conventional disease-modifying antirheumatic drugs (DMARDs) in addition to corticosteroids. In selected cases, tocilizumab or tumour necrosis factor inhibitors (TNFis) may also be used, as they help stop the progression of arterial lesions and allow for limited corticosteroid use. Mono-

therapy should be reserved only for mild or diagnostically uncertain cases [5]. The initial phase requires high daily doses of corticosteroids (40–60 mg) [4] or 1 mg/kg (up to a maximum of 80 mg) of prednisone [5]. Disease control is typically achieved after 2–4 weeks, allowing for the initiation of gradual tapering [7]. The goal is to reach a daily prednisone dose of 15–20 mg within 2–3 months and  $\leq 10$  mg within one year [4]. Lower doses of prednisone (25–30 mg/day) may be considered in patients with mild, localized disease without organ involvement or limb ischemia [4]. The routine use of intravenous methylprednisolone pulses is not recommended and should be reserved for the most severe cases associated with a high risk of complications [5]. The duration of treatment should be individually tailored. Gradual discontinuation should be attempted in patients who have achieved remission after 6–12 months of GC therapy [5]. Early or rapid tapering may be associated with an increased risk of exacerbation, which, as in GCA, rises at GC doses below 20 mg/day [7]. Management depends on the severity of the relapse: prednisone is increased to the initial dose of 40–60 mg/day in severe cases; the last effective dose is resumed, optionally increased by 5–15 mg, in milder cases [4]. Asymptomatic radiological progression should not prompt treatment modification. Escalation of immunosuppressive therapy is recommended in patients with significant arterial stenoses. If surgery is necessary, high doses of oral corticosteroids should be implemented in the perioperative period [5].

The choice of treatment for leukocytoclastic vasculitis (LCV) depends on its aetiology and stage of progression. Systemic corticosteroids are used relatively infrequently; however, prednisone at 0.5–1 mg/kg/day may be administered in cases presenting with haemorrhagic blisters, necrosis, or refractory or recurrent disease [8]. As the lesions resolve, corticosteroids should be gradually tapered, and the overall duration of therapy is typically short (approximately one week). Nevertheless, some authors recommend a longer treatment period of 3–6 weeks, including gradual tapering [9]. Long-term therapy is generally unnecessary and should be avoided, particularly in limited disease. It is also noteworthy that there is no evidence supporting the efficacy of topical corticosteroids [8]. Management of secondary inflammation should target the underlying cause. Exacerbations occurring in the course of systemic connective tissue diseases or other autoimmune disorders require treatment intensification and, in some cases, management similar to that used in the primary form. Cutaneous cases resistant to corticosteroids, as well as those associated with systemic vasculitis, necessitate the use of additional immunosuppressants. According to Micheletti et al., such therapy should be gradually discontinued after 3–6 months of maintained remission [9].

As with other types of vasculitis, corticosteroids remain the cornerstone of treatment for polyarteritis nodosa (PAN). The use of the Five-Factor Score is recommended to guide therapeutic decision-making. In mild cutaneous forms, management is often symptomatic and includes nonsteroidal anti-inflammatory drugs (NSAIDs) or colchicine in combination with topical corticosteroids. More severe cases may require oral prednisone at 0.5–1 mg/kg/day [10].

According to the recommendations of the American College of Rheumatology (ACR), treatment of active, severe inflammation begins with intravenous pulses of methylprednisolone at 0.5–1 g or 30 mg/kg/day, administered for 3–5 days [11]. Other authors also permit the use of lower doses, typically 7.5–15 mg/kg/day for 1–3 days [10]. Parenteral administration should be reserved for life-threatening situations, such as a high risk of visceral infarction. In all other cases, oral prednisone is preferred at a dose of 1 mg/kg/day, up to a maximum of 80 mg/day [11]. After a short initial period, typically three weeks, gradual tapering should be initiated. French experts recommend tapering to 20 mg/day after 3 months, 10 mg/day after 6 months, and 5 mg/day after one year of therapy [10]. The overall duration of PAN treatment has not been precisely defined; the proposed regimen encompasses a duration of 18–24 months [10]. It is worth noting that the use of an additional immunosuppressant, such as cyclophosphamide, methotrexate, azathioprine, or mycophenolate mofetil, is included in the recommendations [11] and allows for reduced GC exposure. For HBV-associated PAN, GCs should be used only initially, at a dose of 0.5–1 mg/kg/day, for a short period of approximately 15 days [10]. Intravenous pulse therapy (above-mentioned regimen) may be considered in severe cases. However, the risk of viral reactivation and increased replication associated with corticosteroid use in patients with chronic hepatitis B should be carefully considered.

The proposed treatment approach for Henoch–Schönlein purpura is largely based on studies conducted in the paediatric population, the findings of which have been extrapolated to adults. Most patients require only symptomatic management, particularly in cases confined to the skin or joints. However, corticosteroid therapy may allow for a more rapid resolution of abdominal and joint pain. According to some authors, it may also reduce the risk of persistent kidney disease, recurrence, or the need for surgical intervention [12]. However, it appears that such an approach, particularly when aimed at preventing nephropathy, should not be implemented routinely [12, 13]. According to the European consensus, GC therapy should be reserved for cases that pose a serious threat to health or life, including testicular, pulmonary, gastrointestinal, or neural involvement [13]. In such cases, treatment should be initiated with oral prednisone at 1–2 mg/kg/day continued for 7–14 days, followed by gradual tapering and complete discontinuation within the subsequent 2 weeks. In severe cases, intravenous pulses of methylprednisolone at 10–30 mg/kg/day (up to a maximum of 1 g) for 3 consecutive days should be considered, as this approach improves therapeutic efficacy in this patient group. In patients with nephritis, corticosteroids are the first-line treatment, and the intensity of therapy is determined by biopsy histopathology [13]. In milder cases, oral corticosteroids are preferred, whereas severe cases require intravenous administration and other immunosuppressants. The Pozzi–Locatelli regimen is commonly employed. It consists of two components: the patient receives 1 g of IV methylprednisolone for three consecutive days at the beginning of months 1, 3, and 5, plus oral prednisone 0.5 mg/kg on alternate days. Therapy is typically continued for six months [12].

To date, no formal recommendations have been developed for cryoglobulinemic vasculitis; therefore, the man-

agement of this condition is based on clinical experience. Although immunosuppressive therapy is typically not needed in cases of mild localized disease, low-dose corticosteroids may improve symptom control in the presence of concomitant arthritis. Corticosteroids combined with rituximab should be used primarily in patients with moderate to severe vasculitis [14]. Severe cases, particularly those with progressive organ damage, including nephritis, may require intravenous pulses of methylprednisolone followed by continued oral prednisone [14]. As the clinical condition improves, the dose should be gradually reduced over the shortest possible time until discontinuation or the lowest tolerated dose is achieved [15]. Relapse necessitates immediate therapy intensification. In cases of secondary cryoglobulinemia, treatment of the underlying disease is essential; however, patients with severe vasculitis may require prompt initiation of corticosteroids. Intravenous pulses should also be considered in these patient, as described above [15].

The management of Behçet's disease (BD) depends on the severity, location, and duration of lesions, and is based on corticosteroids. Topical agents are used for oral and genital ulcers, promoting faster healing of mucocutaneous lesions and reducing pain. Corticosteroid eye drops may be beneficial in isolated anterior uveitis [16]. Ocular, vascular, gastrointestinal, or CNS involvement necessitates systemic therapy. Treatment typically begins with intravenous pulses of 1 g methylprednisolone for 3 consecutive days in cases of gastrointestinal involvement and for up to 7 days in CNS disease. This is followed by short-term oral prednisolone at 1 mg/kg/day (approximately 1–2 weeks for gastrointestinal and about one month for CNS involvement) [16, 17]. The dose is usually reduced with clinical improvement. A reduction of 5 mg per week is suggested in gastrointestinal involvement, whereas a reduction of 5–10 mg every 10–15 days is recommended in CNS disease [16, 17]. In most cases, another immunosuppressant is added to reduce the risk of relapse. As pointed out by some authors, it should be emphasized that maintenance GC therapy is considered inappropriate and should be avoided [17]. Some specific clinical situations require modification of this regimen. In cases of joint involvement, when symptomatic treatment is insufficient, a low dose of corticosteroids may be considered. If the disease is limited to a single joint, intra-articular corticosteroid injections may be an appropriate option. Local intravitreal administration is recommended as an adjunct to systemic therapy in exacerbations of posterior uveitis [16]. When peripheral arterial aneurysms are diagnosed, combined pharmacotherapy should be initiated prior to any surgical intervention; this approach may be sufficient, particularly in small, low-risk lesions [16].

GC dosing regimens proposed for the treatment of retroperitoneal fibrosis are derived primarily from retrospective studies and small-scale clinical trials, where GCs are used to limit the extent of retroperitoneal involvement within the first weeks of therapy, ultimately leading to symptom reduction. The clinical decision to implement a given therapeutic model should take into account the nature of the disease process (primary or secondary), as well as its location, stage, and aggressiveness. First-line treatment consists of GCs. The regimen proposed by Vaglio et al. (2011) may serve as a framework for therapeutic man-

agement. It includes the following daily prednisone doses: 1 mg/kg (up to a maximum of 80 mg) during the first month, 0.5 mg/kg during the second month, and 0.25 mg/kg during the third and fourth months. Subsequently, a gradual taper over the following five months should lead to a maintenance dose of 5 mg/day [18]. Detailed treatment protocols developed by individual centers, such as the regimen presented in Figure 1A and based on the experience of Japanese clinicians [19], also offer valuable guidance. It should be emphasized that a weaker-than-expected therapeutic response always warrants the exclusion of secondary lesions. Despite the high overall remission rate (75–95%), low-dose GC maintenance therapy may be needed; however, the optimal duration of such treatment has not yet been clearly established. Similarly, clear recommendations for the management of relapse are lacking. Japanese authors propose GC therapy according to the protocols presented in Figures 1B (for patients experiencing exacerbation after treatment discontinuation) and 1C (for those continuing corticosteroids) [19]. In refractory cases, combined therapy with corticosteroids and an additional immunosuppressant, such as mycophenolate mofetil, appears to be beneficial.

### GCs in the treatment of other rheumatic diseases

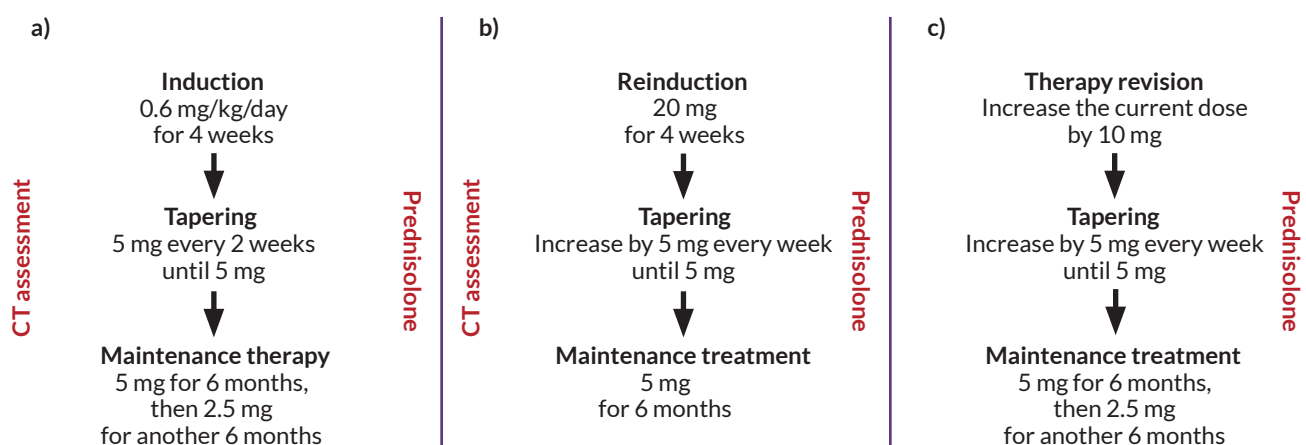
In osteoarthritis, GCs are used when symptoms are severe and when NSAIDs are either contraindicated or fail to provide adequate relief. Intra-articular injection is the recommended route of administration. Scientific societies, including the ACR (2019) [20] and EULAR (2018) [21], strongly support this approach in cases involving knee or hip joints. However, injections into the hand joints are not recommended unless severe pain in the interphalangeal joints is present. At least 3–4 weeks should elapse between subsequent injections, and the total number of injections should not exceed four per year [22]. In this context, the potential destructive effect of GC injections on joint cartilage remains an important consideration. The reported phenomenon of cartilage thinning is of uncertain clinical significance, as it has not been associated with functional deterioration or increased pain in the affected joint [23].

After the onset of erythema nodosum, NSAIDs should be used as first-line therapy; however, if they prove in-

effective or symptoms are severe, corticosteroids may also be included. To date, no clear recommendations for treatment duration or intensity have been established. In clinical practice, the dose ranges from a few milligrams to up to 40–60 mg of oral prednisone daily [24]. Systemic effects may be minimized with triamcinolone injections at 5 mg/mL [24] or by applying potent topical corticosteroids under wet wraps around particularly painful nodules. Panniculitis may develop in the course of pancreatic disorders, infections, dermatomyositis (DM), systemic lupus erythematosus, and other conditions; in such cases, prompt diagnosis of the underlying disease and initiation of causal therapy are essential. If severe panniculitis occurs in a patient with DM, systemic corticosteroids are used; however, it is important to first exclude an underlying malignancy. Local corticosteroid injections into the affected areas may also be considered [25]. Notably, corticosteroid injections themselves may induce panniculitis, a reaction thought to be triggered by carrier substances contained in pre-mixed formulations [25].

GCs play a key therapeutic role in acute gout attacks, particularly in patients intolerant to NSAIDs or colchicine. In such cases, oral therapy is preferred, typically for 3–5 days, using a daily dose equivalent to 30–35 mg of prednisone [26]. When the inflammatory process is limited to only a few joints, intra-articular corticosteroid injections may be used as an alternative to systemic treatment. It should be emphasized that the 2016 EULAR recommendations advise considering combined first-line therapy with colchicine and GCs [26]. The choice of a specific regimen should always be individualized, taking into account contraindications, disease duration, the anatomical location of the affected joints, as well as the severity of symptoms. A similar therapeutic approach, based primarily on intra-articular GC injections, and, in more challenging cases, also incorporating systemic therapy, is used in disorders associated with the deposition of calcium pyrophosphate crystals in soft tissues and joint cartilage, commonly referred to as pseudogout.

GCs are the cornerstone of IgG4-RD therapy. Contemporary therapeutic regimens rely on administering an initial dose sufficient to induce remission, followed by a gradual taper. These protocols vary primarily in the recommended intervals and dosing ranges. According to



**Figure 1.** The use of GCs in retroperitoneal fibrosis. Based on Tanaka and Masumori [19]

a 2015 statement by an international panel of experts, initiating therapy with prednisone at 40 mg/day offers no clear benefit over a starting dose of 30 mg/day [27]. The initial dose should be maintained for the first 2–4 weeks of therapy and subsequently tapered by 10 mg every two weeks until a dose of 20 mg is reached. After maintaining this dose for two weeks, further reductions of 5 mg every two weeks are recommended. The therapeutic goal is GC discontinuation, if feasible, within 3–6 months. However, some authors advocate continuing low-dose GC therapy for up to 3 years [27]. Valuable guidance may be drawn from the experience of Japanese investigators, as illustrated in Figure 2 [28]. After treatment initiation, the patient's condition should be closely monitored and the therapeutic response carefully assessed. Delayed or unsatisfactory improvement should prompt another diagnostic evaluation to confirm the initial diagnosis. The literature also indicates that more rapid tapering and early treatment discontinuation are associated with an increased risk of disease exacerbation.

In Cogan syndrome, the primary therapeutic goal is to prevent hearing loss, vestibular dysfunction, and ocular or systemic complications associated with active vasculitis. Unfortunately, GCs have only limited efficacy in treating inner ear involvement. Nevertheless, when initiated within the first two weeks after the onset of auditory symptoms, they can reduce the risk of permanent hearing impairment [29]. Treatment includes subconjunctival and systemic corticosteroids. In severe cases, prompt initiation of systemic prednisolone at a dose of 1–2 mg/kg/day is essential. If clinical improvement occurs, the corticosteroid dose should be gradually tapered over 2–6 months, depending on the patient's condition [30].

Susac syndrome can lead to irreversible complications, including hearing and vision loss. Early initiation of immunosuppressive therapy is therefore crucial and significantly improves prognosis. The recommended regimen includes intravenous methylprednisolone at 1 g/day for 3–7 days, followed by oral prednisone at 60–80 mg/day for 2–4 weeks. After this period, the dose should be reduced by 10% every two weeks until a maintenance dose of 20 mg/day is reached. Subsequently, tapering cycles are extended to 4 weeks until a maintenance dose of 5 mg/day is achieved [31]. More rapid tapering may be used in patients with mild disease. In the event of relapse, IV methylprednisolone for 3 days or oral prednisone 60 mg/day should be administered, followed by the previously described tapering regimen as clinical improvement occurs [31]. Intratympanic corticosteroid injections

may also be considered; however, evidence supporting their efficacy in Susac syndrome remains limited.

For relapsing polychondritis, corticosteroids are indicated in patients with rapid symptom onset, severe disease, organ or systemic involvement, and vasculitis. They may also be used in mild cases when first-line therapies, such as NSAIDs, are not tolerated. The dose of prednisone depends on the severity of symptoms and typically ranges from 0.25–1 mg/kg/day, followed by a gradual taper as clinical improvement occurs. In severe cases, a several-day course of IV methylprednisolone at 0.5–1 g/day, followed by continued prednisone therapy, may be considered [32]. Local administration of infiltrative corticosteroids may also be used in cases of laryngeal, tracheal, or bronchial involvement. Once the acute phase of the disease is controlled, GCs should be gradually tapered. The duration and rate of tapering depend on the severity of the disease and the response to treatment. In some cases, complete discontinuation of corticosteroids is achievable. However, long-term maintenance therapy is often required to sustain remission. In such cases, the addition of other immunosuppressants should be considered.

Soft tissue rheumatism is a collective term for disorders affecting the soft tissues around joints, including conditions like tendinopathies, enthesopathies, periarthropathies, tenosynovitis, bursitis, and fibromyalgia. With the exception of fibromyalgia, these conditions share similar therapeutic strategies. GCs are most commonly used when physiotherapy and NSAIDs fail to provide adequate symptom control. In such cases, they are administered as local injections directly into the most affected areas, often combined with lidocaine [33]. Bursal injections should be preceded by evacuation of the inflammatory fluid. In patients with active autoimmune disease, such as rheumatoid arthritis (RA), episodes of superficial bursitis require not only aspiration and possible corticosteroid injection, but also intensification of therapy for the underlying condition. According to some reports, pain reduction and functional improvement following corticosteroid injections for tendinopathy are only temporary [34]. In the long run, such therapy may impair tissue healing and contribute to further progression of the disease.

The lack of evidence supporting the efficacy of GCs in fibromyalgia, together with their substantial risk of adverse effects, is reflected in the 2016 EULAR recommendations, which do not endorse their use in this group of patients [35]. Although the potential utility of GCs and

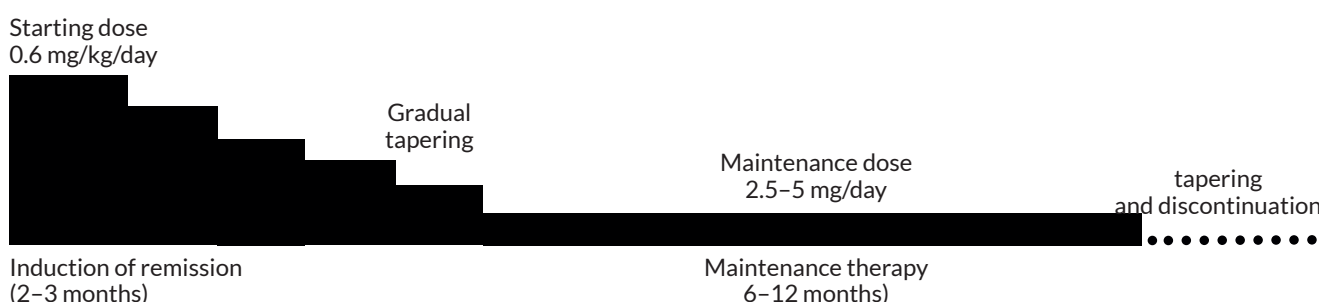


Figure 2. GC tapering in IgG4-related disease. Based on Kamisawa, et al. [28]

lidocaine injections into trigger points was suggested in the past, no evidence has confirmed the efficacy of this approach.

GCs are used in the treatment of the vast majority of rheumatic diseases. Their efficacy is well established; however, emerging research prompts further improvements in therapeutic regimens. As with any therapy, the primary goal is to achieve optimal clinical outcomes while minimizing the risk of adverse effects.

The efficacy of GCs strongly depends on the appropriate selection of the initial dose, the rate of dose tapering, and the overall duration of therapy. Similarly, the risk of complications is largely determined by treatment length and cumulative exposure. Adequate monitoring should substantially reduce the risk of adverse effects. This issue is frequently emphasized in clinical recommendations, particularly for conditions requiring long-term GC use. The use of appropriate preventive strategies, together with adequate patient education, has become an essential component of GC therapy and should be considered whenever treatment is initiated. For preventing complications, the concurrent use of immunosuppressants is particularly important as it helps sustain the therapeutic effect of GCs while enabling their more rapid discontinuation.

Despite their broad spectrum of adverse effects, the widespread use of GCs remains justified by the absence of alternative therapies with comparable properties. Their key benefits include a rapid onset of therapeutic action and the ability to titrate the dose across a wide range tailored to disease activity and the patient's clinical status. For these reasons, glucocorticoids still play a pivotal role in the management of acute and life-threatening conditions, both within and beyond rheumatology.

It seems that the importance of GC therapy in rheumatic diseases will not diminish in the near future. Ensuring treatment safety and preventing adverse effects therefore remain key priorities. These objectives can be achieved through the use of GCs in accordance with current medical evidence and published recommendations.

## References

- Hellmich B, Sanchez-Alamo B, Schirmer JH, et al. EULAR recommendations for the management of ANCA-associated vasculitis: 2022 update. *Ann Rheum Dis*, 2024; 83: 30–47. doi: 10.1136/ard-2022-223764
- Chung SA, Langford CA, Maz M, et al. 2021 American College of Rheumatology/Vasculitis Foundation Guideline for the Management of Antineutrophil Cytoplasmic Antibody-Associated Vasculitis. *Arthritis Rheumatol*, 2021; 73: 1366–1383. doi: 10.1002/art.41773
- White J, Dubey S. Eosinophilic granulomatosis with polyangiitis: A review. *Autoimmun Rev*, 2023; 22: 103219. doi: 10.1016/j.autrev.2022.103219
- Hellmich B, Agueda A, Monti S, et al. 2018 Update of the EULAR recommendations for the management of large vessel vasculitis. *Ann Rheum Dis*, 2020; 79: 19–30. doi: 10.1136/annrheumdis-2019-215672
- Maz M, Chung SA, Abril A, et al. 2021 American College of Rheumatology/Vasculitis Foundation Guideline for the Management of Giant Cell Arteritis and Takayasu Arteritis. *Arthritis Rheumatol*, 2021; 73: 1349–1365. doi: 10.1002/art.41774
- Ling ML, Yosar J, Lee BW, et al. The diagnosis and management of temporal arteritis. *Clin Exp Optom*, 2020; 103: 572–582. doi: 10.1111/cxo.12975
- Pugh D, Karabayas M, Basu N, et al. Large-vessel vasculitis. *Nat Rev Dis Primers*, 2022; 7: 93. doi: 10.1038/s41572-021-00327-5
- Sunderkötter C, Bonsmann G, Sindrilaru A, Luger T. Management of leukocytoclastic vasculitis. *J Dermatolog Treat*, 2005; 16: 193–206. doi: 10.1080/09546630500277971
- Micheletti RG, Pagnoux C. Management of cutaneous vasculitis. *Presse Med*, 2020; 49: 104033. doi:10.1016/j.lpm.2020.104033
- Terrier B, Darbon R, Durel CA, et al.; Collaborators. French recommendations for the management of systemic necrotizing vasculitides (polyarteritis nodosa and ANCA-associated vasculitides). *Orphanet J Rare Dis*, 2020; 15(Suppl 2): 351. doi: 10.1186/s13023-020-01621-3. Erratum in: *Orphanet J Rare Dis*, 2021; 16: 155. doi: 10.1186/s13023-021-01787-4
- Chung SA, Gorelik M, Langford CA, et al. 2021 American College of Rheumatology/Vasculitis Foundation Guideline for the Management of Polyarteritis Nodosa. *Arthritis Care Res (Hoboken)*, 2021; 73: 1061–1070. doi: 10.1002/acr.24633
- Maritati F, Canzian A, Fenaroli P, Vaglio A. Adult-onset IgA vasculitis (Henoch-Schönlein): Update on therapy. *Presse Med*, 2020; 49: 104035. doi: 10.1016/j.lpm.2020.104035
- Ozen S, Marks SD, Brogan P, et al. European consensus-based recommendations for diagnosis and treatment of immunoglobulin A vasculitis-the SHARE initiative. *Rheumatology (Oxford)*, 2019; 58: 1607–1616. doi: 10.1093/rheumatology/kez041
- Nelveg-Kristensen KE, Paterson A, Willcocks LC. Cryoglobulinaemic vasculitis diagnostic and treatment recommendations. *Rheumatology (Oxford)*, 2021; 60(Suppl 3): iii39–iii42. doi: 10.1093/rheumatology/keab121
- Roccatello D, Saadoun D, Ramos-Casals M, et al. Cryoglobulinaemia. *Nat Rev Dis Primers*, 2018; 4: 11. doi: 10.1038/s41572-018-0009-4
- Hatemi G, Christensen R, Bang D, et al. 2018 update of the EULAR recommendations for the management of Behçet's syndrome. *Ann Rheum Dis*, 2018; 77: 808–818. doi: 10.1136/annrheumdis-2018-213225
- Skef W, Hamilton MJ, Arayssi T. Gastrointestinal Behçet's disease: a review. *World J Gastroenterol*, 2015; 21: 3801–3812. doi: 10.3748/wjg.v21.i13.3801
- Vaglio A, Palmisano A, Alberici F, et al. Prednisone versus tamoxifen in patients with idiopathic retroperitoneal fibrosis: an open-label randomised controlled trial. *Lancet*, 2011; 378: 338–346. doi: 10.1016/S0140-6736(11)60934-3
- Tanaka T, Masumori N. Current approach to diagnosis and management of retroperitoneal fibrosis. *Int J Urol*, 2020; 27: 387–394. doi: 10.1111/iju.14218
- Kolasinski SL, Neogi T, Hochberg MC, et al. 2019 American College of Rheumatology/Arthritis Foundation Guideline for the Management of Osteoarthritis of the Hand, Hip, and Knee. *Arthritis Care Res (Hoboken)*, 2020; 72: 149–162. doi: 10.1002/acr.24131. Erratum in: *Arthritis Care Res (Hoboken)*, 2021; 73: 764. doi: 10.1002/acr.24615

21. Kloppenburg M, Kroon FP, Blanco FJ, et al. 2018 update of the EULAR recommendations for the management of hand osteoarthritis. *Ann Rheum Dis*, 2019; 78: 16–24. doi: 10.1136/annrheumdis-2018-213826
22. Guermazi A, Hunter DJ, Kloppenburg M. Debate: Intra-articular steroid injections for osteoarthritis – harmful or helpful? *Osteoarthr Imaging*, 2023; 3: 100163. doi: 10.1016/j.ostima.2023.100163
23. McAlindon TE, LaValley MP, Harvey WF, et al. Effect of intra-articular triamcinolone vs saline on knee cartilage volume and pain in patients with knee osteoarthritis: a randomized clinical trial. *JAMA*, 2017; 317: 1967–1975. doi: 10.1001/jama.2017.5283
24. Pérez-Garza DM, Chavez-Alvarez S, Ocampo-Candiani J, Gomez-Flores M. Erythema nodosum: a practical approach and diagnostic algorithm. *Am J Clin Dermatol*, 2021; 22: 367–378. doi: 10.1007/s40257-021-00592-w
25. Wick MR. Panniculitis: A summary. *Semin Diagn Pathol*, 2017; 34: 261–272. doi: 10.1053/j.semdp.2016.12.004
26. Richette P, Doherty M, Pascual E, et al. 2016 updated EULAR evidence-based recommendations for the management of gout. *Ann Rheum Dis*, 2017; 76: 29–42. doi: 10.1136/annrheumdis-2016-209707
27. Khosroshahi A, Wallace ZS, Crowe JL, et al. International Consensus Guidance Statement on the Management and Treatment of IgG4-Related Disease. *Arthritis Rheumatol*, 2015; 67: 1688–1699. doi: 10.1002/art.39132
28. Kamisawa T, Okazaki K, Kawa S, et al. Amendment of the Japanese Consensus Guidelines for Autoimmune Pancreatitis, 2013 III. Treatment and prognosis of autoimmune pancreatitis. *J Gastroenterol*, 2014; 49: 961–970. doi: 10.1007/s00535-014-0945-z
29. Espinoza GM, Wheeler J, Temprano KK, Keller AP. Cogan's syndrome: clinical presentations and update on treatment. *Curr Allergy Asthma Rep*, 2020; 20: 46. doi: 10.1007/s11882-020-00945-1
30. Iliescu DA, Timaru CM, Batras M, et al. Cogan's syndrome. *Rom J Ophthalmol*, 2015; 59: 6–13
31. Marrodan M, Fiol MP, Correale J. Susac syndrome: challenges in the diagnosis and treatment. *Brain*, 2022; 145: 858–871. doi: 10.1093/brain/awab476
32. Mathian A, Miyara M, Cohen-Aubart F, et al. Relapsing polychondritis: A 2016 update on clinical features, diagnostic tools, treatment and biological drug use. *Best Pract Res Clin Rheumatol*, 2016; 30: 316–333. doi: 10.1016/j.berh.2016.08.001
33. Jeka S, Dura M. Soft tissue rheumatism. *Reumatologia/Rheumatology Supplements*, 2016: 114–123. doi: 10.5114/reum.2016.60013
34. Millar NL, Silbernagel KG, Thorborg K, et al. Tendinopathy. *Nat Rev Dis Primers*, 2021; 7: 1. doi: 10.1038/s41572-020-00234-1. Erratum in: *Nat Rev Dis Primers*, 2021; 7: 10. doi: 10.1038/s41572-021-00251-8
35. Macfarlane GJ, Kronisch C, Dean LE, et al. EULAR revised recommendations for the management of fibromyalgia. *Ann Rheum Dis*, 2017; 76: 318–328. doi: 10.1136/annrheumdis-2016-209724



# ASSESSMENT OF THE PREVALENCE OF CARDIOVASCULAR RISK FACTORS AND ASSOCIATED HEALTH THREATS AMONG SOLDIERS OF NATO MEMBER STATES

Ocena rozpowszechnienia czynników ryzyka sercowo-naczyniowego i związanych z nimi zagrożeń zdrowotnych wśród żołnierzy państw Sojuszu Północnoatlantyckiego



Bartłomiej Marek Gawron, Grzegorz Gielerak

Military Institute of Medicine – National Research Institute, Department of Cardiology and Internal Medicine, Poland

Bartłomiej Marek Gawron –  0009-0004-6080-4462

Grzegorz Gielerak –  0000-0002-6239-7918

## Abstract

Cardiovascular diseases pose a significant health threat also to professional soldiers, who theoretically should present with better health due to rigorous medical requirements and lifestyle. In reality, the rates of overweight, hypertension, and lipid disorders among military personnel of NATO member states are alarmingly high, which may negatively impact their combat capability and operational readiness. The aim of this paper was to assess the prevalence of classical cardiovascular risk factors among NATO soldiers and to analyze their potential impact on health and operational performance. The literature review included original papers published in the PubMed database between 2019 and 2024. Based on the selection criteria, only studies evaluating classical cardiovascular risk factors such as overweight, obesity, hypertension, hyperlipidemia, and smoking, in active-duty NATO soldiers were considered. The data were subjected to a comparative analysis across different armed forces of NATO member states. The review findings indicate a high prevalence of cardiovascular risk factors among NATO soldiers, with significant differences between individual countries. The results highlight the need for modern preventive strategies to minimize cardiovascular risk in the NATO military population.

## Streszczenie

Choroby układu sercowo-naczyniowego stanowią istotne zagrożenie zdrowotne nawet dla żołnierzy zawodowych, którzy teoretycznie powinni cechować się lepszym stanem zdrowia dzięki rygorystycznym wymogom medycznym i trybowi życia. W rzeczywistości jednak wskaźniki nadwagi, nadciśnienia i zaburzeń lipidowych wśród personelu wojskowego państw NATO są alarmująco wysokie, co może negatywnie wpływać na zdolność bojową i gotowość operacyjną. Celem niniejszego artykułu jest ocena rozpowszechnienia klasycznych czynników ryzyka sercowo-naczyniowego wśród żołnierzy NATO oraz analiza ich potencjalnego wpływu na zdrowie i wydajność operacyjną. Przegląd literatury obejmował analizę badań oryginalnych opublikowanych w bazie PubMed w latach 2019–2024. Selekcji dokonano na podstawie kryteriów obejmujących wyłącznie badania dotyczące czynnych żołnierzy NATO, oceniające klasyczne czynniki ryzyka sercowo-naczyniowego, takie jak nadwaga, otyłość, nadciśnienie tętnicze, hiperlipidemia i palenie tytoniu. Dane poddano analizie porównawczej między różnymi armiami państw członkowskich Sojuszu. Wyniki przeglądu wskazują na wysoką częstość występowania czynników ryzyka sercowo-naczyniowego wśród żołnierzy NATO, z istotnymi różnicami między poszczególnymi krajami, oraz na konieczność wdrożenia nowoczesnych strategii profilaktycznych w celu minimalizacji ryzyka sercowo-naczyniowego w tej populacji.

**Keywords:** cardiovascular diseases (CVD); health prevention; CVD risk factors; soldiers' health; NATO forces

**Słowa kluczowe:** choroby sercowo-naczyniowe (CVD); profilaktyka zdrowotna; czynniki ryzyka CVD; zdrowie żołnierzy; wojsko NATO

DOI 10.53301/lw/203553

Received: 17.02.2025

Accepted: 31.03.2025

Published: 30.12.2025

## Corresponding author:

Bartłomiej Marek Gawron  
Military Institute of Medicine – National  
Research Institute, Department of Cardiology  
and Internal Medicine,  
128 Szaserów Str., 04-141 Warsaw, Poland  
e-mail: bgawron@wim.mil.pl

## Introduction

Cardiovascular diseases (CVDs) pose a significant challenge also in individuals undergoing rigorous health screening, such as professional soldiers. Paradoxically, despite mandatory regular medical check-ups, military personnel exhibit a disturbingly high prevalence of classical CVD risk factors. Similarly unexpected findings have been obtained for various military forces around the world. Only in Poland, 58% of soldiers > 50 years of age are overweight, and 45% have hypertension (HT), with up to 60% presenting with abnormal LDL cholesterol levels [1]. Similar trends are observed globally: the proportion of U.S. soldiers with optimal blood pressure (30%) is nearly half that of the civilian population (55%) [2].

These statistics are particularly relevant in the context of the specific conditions of military service. Stress, which is responsible for a 63% increase in the soldiers' risk of CVDs, is associated with an irregular lifestyle. Indeed, up to 33% of Polish soldiers over 40 years report a sedentary lifestyle. Furthermore, cultural and organizational factors, such as a diet high in saturated fats and easy access to stimulants, give rise to a unique combination of health risks.

International comparisons indicate that Polish soldiers occupy a middle-of-the-pack position, with obesity and HT rates comparable to those observed in the United States, but significantly lower than those reported in developing countries. However, this relative optimism is tempered by a troubling trend of changes. Between 2007 and 2014, the number of CVD cases increased by 38% among U.S. soldiers, indicating that conventional prevention models are becoming ineffective against contemporary health threats. It is worth emphasizing that a modern military relies on highly trained specialists, whose preparation for service requires substantial investment of time and resources. Maintaining their full operational capacity constitutes a major challenge. Therefore, preventive measures are justified not only from a medical standpoint but also from the point of view of efficient resource utilization, which directly impacts the effectiveness and combat readiness of the armed forces. The aim of this paper was not only to enhance understanding of CVD epidemiology in NATO military populations, but also to provide a basis for revising the criteria for assessing combat capability in the context of long-term health risks. Combining an epidemiological perspective with an analysis of the specific conditions of military service may help develop innovative CVD prevention strategies tailored to the dynamically evolving requirements of modern armed forces. These actions are not only fully justified, but also play a key role in maintaining high combat efficiency and constitute a long-term investment in the health of military personnel of NATO countries.

## Methods

This literature review included papers selected from the PubMed database using the following criteria: publications dated 2019 or later, original papers on active-duty soldiers from NATO countries, and studies

addressing classical CVD risk factors. Our approach allowed for collecting up-to-date and reliable data for investigating issues related to CVD prevention in the population of interest.

The methods we employed allowed us for collecting relevant information on the cardiovascular health among military personnel. PubMed was selected as the primary data source due to its high quality and peer-reviewed content. The five-year time limit for the analysed research was aimed to ensure the inclusion of up-to-date data reflecting the latest trends in CVD diagnosis and prevention among NATO soldiers.

Restricting the review to original papers provided direct insight into empirical findings and minimized the risk of bias associated with secondary analyses. Limiting the study population to active NATO service members ensured a homogeneous sample and enabled comparison of results across Alliance countries. Focusing on classical CV risk factors allowed for a comprehensive assessment of the primary health determinants in this professional group. The adopted methodology enabled the collection of research data necessary for developing effective preventive strategies tailored to the unique needs and challenges faced by armed forces personnel.

## Results

After limiting the search to publications from the past five years, the PubMed database yielded six studies on the prevalence of CV risk factors among NATO soldiers, including two conducted in Poland. The key findings from these papers are presented in Table 1.

A recent study conducted by the Military Institute of Aviation Medicine in Warsaw included anthropometric measurements, body composition analysis, and laboratory tests in 200 young male air personnel of the Polish Armed Forces [3]. Of these, 36.5% individuals had a normal body weight by BMI. However, when body composition analysis and body fat percentage were taken into account, the proportion of individuals with normal parameters increased to 47.5%. The study demonstrated a significant correlation between the prevalence of overweight and obesity (defined based on both BMI and body fat percentage) and abnormal metabolic findings. In the obese group, abnormal total cholesterol was found in 54% and 58% of soldiers using BMI and BIA (bioelectrical impedance analysis), respectively, while abnormal HOMA-IR (Homeostatic Model Assessment of Insulin Resistance) was found in 57.1% and 51.6% of individuals assessed by BMI and BIA, respectively.

As reported in a paper published in 2022, soldiers of the French Armed Forces have a lower prevalence of obesity and fewer CV risk factors than the general French population [4]. These conclusions were based on a study conducted among 1,589 soldiers, 86.4% of whom were men. In addition to anthropometric measurements, the study incorporated blood pressure, biochemical parameters, and a lifestyle questionnaire. The mean BMI was 25.4, comparable to that of the

**Table 1.** Summary of original studies on the prevalence of CV risk factors among NATO soldiers

Country/group	Poland (pilots)	France	Germany (pilots)	Czech Republic	Poland (MILSCORE)	USA
Year of publication	2023	2022	2020	2020	2020	2019
N (number of participants)	200	1589	1957	659	6440	263 430
Males %	100	86,4	98,3	87,4	97	85,32
Females %	0	13,6	1,7	12,6	3	14,68
Mean age	37,8	35,7	41,9	43,8 (M) / 45 (K)	34,9	ND
Mean BMI	26,7	26,7	25,6	27,1 (M) / 23,9 (K)	ND	ND
Overweight (%)	46,0 (BMI) 37 (BIA)	38,7	54,3	ND	54,6	48,2
Obesity (%)	17,5 (BMI) 15,5 (BIA)	10,0	4,4	ND	14,1	18,3
Nicotine dependence (%)	10,5	ND	25,2	ND	46,2	19,9
Known HT (%)	ND	2,0	0,3	ND	13,7	5,0
Known DM (%)	ND	1,0	0,2	ND	1,0	1,7
Mean SBP (mmHg)	ND	ND	120	ND	134,7	ND
Mean DBP (mmHg)	ND	ND	80	ND	83,1	ND
Normal BP (%)	ND	ND	ND	ND	32,2	30,3
Elevated BP (%)	ND	ND	ND	ND	16	64,7
Hypertension (%)	ND	ND	ND	ND	51,8	5
LDL (mg/dL)	109,1	ND	132	ND	128,3	ND
HDL (mg/dL)	55,3	ND	54	ND	52,7	ND
Triglycerides (mg/dL)	138,5	ND	102	ND	152	ND

ND - no data; BMI - body mass index; BIA - bioelectrical impedance analysis; HT - hypertension

general French population. However, obesity affected 10% of the military cohort, as opposed to 15% in the civilian population. The percentage of individuals with abnormal body weight increased with age. Furthermore, the prevalence of HT and diabetes mellitus (DM) among French Army soldiers was significantly lower than that in the general population (2% vs 17.6% for HT and 1% vs 5.8% for DM, respectively).

The Institute of Aerospace Medicine in Cologne published their aviation medicine studies conducted among German military pilots during two periods: 2007–2009 and 2016–2018 [5]. To facilitate comparison with other military forces, only 2016–2018 results have been included in Table 1. Both study cohorts underwent anthropometric and blood pressure measurements, and laboratory workup, as well as were assessed for the risk of coronary events using the PROCAM score, originally developed for the German population. Both studies included a total of 1,717 pilots. When comparing the results from the two periods, the number of pilots decreased (from 3,396 to 1,957), while the mean age (from 36.7 to 41.9 years), all cholesterol fractions, BMI, and CV risk assessed using the PROCAM algorithm increased. It should be emphasized that this tool is used exclusively to assess the risk of acute coronary events, incorporating age, lipid levels, smoking status, DM, family history, and systolic blood pressure. The authors reported low rates of HT (0.3%) and DM (0.2%) among pilots, lower than those observed in the general population. They further emphasized that the increased risk of coronary events (13.9% at a CVD

RISK threshold of  $\geq 5\%$ , indicating a 5% risk of a coronary event within 10 years, and 4.9% at a threshold of  $\geq 10\%$ ), was solely due to age differences, as the risk assessed using the age-adjusted PROCAM score was identical in both groups.

Researchers from the Faculty of Military Health Sciences University of Defence presented the results of mandatory periodic medical check-ups conducted among soldiers of a selected elite unit of the Czech Army [6]. The health status of 659 soldiers (87.4% of men) was compared with health findings from a civilian cohort of similar size and demographic structure. In addition to anthropometric measurements, laboratory tests and lifestyle surveys were also performed. Analysis by gender revealed significant differences. In both age categories, female soldiers had a mean BMI within the normal range (23.9 and 24.7, respectively), whereas the BMI values of female civilians ranged between 27 and 27.7. A similar trend was observed for biochemical findings, with more favourable values observed in female soldiers. However, a reverse trend was seen in the male group, both for BMI and biochemical findings. Furthermore, abnormal body weight was significantly correlated with increasing age among the men.

The largest cohort of NATO soldiers in Europe was included in a study conducted by a research team from the Military Institute of Medicine in Warsaw [1]. The MIL-SCORE study was a comprehensive epidemiological analysis of CV risk factors in the population of the Polish armed forces. The study involved 6,440

soldiers, with men accounting for 97%. The study protocol included a multidimensional health assessment consisting of a detailed medical interview focused on chronic conditions, family history, and behavioural health determinants; a comprehensive physical examination with anthropometric measurements; and a laboratory panel. The obtained data indicated a high prevalence of modifiable CV risk factors, whose occurrence was significantly correlated with age. Of particular concern was the high percentage of smokers (46.2%). Combined with abnormal body weight (only 31.3% of participants had a normal BMI) and lipid disorders (elevated LDL cholesterol in 59% of soldiers), this gave rise to an unfavourable cardiometabolic risk profile. Suboptimal blood pressure control, with only 32% of participants exhibiting values within the reference range, was an additional risk factor. Cardiovascular risk was stratified using POL-SCORE, validated for the Polish population, yielding high risk in 7.9% ( $\geq 5\%$  and  $< 10\%$  risk of a CV event within 10 years) and very high risk in 0.4% ( $\geq 10\%$ ) of participants.

The largest prospective comparative study on CVDs, comparing a population of active U.S. soldiers with civilian controls, was conducted and published by a team of U.S. researchers [2]. The study included a cohort of 263,430 active duty army personnel aged 17–64 years, undergoing standard periodic check-ups, with men accounting for 85.32%. A representative civilian group characterised by a different demographic distribution was used for comparative analysis. The military population consisted mainly of younger age groups: 56% in the age range 17–29 years, 29% aged 30–39 years, 12.6% aged 40–49 years, and 1.28% aged  $> 50$  years. The age structure of the control group differed markedly, with 30% of participants aged 17–29 years, 20% aged 30–39 years, 19% aged 40–49 years, 31% aged  $> 50$  years; and with evenly distributed gender groups (50% women and 50% men). Risk factor analysis revealed a significantly lower prevalence of DM (1.7% vs. 5.7%) and nicotine dependence (19.9% vs. 22.5%) in the military cohort. The more favourable anthropometric profile of military personnel was reflected in significantly lower rates of obesity, defined based on standard BMI criteria (18% vs. 33.6%). Excess body weight was observed in 48.2% of soldiers and 32.3% of civilians, while normal BMI was found in 33.5% and 34.1% of the subjects, respectively. Blood pressure findings were particularly noteworthy. Despite comparable HT rates in both groups (5.0% vs. 5.4%), a significantly higher percentage of soldiers (64.7% vs 40%) had blood pressure classified as high-normal. Also, the positive correlation between elevated blood pressure and the frequency of exposure to combat deployment in the military group was a noteworthy finding.

## Discussion

This systematic comparative analysis of studies on CV risk factors in NATO military populations delivered a comprehensive picture of the health status of military personnel while simultaneously revealing the complexity of research issues within this specific professional group. It further demonstrated that methodological heterogeneity and demographic diversity

within the study populations, although preventing direct comparison of results, allow for the identification of key health trends and challenges. This in turn offers a meaningful contribution to the development of preventive strategies and the optimisation of healthcare systems within the field of military medicine.

Analysing the age and gender structure of soldiers, several significant correlations can be identified. The U.S. Army is comprised of the youngest population; the combined proportion of individuals in the 17–29 and 30–39 age ranges is 85% [2]. For comparison, the mean age in the elite unit of the Czech Armed Forces is much higher, with nearly 44 years for men and 45 years for women [6]. The U.S. Army also stands out in terms of gender structure, with women accounting for 14.68% of its personnel [2], and male predominance among military pilots. Systematic analysis of the available research indicates widespread anthropometric abnormalities, manifested as overweight and obesity, affecting both the general population and military personnel. Particularly valuable conclusions arise from research conducted by the Military Institute of Aviation Medicine, which revealed significant diagnostic limitations of standard tools used to assess nutritional status [3]. Conventional BMI, which is based solely on weight relative to the square of a person's height, has limited specificity in populations characterized by a high proportion of muscle tissue, which can result in misclassification of metabolic risk. The introduction of advanced tools for body composition analysis, which enable precise assessment of body fat percentage, provides significantly more accurate diagnostic data and should become the standard for evaluating the health status of military personnel.

A comparative assessment of the anthropometric profiles of the study populations revealed significant differences between the individual armies. The most favourable anthropometric parameters were observed in the French Armed Forces, which were characterized by the highest percentage of soldiers with a healthy body weight. In contrast to other military units, the U.S. Army had the highest obesity rate. Conversely, particularly low obesity rates were observed in a selected group of German military pilots [2, 4, 5].

Not all studies included comprehensive data on smoking and the prevalence of clinically confirmed HT and DM. The highest smoking rates were reported in the MIL-SCORE study, with cigarette smokers accounting for 46.2% of respondents. By comparison, smoking rates were estimated at 19.9% for the U.S. Army, 25.2% for German pilots, and 10.5% for Polish pilots [1–3, 5]. The high percentage of smokers in the MIL-SCORE group may substantially increase the risk of CVD, further underscoring the need for intensive preventive measures.

Comparative evaluation of the prevalence of hypertension revealed significant intergroup heterogeneity. The MIL-SCORE study reported the highest rates of HT, reaching 13.7% of the study population, a value considerably higher than that observed in the U.S. (5.0%) and French cohort (2.0%, with a median age of

35.7 years). Particularly low HT rates were found in the group of German military pilots (0.3%) [1, 2, 4, 5]. The observed disparities may be due to multiple factors, including varying levels of physical activity, differences in behavioural patterns, and specific medical selection criteria used across individual military formations.

In terms of metabolic disorders, the highest prevalence of DM was reported for the U.S. military population (1.7%). Lower rates were observed in the MIL-SCORE study group and among French military personnel (1.0% in both populations). The lowest prevalence of DM was found in the cohort of German military pilots (0.2%) [1, 2, 4, 5]. As in the case of HT, the intergroup differences in the prevalence of DM may result from a combination of demographic factors and the specific conditions of military service, including different medical qualification criteria and varying health monitoring protocols.

Cardiovascular risk factors can significantly affect combat capabilities of soldiers. Individuals with HT, hyperlipidaemia, or excess body weight are at increased risk of CV events when exposed to high stress and intense physical exertion. A very high CVD risk, defined as the probability of a CV event within the next 10 years greater than the  $\geq 10\%$  threshold (according to the Pol-SCORE scale), was identified in 0.4% of Polish soldiers participating in the MIL-SCORE study, while high risk ( $\geq 5\%$  and  $< 10\%$ ) was found in nearly 8% of the assessed military personnel. German researchers estimated the risk of coronary events among military pilots using the PROCAM score developed for the German population. A high risk ( $> 10\%$  probability of an event within 10 years) was identified in 4.9% of pilots, while a moderate risk (5–10% probability within 10 years) was found in 13.9% of the study population.

Highly specialized military units, such as the Air Force, apply stringent qualification criteria and continuous medical monitoring protocols, which effectively exclude individuals with certain health conditions from active duty. This approach, employed by both the Polish and German Air Forces, results in significantly lower rates of chronic conditions, including HT, DM, and obesity, compared with other military units. These findings highlight the importance of regular health monitoring and targeted preventive strategies within the military population.

## Conclusions

This review of original research on the health of NATO soldiers showed that, despite rigorous physical demands, regular medical check-ups, and systematic health screening, military personnel are not immune to CV risk factors and cardiovascular diseases. Comparative analyses revealed significant differences between individual armies, resulting not only from demographic characteristics, but also from the specific nature and intensity of military service.

As evidenced in international comparisons, the health status of Polish soldiers appears less favourable than

that of personnel in other NATO armies. Our troops present with the highest rates of smoking, hypertension, and multiple metabolic abnormalities, including lipid disorders. Obesity, which is one of the most significant CVD risk factors, is also more prevalent in the Polish Armed Forces than in most of the analysed military populations, being second only to the U.S. Army. It is worth noting that the overall CVD risk assessed in the MIL-SCORE study indicates that nearly 8% of Polish soldiers are at high risk of cardiovascular events ( $\geq 5\%$  and  $< 10\%$ ), despite their relatively young mean age (34.9 years).

These data indicate the need for more effective preventive programmes for the Polish Army, encompassing not only systematic monitoring of soldiers' health, but also intensified health education efforts. Of particular importance are comprehensive initiatives aimed at reducing smoking, promoting regular physical activity, and encouraging dietary modifications consistent with evidence-based healthy eating principles. Although NATO soldiers generally present with better health parameters compared with the civilian population, the substantial differences observed between individual armies highlight the need to tailor preventive strategies to the specific health profiles and operational demands of each military group. Long-term cardiovascular disease prevention initiatives encompassing health education, risk-factor reduction, and the promotion of healthy lifestyle behaviours should constitute a fundamental component of the health strategy implemented within the armed forces.

## Conclusions and recommendations

- The increased prevalence of hypertension among Polish and U.S. soldiers underscores the need to intensify preventive measures and ensure systematic blood pressure monitoring in these populations.
- Dyslipidaemia and metabolic disorders, particularly among Polish soldiers, necessitate the implementation of more effective preventive strategies, including targeted dietary interventions and the promotion of regular physical activity.
- The high prevalence of smoking, particularly among Polish soldiers, constitutes a major cardiovascular risk factor and should prompt intensive preventive measures, including comprehensive anti-smoking campaigns and smoking cessation support programmes.
- The low incidence of diabetes among NATO soldiers may be attributed to rigorous health standards and systematic medical screening, which contribute to early detection of metabolic abnormalities and the exclusion of high-risk individuals from active duty. However, noticeable differences in fasting glucose levels across the analysed populations suggest that factors such as diet, lifestyle, physical activity, and the specific medical selection criteria used across different armies may significantly influence the metabolic status of soldiers. Therefore, further research is needed to clarify the mechanisms underlying these disparities and to help develop more personalised and effective preventive strategies.

## References

1. Gielera G, Krzeński P, Piotrowicz K, et al. The prevalence of cardiovascular risk factors among Polish soldiers: the results from the MIL-SCORE Program. *Cardiol Res Pract*, 2020; 2020: 3973526. doi: 10.1155/2020/3973526
2. Shrestha A, Ho TE, Vie LL, et al. Comparison of Cardiovascular Health Between US Army and Civilians. *J Am Heart Assoc*, 2019; 8: e009056. doi: 10.1161/JAHA.118.009056
3. Gaździńska A, Gaździński S, Jagielski P, Kler P. Body composition and cardiovascular risk: a study of Polish military flying personnel. *Metabolites*, 2023; 13: 1102. doi: 10.3390/metabo13101102
4. Quertier D, Goudard Y, Goin G, et al. Overweight and obesity in the French army. *Mil Med*, 2022; 187: e99–e105. doi: 10.1093/milmed/usaa369
5. Sammito S, Guttler N. Cardiovascular risk profiles in German Air Force pilots. *BMJ Mil Health*, 2023; 169: 176–180. doi: 10.1136/bmj-military-2020-001608
6. Pavlík V, Šafka V, Pravdová L, et al. Comparison of selected risk factors in cardiovascular diseases in two different populations of the Czech Republic. *Cent Eur J Public Health*, 2020; 28 Suppl: S47–S52. doi: 10.21101/cejph.a6182



# THE ROLE OF DENTISTRY IN MAINTAINING THE HEALTH OF SOLDIERS: PREVENTION, DIAGNOSIS, AND TREATMENT IN THE CONTEXT OF MILITARY SERVICE

Rola stomatologii w utrzymaniu zdrowia żołnierzy: prewencja, diagnostyka i leczenie w kontekście służby wojskowej



Adrianna Gliszczyńska, Adam Łuczak, Agata Tuczyńska

Military Specialist Medical Clinic in Poznań, Szyling Branch, Poland

Adrianna Gliszczyńska –  0009-0009-1721-5327

Adam Łuczak –  0009-0004-1848-5437

Agata Tuczyńska –  0000-0003-1648-6765

## Abstract

**Introduction:** Dentistry, which encompasses preventive, diagnostic, and therapeutic care, plays a crucial role in maintaining the health of soldiers. In the context of military service, where physical and psychological demands are exceptionally high, maintaining oral health is essential not only for the comfort of soldiers but also for preserving their operational performance. Oral health problems can adversely affect operational efficiency; therefore, military dental care should further include preventive measures and early detection of any abnormalities. Polish soldiers receive specialized dental care, including routine check-ups, conservative treatment, and surgical procedures, particularly those specialized. **Objective:** The aim of this literature review was to raise awareness of the current oral health needs among soldiers and the necessity of adapting dental practices to meet their specific needs. **Materials and methods:** A review of scientific reports was conducted using the PubMed database, taking into account the impact of military conditions on oral health. **Conclusions:** Dentistry plays a key role in maintaining soldiers' health. It influences their combat, as well as physical and mental readiness. Oral health issues such as cavities, infections, or injuries can compromise physical performance, concentration, and even morale. In Poland, soldiers have access to comprehensive dental care, including diagnosis, treatment, and prevention. Stress, mental disorders, and addictions can further deteriorate oral health. In wartime situations, access to dental services is limited, making preventive measures and the development of mobile dental units crucial.

## Streszczenie

**Wstęp:** Stomatologia odgrywa kluczową rolę w utrzymaniu zdrowia żołnierzy, obejmując aspekty prewencyjne, diagnostyczne i lecznicze. W kontekście służby wojskowej, gdzie warunki fizyczne i psychiczne są szczególnie wymagające, dbanie o zdrowie jamy ustnej ma istotne znaczenie nie tylko dla komfortu żołnierzy, ale również ich gotowości bojowej. Problemy zdrowia jamy ustnej mogą negatywnie wpłynąć na efektywność pracy żołnierza, dlatego opieka stomatologiczna obejmuje także profilaktykę i wczesne wykrywanie nieprawidłowości. W Polsce żołnierze objęci są szczególną opieką stomatologiczną, która zapewnia im m.in. badania kontrolne, leczenie zachowawcze i zabiegi chirurgiczne, szczególnie dla osób pełniących specjalistyczne funkcje. **Cel:** Celem przeglądu piśmiennictwa jest zwiększenie świadomości na temat aktualnych potrzeb dotyczących zdrowia jamy ustnej żołnierzy i konieczności adaptacji praktyk stomatologicznych do ich potrzeb. **Materiał i metoda:** Przeprowadzono przegląd doniesień naukowych, wykorzystując bazę danych PubMed, uwzględniając wpływ warunków wojskowych na zdrowie jamy ustnej. **Wnioski:** Stomatologia odgrywa kluczową rolę w utrzymaniu zdrowia żołnierzy, wpływając na ich gotowość bojową, fizyczną i psychiczną. Problemy zdrowotne jamy ustnej, takie jak próchnica, infekcje czy urazy, mogą prowadzić do zmniejszenia sprawności fizycznej, koncentracji, a także osłabienia morale żołnierzy. W Polsce żołnierze mają dostęp do szerokiej opieki stomatologicznej, obejmującej diagnostykę, leczenie i profilaktykę. Stres, zaburzenia psychiczne, nałogi mogą pogarszać stan zdrowia jamy ustnej. W przypadku działań wojennych dostęp do usług z zakresu stomatologii jest ograniczony, dlatego kluczowe staje się wprowadzenie działań prewencyjnych oraz rozwoju mobilnych jednostek stomatologicznych.

**Keywords:** oral hygiene; mental health; military dental care; military conditions; mobile dental units

**Słowa kluczowe:** higiena jamy ustnej; zdrowie psychiczne; opieka stomatologiczna w wojsku; warunki wojskowe; mobilne jednostki stomatologiczne

DOI 10.53301/lw/204333

Received: 08.04.2025

Accepted: 24.04.2025

Published: 30.12.2025

## Corresponding author:

Adrianna Gliszczyńska  
Military Specialist Medical Clinic in Poznań,  
Szyling Branch, Poland  
e-mail: adagliszczynska99@gmail.com

## Introduction

Dentistry plays an important role in maintaining the health of military personnel across preventive, diagnostic, and therapeutic domains. In the context of military service, where physical and psychological demands are exceptionally high, maintaining proper oral health is essential not only for the comfort of soldiers, but also for preserving their operational performance. Poor oral health can impair operational performance and effectiveness during military operations [1-3]. Therefore, military dental care needs to extend beyond treatment alone and include comprehensive preventive and diagnostic strategies that facilitate early detection of abnormalities and their timely, effective management [3]. Nobel Prize winner Rudyard Kipling once stated that "War is not only a battlefield, but also a testing ground for medicine. Without doctors who treat and inventions that support them, war would be much shorter". These words underscore the crucial role that medicine has played since World Wars I and II. Armed conflicts have significantly contributed to the development of several medical disciplines, general, maxillofacial, and dental surgery in particular. Sir Archibald Hector McIndoe, a New Zealand plastic surgeon who served in the Royal Air Force during World War II and improved the treatment and rehabilitation of badly burned aircrew, deserves particular recognition [4, 5]. Contemporary research increasingly focuses on the impact of war on the mental health of soldiers. Post-traumatic stress disorder (PTSD) is one of the most commonly diagnosed conditions among veterans deployed to Iraq and Afghanistan, underscoring that military activities have profound and lasting effects on human health [6, 7]. Furthermore, soldiers experience oral health problems both during armed conflict and in peacetime, which may adversely affect their operational performance and daily functioning.

Polish military personnel are entitled to special dental care in accordance with the Regulation of the Minister of National Defense of 27 June 2023, which defines the rules for providing additional dental services and materials. This regulation outlines the scope of available services, including dental checkups, hygiene procedures, conservative and endodontic treatment, surgical interventions, and the management of periodontal and mucosal diseases. These services are provided both within military units and through cooperation with external medical facilities.

The regulation is intended to ensure comprehensive dental care for soldiers exposed to substantial physical and psychological strain. Military professionals, including pilots, divers, and members of special units, are eligible for this expanded package of benefits. By guaranteeing regular diagnostic workup, preventive measures, and dental treatment, these provisions support the maintenance of a high level of health and combat readiness within the Polish Armed Forces [8].

## Aim

The aim of this review was to investigate the available literature discussing the oral health of military person-

nel, taking into account the specific needs of soldiers, and to highlight the need for adapting dental practices to the unique conditions of military service [9].

## The importance of dentistry in the context of operational performance

Dentistry plays a crucial role in ensuring combat readiness, as oral health directly impacts the overall performance of soldiers. Dental problems, such as pain or infection, can lead to hospital admission, resulting in loss of performance and the ability to perform duties. Dental pain in the military, especially during intense training or prolonged exposure to challenging conditions, can significantly compromise both the ability to focus and physical performance in soldiers. Dental infections can also lead to more serious systemic complications. Furthermore, oral health impacts soldiers' mental well-being and morale, and even minor ailments can be crucial in a military setting, where physical and mental resilience are crucial [3].

Consequently, specialized dental care supports both physical and mental well-being of military personnel, which translates into their operational performance. Military dentistry therefore has a significant impact on improving the operational effectiveness of the armed forces.

## Oral health issues among military personnel

The oral health of military personnel requires special attention. Banakar et al. [2] conducted a study to assess the oral health status, dental caries, and related factors, as well as the impact of socioeconomic and behavioural determinants among Iranian soldiers.

This cross-sectional study included 658 male soldiers aged 18-30 years from three military barracks in Fars Province, Iran. Data were collected using a structured questionnaire and clinical oral examinations. Oral health status was assessed using DMFT (Decayed-Missing-Filled) index and the Simplified Oral Hygiene Index (OHI-S), a measure of overall oral health. The study revealed a complex interaction between socioeconomic conditions and oral health habits among Iranian soldiers [2].

Figure 1 shows correlations between socioeconomic factors, health habits, and oral health outcomes described in Banakar et al. [2]. Socioeconomic status is conceptualized as a formative construct formed by various multiple factors, such as place of residence, personal and parental education, insurance, birth order, ethnicity, income, and costs of living. These indicators jointly influence oral health behaviours (e.g., brushing, flossing, sugar intake) and oral health (DMFT and OHI-S) [2].

The results underscore the need for targeted preventive interventions aimed at reducing modifiable risk factors and improving access to preventive dental care within military settings [2].

Mendoza et al. [10] demonstrated that soldiers are exposed to dental injuries during service. Dental surgery

was the most common type of intervention in cases of dental trauma, accounting for 55.8% of all procedures [10]. Struthers et al. [11] showed that the majority of emergency cases (38.60%) were associated with tooth fractures or dental caries. Dental pain requiring endodontic treatment was the second most common reason for dental visits (16.81%). Musculoskeletal dental pain or pain unrelated to endodontic treatment accounted for 16.10% of cases and was most likely to be stress-related. Periodontal problems accounted for 14.33% of emergency presentations, while the need for tooth extraction was identified in 7.16% of cases [11].

### Statistics

The World Dental Federation reported that tooth decay is one of the most common diseases globally, with up to 90% of the population affected by oral health problems. Polish epidemiological data from the Oral Health Monitoring programme implemented by the Ministry of Health indicate that up to 99.9% of individuals aged 35–44 years present with dental caries.

In their study involving 176 naval personnel, Nik Azis et al. [1] highlighted another important issue, i.e. poor oral hygiene. The authors reported a high prevalence of dental plaque (30.7%) and gingival bleeding (39.6%). CPITN (Community Periodontal Index of Treatment Needs), which is used to assess the frequency of selected periodontal symptoms, revealed that a substantial portion of participants (52.1%) required advanced periodontal treatment (CPITN 3 or 4). DMFT indicated a substantial disease burden, with a mean score of  $4.59 \pm 4.24$ , including untreated caries ( $1.15 \pm 1.63$ ). Assessment of oral health-related quality of life using the Oral Health Impact Profile (OHIP-14) revealed low scores in some participants (mean 13.47, with a maximum possible score of 42). Additionally, oral health behaviours were found to be inadequate, with 12% of participants reporting irregular toothbrushing and 68.2% indicating limited use of interdental cleaning tools [1]. Figure 2 summarizes the main findings by Nik Azis et al. [1].

In the study by Lavrin et al. [12], 348 soldiers of the Ternopil zonal department of the Military Law Enforcement Service (TZDMLES) underwent a clinical assessment for dental caries. The DMF index was used to evaluate caries intensity. The analysis revealed a high prevalence of dental caries among TZDMLES personnel, ranging from 83.08% in the 20–25-year age group to 100% in the 36–40 and 41–45-year age groups. Caries severity demonstrated an upward trend in both men and women across all age groups [12]. These findings underscore the substantial problem of inadequate oral hygiene.

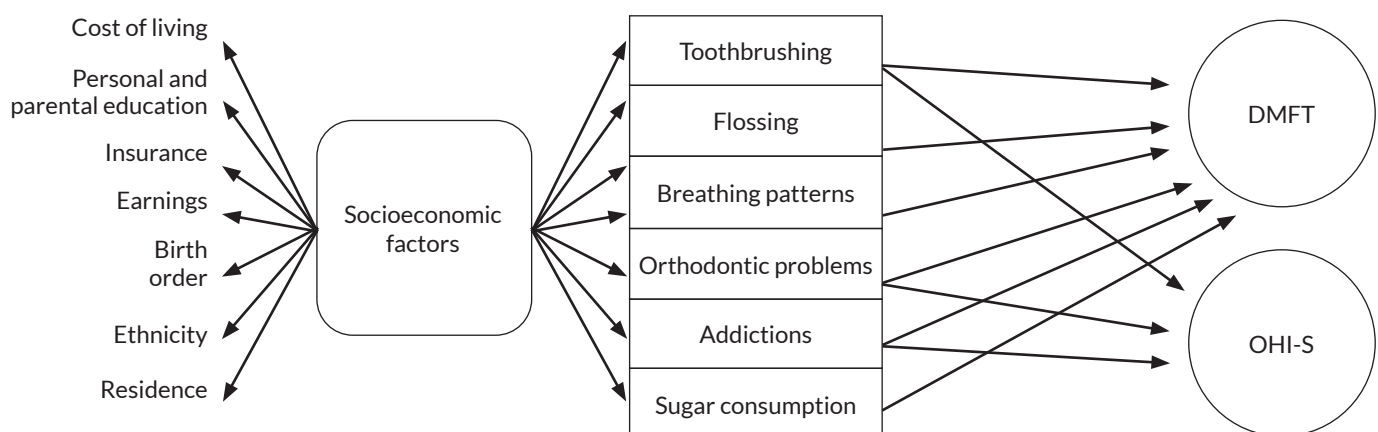
### Poor mental health as a risk factor for dental problems

Ryan et al. and Scott et al. [13] reported that veterans have an increased risk of dental caries, and that depressive individuals are more likely to develop active caries than non-depressed veterans. Karimi et al. [14] showed that tooth loss, pain, and reduced oral function were correlated with higher rates of depressive symptoms. Greater tooth loss was associated with a higher risk and severity of depression. Oral pain exacerbated depressive symptoms, while difficulty chewing and speaking were linked to a higher risk of depression [14]. These findings indicate a reciprocal relationship between oral health and depression, underscoring the urgent need for comprehensive public health interventions.

Military stress is also a significant problem. It has a substantial impact on daily functioning and causes bruxism in many soldiers, especially those with coexisting PTSD. Wörner et al. [15] highlighted the consequences of bruxism for oral health, particularly its detrimental effects on the temporomandibular joint, resulting in degenerative changes and pain [15].

### The effect of tobacco use on oral health

Military personnel often start smoking tobacco as a means to relieve stress and tension, especially during challenging missions or training. In a study by Smith



DMFT - decayed-missing-filled teeth; OHI-S - Oral Hygiene Index - Simplified

Fig. 2. The relationship between the type of work performed and the frequency of toothbrushing

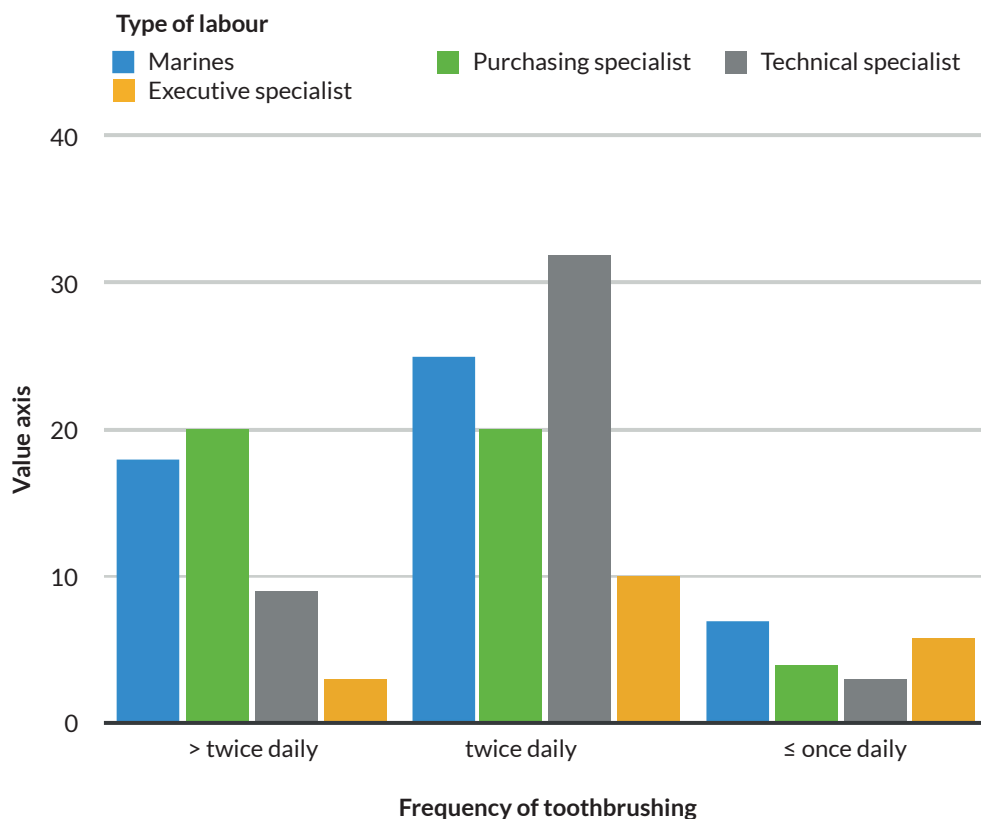


Fig. 2. The relationship between the type of work performed and the frequency of toothbrushing

et al. [16], individuals who experienced combat during deployment were found to have a 1.6-fold higher risk of starting smoking compared to those who had never smoked (95% CI 1.2–2.3), and a 1.3-fold higher risk of resuming smoking among former smokers compared to those who had never had such experience [16]. Both tobacco and nicotine affect oral health. Rafati et al. [17] showed a significantly higher DMFT values in smokers, indicating that these substances have negative effects on oral health. Similarly, Beklen et al. [18] confirmed the substantial impact of tobacco on periodontitis, showing that smokers had a markedly higher rates of periodontal disease compared with nonsmokers [18].

The data presented indicate a high prevalence of tobacco smoking among military personnel and highlight the significant health risks associated with this habit.

### Factors limiting access to dental care during deployment

The Russian-Ukrainian armed conflict has underscored the challenges of ensuring adequate dental care in combat conditions. According to Mendoza et al., Ukrainian military personnel received dental care from, among others, two clinics in Germany [10]. The Corporate Dental System (CDS) report, a repository of dental treatment records used by the U.S. Army, included 408 cases involving Ukrainian military personnel. During the 9-month reporting period in 2023, 360 Ukrainian soldiers received treatment for dental trauma [10]. Al-

though military operations take place in Ukraine, some soldiers were required to seek treatment in Germany.

Combes et al. [19] reported 278 patients who were stationed far from a dental centre and required transport solely for dental consultation, including 79% by helicopter. The mean time lost was 24 hours compared with only one hour for military personnel stationed near a dental facility. In the study group, 37 out of 118 soldiers (31.4%) who returned from Afghanistan and had requested dental care during deployment were unable to receive the necessary treatment [19].

### Discussion

It can be concluded from the presented research that although dental problems among military personnel are not the primary health concern, they nonetheless constitute an important factor that affects both comfort and operational performance during deployment.

Lavrin et al. [12] suggested that the implementation of NATO dental care standards and the modernization of the existing care system could significantly improve the oral health of Ukrainian soldiers, thereby enhancing their combat performance.

The introduction of mobile dental units, along with the promotion of oral hygiene practices consistent with NATO guidelines, could effectively address the most common dental problems observed among military personnel [12]. In view of the findings reported by Nik Aziz

et al. [1], attention should be directed toward strengthening educational and hygiene programmes for military personnel. Furthermore, the development of dental care within the armed forces, including a comprehensive approach to prevention and treatment, is essential for addressing the high prevalence of dental caries and ensuring effective oral health management among soldiers [12].

Referring to Ryan and Scott et al. [13] and Wörner et al. [15], it becomes evident that pervasive stress and mental disorders have a detrimental impact on the stomatognathic system, leading to masticatory dysfunctions, including bruxism. Moreover, poor oral health may further exacerbate the already compromised well-being of depressive individuals [13]. There is also noteworthy evidence linking tobacco smoking to poor oral health. These findings indicate that military deployment may increase the risk of initiating smoking [16].

Rafati et al. [17] reported a deterioration in dental health among smokers. Beklen et al. [18] also demonstrated a significant adverse impact of tobacco use on periodontal tissues.

## Conclusions

Dentistry plays a crucial role in maintaining good health among military personnel and has a direct physical and psychological impact on their combat performance. During deployment, when military personnel are exposed to challenging environmental, physical, and mental conditions, oral health problems can significantly impair performance, concentration, and overall morale. Polish soldiers receive special dental care that includes a comprehensive range of diagnostic, therapeutic, and preventive services, ensuring early detection and effective management of oral diseases.

Oral conditions, including tooth decay, infections, and trauma, may significantly impair the ability of soldiers to perform operational duties. Furthermore, mental health conditions such as depression and PTSD frequently exacerbate oral health problems, while chronic stress may contribute to bruxism, which in turn leads to temporomandibular joint dysfunction and associated pain. Inadequate oral hygiene, along with unhealthy habits such as smoking, poses a significant threat to oral health. In wartime conditions, such as the Russian-Ukrainian conflict, access to dental care is markedly limited. Therefore, preventive and educational strategies, better access to treatment, and the development of mobile dental units are essential to improve the oral health of military personnel.

## References

- Nik Azis NM, Raja Abdullah RN, Mohamad Ayub MNA, Baharin B. Oral health status, behavior and impact profile among naval personnel in the Malaysian naval armed forces. *BMC Oral Health*, 2025; 25: 209. doi: 10.1186/s12903-025-05478-5
- Banakar M, Ghannadpour A, Behbahanirad A, et al. Determinants of oral health among Iranian soldiers: a structural equation modeling study. *BMC Oral Health*, 2024; 24: 1288. doi: 10.1186/s12903-024-05052-5
- Armstrong S, Dermont M. Defence dentistry: an occupationally focused health service with worldwide deployable capability. *Br Dent J*, 2021; 230: 417–423. doi: 10.1038/s41415-021-2834-1
- Pennington H. The impact of infectious disease in war time: a look back at WW1. *Future Microbiol*, 2019; 14: 165–168. doi: 10.2217/fmb-2018-0323
- Macnamara AF, Metcalfe NH. Sir Archibald Hector McIndoe (1900–1960) and the Guinea Pig Club: the development of reconstructive surgery and rehabilitation in the Second World War (1939–1945). *J Med Biogr*, 2014; 22: 224–228. doi: 10.1177/0967772013480691
- Richardson LK, Frueh BC, Acierno R. Prevalence estimates of combat-related post-traumatic stress disorder: critical review. *Aust N Z J Psychiatry*, 2010; 44: 4–19. doi: 10.3109/00048670903393597
- Konhäuser L, Renner KH, Himmerich H, et al. Auswirkungen kritischer Ereignisse bei Auslandseinsätzen auf die psychische Gesundheit von Militärpersonal [Impact of Critical Events During Deployments on the Mental Health of Military Personnel]. *Gesundheitswesen*, 2025; 87: 21–26. German. doi: 10.1055/a-2448-3968
- Rozporządzenie Ministra Obrony Narodowej z dnia 27 czerwca 2023 r. w sprawie dodatkowych świadczeń zdrowotnych lekarza dentysty i materiałów stomatologicznych przysługujących żołnierzom zawodowym (Dz.U. 2023 poz. 1334)
- Pasquier P, de Rudnicki S, Donat N, et al. Type et épidémiologie des blessures de guerre, à propos de deux conflits actuels: Irak et Afghanistan. *Ann Fr Anesth Reanim*, 2011; 30: 819–827. doi: 10.1016/j.annfar.2011.05.018
- Mendoza AM, Simecek JW, Colthirst PM, Mitchener TA. A description of the dental health and treatment of Ukraine military at U.S. Army clinics in Germany. *Mil Med*, 2025; 190: e1543–e1548. doi: 10.1093/milmed/usae480
- Struthers MW, Kosaraju A, Vandewalle KS. Dental emergency rates at an expeditionary medical facility supporting operation inherent resolve. *Mil Med*, 2025; 190: e1564–e1569. doi: 10.1093/milmed/usae505
- Lavrin O. Assessment of the prevention measures effectiveness for the development of carious dental lesions in military personnel of the armed forces of Ukraine. *East Ukr Med J*, 2023; 11: 483–491. doi: 10.21272/eumj.2023;11(4):483-491
- Ryan JB, Scott TE, McDonough RE, et al. Depression and differential oral health status among U.S. adults with and without prior active duty service in the U.S. military, National Health and Nutrition Examination Survey 2011–2018. *Mil Med*, 2024; 189: e157–e165. doi: 10.1093/milmed/usad217
- Karimi P, Zojaji S, Fard AA, et al. The impact of oral health on depression: A systematic review. *Spec Care Dentist*, 2025; 45: e13079. doi: 10.1111/scd.13079
- Wörner F, Eger T, Simon U, et al. Lifespan of splints in a sample of German soldiers hospitalised with post-traumatic stress disorder (PTSD) in combination with sleep bruxism and painful temporomandibular disorder (TMD). *Oral Health Prev Dent*, 2024; 22: 249–256. doi: 10.3290/j.ohpd.b5569645

16. Smith B, Ryan MA, Wingard DL, et al.; Millennium Cohort Study Team. Cigarette smoking and military deployment: a prospective evaluation. *Am J Prev Med*, 2008; 35: 539–546. doi: 10.1016/j.amepre.2008.07.009
17. Rafati S, Dadipoor S, Eshaghi Sani Kakhaki H, Shahabi N. Oral health and smoking in Bandare-Kong cohort study: a cross-sectional population-based study (findings from PERSIAN cohort study). *J Ethn Subst Abuse*, 2025; 24: 574–589. doi: 10.1080/15332640.2023.2253177
18. Beklen A, Sali N, Yavuz MB. The impact of smoking on periodontal status and dental caries. *Tob Induc Dis*, 2022; 20: 72. doi: 10.18332/tid/152112
19. Combes J, Pepper T, Bryce G, MacBeth N. Dental care provision to UK military personnel serving on Operation Herrick in Afghanistan. Part 1: access to dental care. *Br Dent J*, 2018; 225: 1068–1072. doi: 10.1038/sj.bdj.2018.1037



# AN INTERNATIONAL APPROACH TO HOMELESSNESS. PART I: THE CASE OF INDIA

Międzynarodowe podejście do problemu bezdomności.  
Część I: Przypadek Indii



Pranit Lanjewar, Jaroslaw Richard Romaniuk

*Jack, Joseph, and Morton Mandel School of Applied Social Sciences, Case Western Reserve University, Cleveland, Ohio, United States*

Pranit Lanjewar –  0009-0005-0083-4042  
Jaroslaw Richard Romaniuk –  0000-0002-8568-6587

## Abstract

This paper, the first in a two-part study on homelessness in developing countries, explores the causes of homelessness in countries with significant populations living in poverty. This instalment focuses primarily on homelessness in India. The country's diversity in terms of culture and religion is reflected in challenges when approaching issues related to homelessness. We highlight governmental initiatives to combat homelessness and provide impoverished people and families with access to essential services. A qualitative research method was used. We interviewed the recipients of government services aimed at helping their families overcome homelessness. Our findings highlight the role of education and educational programs in breaking the cycle of poverty. We also compare the approaches to homelessness in the United States and India, the programs, and the challenges to assist individuals and families. The research also finds that people who migrate from one place to another to find employment are economically vulnerable and build makeshift shelters wherever they find a place. We explain how this process gradually leads to the formation of slums – condensed, crowded places where residents lack basic amenities and resources. We also examine how local organizations help people by providing services such as food distribution during festivals and clothing from NGOs. We conclude that providing long-term services and benefits to individuals and families is helpful in eliminating poverty. Furthermore, resource acquisition and collaboration between organizations and government bodies are essential for addressing systemic barriers to reduce homelessness.

## Streszczenie

W niniejszej pracy, która jest pierwszą z dwóch części poświęconych problemom bezdomności w krajach rozwijających się, omawiamy przyczyny bezdomności w krajach o znaczącym odsetku ludzi żyjących w biedzie. W tej części skupiamy się przede wszystkim na problemie bezdomności w Indiach. Sytuacja ludzi biednych i bezdomnych zależy od miejsca, w którym się znajdują, oraz od uwarunkowań kulturowych i religijnych. Rząd stara się ograniczać bezdomność, wprowadzając różne formy pomocy, oferowanej ludziom znajdującym się w skrajnej biedzie. W celu poznania skuteczności i zasięgu pomocy rządowej przeprowadziliśmy badania jakościowe i wywiady z osobami korzystającymi z takiej pomocy. W pracy omówiono znaczenie edukacji i programów oświatowych dla przerwania międzygeneracyjnego cyklu biedy. Porównano pomoc okazaną jednostkom i rodzinom w wychodzeniu z bezdomności w USA i Indiach. Opisano zjawisko migracji ludzi w poszukiwaniu pracy, które przyczynia się do zwiększenia liczby osób znajdujących się w kryzysie bezdomności. Osoby bezdomne budują tymczasowe schronienia, które po pewnym czasie nabierają form rozległych slumsów pozbawionych podstawowych warunków bezpieczeństwa życia i higieny. Mieszkańcom slumsów pomagają instytucje pozarządowe, dostarczając żywność i ubrania, szczególnie w trakcie tłumnych obchodów wydarzeń społecznych i religijnych. Organizacja lokalnych zasobów i współpraca między rządowymi i pozarządowymi ośrodkami pomocy stwarza warunki umożliwiające ludziom wychodzenie z bezdomności.

**Keywords:** migration; poverty; social work; diversity; slums

**Słowa kluczowe:** migracja; bieda; praca społeczna; różnorodność społeczna; slumsy

DOI 10.53301/lw/204971

Received: 04.04.2025

Accepted: 12.05.2025

Published: 30.12.2025

### Corresponding author:

Jaroslaw Richard Romaniuk  
Jack, Joseph, and Morton Mandel School of Applied  
Social Sciences, Case Western Reserve University,  
Cleveland, Ohio, 11235 Bellflower Rd, 44106,  
Cleveland, United States  
e-mail: jrr3@case.edu

## Introduction

People are homeless because they cannot afford to pay for living space. Many systems of social welfare designed to help people obtain and maintain housing have demonstrable limitations in their effectiveness and long-term stability. Systems in certain geographical areas, especially during periods of social unrest (epidemics, natural disasters, war), are often overwhelmed by the rising numbers of people without shelter. Homelessness negatively affects people who are subjected to it and has an effect on the wider environment where unhoused people live. Tourists generally react negatively to seeing people living on the streets when they travel [1]. Homelessness also costs money, particularly when cities try to make the homeless disappear when they wander in the public spaces. However, there are researchers who believe that ending homelessness, although expensive, in the end, saves money [2].

Each homeless person presents a different history of becoming homeless. Such history depends on the community they are part of and the country they live in, with its economy and culture. The main cause of homelessness is poverty, which may arise from health conditions, unemployment, and factors related to gender, relationships, violence, poor education, a lack of social support, citizenship status, stigma, social exclusion, and discrimination [3]. There is an interdependence between homelessness and poverty; people without a permanent address face barriers to improving their health and economic status. Homelessness contradicts basic human rights, including the rights to adequate housing, food and water, health, education, and non-discrimination. It reflects the failure of the welfare state and the poor decisions of governing bodies [4]. In short, it is the responsibility of society as a whole to eradicate homelessness; those who have lost housing should not be blamed.

People who are homeless can often be categorized into groups with their own special characteristics. Some of them are transiently homeless and able to gain and maintain income and housing within a relatively short time. But the so-called chronically homeless may remain unhoused for several years. They usually suffer from mental illness and/or different forms of social marginalization. This second group is the most costly to society because they use expensive emergency health services and specialized community care management without any resolution of their situation [5].

The significant use of community resources in the care of the chronically homeless has resulted in the development of an approach that provides housing first and then offers essential services while individuals remain stably housed. This approach is known as the "Housing First" model. Many communities and countries use this approach for all homeless populations. For example, Finland has been able to house all who needed housing using this strategy. Other countries that have been able to create successful systems of governmental and non-governmental support for the homeless are Japan and Denmark. New research suggests that the best programs simultaneously promote health and address disparities while offering a version of the Housing First model [5].

However, there are states with large populations, such as India, Nigeria, and the United States, that are unable to apply the Housing First model for everybody who needs it due to financial constraints. The problem of the absolute number of homeless overwhelms many social welfare approaches. In this work (Part I), we present the case of India to illustrate the reality of how one society attempts to support its homeless population. In Part II, we discuss available options for resolving the problems of homelessness in low-income countries with large populations.

## Goals and methods

Both authors worked in the Comprehensive Homeless Center (CHC) of the Cleveland Department of Veterans Affairs (VA). CHC VA uses several approaches to help unhoused veterans. One of the most successful is the HUD-VA Supported Housing (HUD-VASH) program, in which housing is provided through the U. S. Department of Housing and Urban Development (HUD) together with professional support from VA social services [6]. This model, although very successful [7], is also one of the most expensive programs known to the authors. This raises the question of what methods are used in low-income countries with high populations of people who might be homeless or at risk of homelessness. We decided to study the case of India, a country with an overwhelming population of unhoused people, and evaluate the most promising social actions that could lead to eliminating homelessness. Both authors know the situation in India through personal encounters and from research. Lanjewar was able to interview individuals from India about their experiences of government assistance in helping them to move out of homelessness. We felt that the knowledge we gained in India was closely related to its history and culture, and we decided to compare how other countries with different backgrounds and cultures deal with similar challenges related to homelessness. We found out in our earlier studies that a comparative analysis of social problems across different cultures may uncover broader general phenomena that otherwise stay invisible [8]. Our experiences and cross-cultural comparison results will be presented in the second part of this study.

Both articles are the result of studies conducted by two immigrants working with the unhoused population in the U.S. and comparing their thoughts and perspectives on homelessness in one of the wealthiest countries in the world. We wanted to show both the commonalities and differences in each of the countries we studied, focusing on the lived experiences of homelessness and societal strategies to eradicate homelessness. Just as each individual's story of becoming unhoused is unique, the national response to help the homeless also varies. Each government addresses homelessness by trying to prevent it from occurring, building affordable housing, and creating social support systems, including public benefits. Offering housing to the unhoused is always the most effective strategy, but many communities and countries cannot afford such an approach, and sometimes other methods (like mental health and employment support) may be even more suitable.

## Homelessness in India

Homelessness remains a challenge in India. The Indian government defines the homeless as “those who live on roadside pavements, in Hume pipes, under flyovers and staircases, or in temples, and railway platforms, or other open spaces” [9]. In contrast, under the UN General Assembly, the Universal Declaration of Human Rights (UDHR) defines homelessness as applying to “those who do not live in a regular residence due to lack of adequate housing, safety, and availability” [10]. People face homelessness or live below the poverty line because of several reasons such as unemployment, the lack of affordable housing, migration from rural areas to cities, discrimination, insufficient government support, and situational needs.

When talking about India, we must address religion and the caste system. A report from the Union of Catholic Asian News provides a good understanding of the statistics of marginalized or minority communities, such as Muslims, tribal peoples, lower castes, and Dalits, who were historically labeled “untouchables”. Individuals and families belonging to these sections are predominantly sanitation workers; they are largely restricted to menial occupations traditionally considered “unclean”, including scavenging, scrap metal collection, butchering, rag picking, labor, and the leather industry [11]. These classes remain below the poverty line and migrate from one place to another in search of work, with no permanent place to stay. Significantly, there is a generations-long chain in these societies, with children following the same path as their fathers. Among the reasons for this persistent, generational homelessness are limited access to education, lack of awareness and opportunities, ongoing discrimination, the use of alcohol and drugs, and involvement in crime.

The survey conducted by the Indo-Global Social Service Society (IGSSS) in May 2019 discussed the caste-related aspect of homelessness. It showed that 80% of the homeless population belonged to SC (Scheduled Caste), ST (Scheduled Tribe), or OBC (Other Backward Class). This data was pulled from a few states, including Bihar, Maharashtra, Jharkhand, Andhra Pradesh, and Kerala. One of the themes that came out of the survey was the intergenerational cycle of poverty that contributes to homelessness. Among these groups, homeless women experience malnutrition, mental illness, other diseases, and high-risk pregnancies [10]. Those living below the poverty line and at risk of becoming homeless by migrating from place to place often pass on these issues to the next generations.

Some of the homeless statistics are not recorded because individuals live in remote locations in rural areas without technology. Urban societies and the government of India have defined several types of rural homelessness. For instance, individuals who live in relief camps due to various causes like natural disasters, communal riots, political conflicts, etc. are known as displaced persons. Another category includes migrants who make their way to urban locations because of land scarcity or poverty. There are also seasonal migrations from villages to cities, and sometimes during festivals, to earn money. Migrants may stay in urban centers, while the rest of their families stay

in rural areas. A somewhat similar category of homeless individuals is itinerant groups who have no fixed address and are usually tribal groups or individuals engaged in religious worship. Beggars, a popularly used word for homeless individuals in India, also include those who live in settlement houses or leprosy colonies. Those who live in overcrowded or insecure dwellings with others are classified as homeless while living with other people in the same household [12].

The popular newspaper *The Wire* [13] has presented information about the homeless population in various districts. Around 80%, or 640 of 797 districts in India, were included in the newspaper’s research. Most of the rural areas of India that contribute to homeless populations are in the western and southern parts of the country. *The Wire* also points out that homelessness is growing rapidly in urban areas. Moving to big cities is a way to raise the standard of living and work opportunities. This increases population density and cultural diversity; however, not every migrant or every family of a migrant obtains employment sufficient to live comfortably. Individuals are often found performing labor work with daily wages, selling handmade items/souvenirs at traffic signals, or living on the street in makeshift tents with families. They lack arrangements for water, proper lighting, food, cooking space, bedding materials, safety, hygiene, and children’s nutrition. When the growing number of families with similar conditions becomes visible, the perception of metropolitan areas changes. Major cities with such conditions include Kanpur, Kolkata, Mumbai, Surat, Delhi, and Hyderabad.

In general, women, children, individuals with disabilities, and migratory workers are adversely impacted by homelessness in India. Homelessness contributes to poverty, illiteracy, unemployment, and poor health. The homeless population in India faces challenges at all levels, for example, health concerns, individuals and families living on the street, *kaccha* houses (made of mud, leaves, plastic sheeting, and bricks without cement), and unsanitary or uninhabitable environments that make the homeless vulnerable to illness. Malnutrition in children is an existing problem that becomes even more complicated when a family is homeless.

As discussed earlier, migrants and their families live on the streets, working for daily wages which only fulfill the needs of the day, and they face poor living conditions with limited or absolutely no resources and support from the community. This lifestyle leaves a great impact not only on families themselves but also on their children, who follow a similar path to make their living due to lack of exposure, unlike children in stable families. This chain can continue for generations [14]. Homelessness occurs because of several factors, including physical and mental disabilities. Moreover, poverty and the acquisition of the lands of families in rural areas by large or government-affiliated institutions are significant causes of homelessness. Poverty as a cause of homelessness in India is well-known. People living in poverty make less money compared to other individuals in the community. Individuals are dependent on daily income just to survive. Some of the most common occupations where individuals live below the poverty line include street vendors, rag pickers, scavenging, rickshaw pullers, per-day laborers, etc. [15].

Individuals and families spend years and years living in shacks, on the streets, or in rooms covered with large plastic sheeting. Migrants from different places in India make their own arrangements in ways that gradually form slums. They lack adequate housing and face economic disparities. This is simply urban homelessness. The social stigma surrounding the lifestyle of people in slums or on the streets leads to discrimination, later associated with disparities in education, government benefits, and medical services. All these disparities reinforce the cycle of poverty.

After COVID-19, many people lost their jobs, which also impacted homelessness due to unemployment. According to the Centre for Monitoring Indian Economy (CMIE), around 7 million jobs were lost during the COVID wave; thus, the national unemployment rate in April increased to 8 percent from 6.5 percent in March [16]. According to the CMIE, “approximately 18 million jobs were lost during this pandemic” [15]. Unemployment in the middle class makes it difficult for individuals and families to make a living and fulfill the basic needs of life. It pushes them into poverty, which eventually leads to homelessness. Due to unemployment, affording basic necessities, such as food and clothing, has become difficult, as prices rose after the pandemic. Migrants returned to their homes, which put them in an even tougher situation due to limited food supply versus more demand at home. The motivation and focus on buying a house shifted to obtaining enough food for the families, maintaining health, fulfilling basic needs, and at the same time, finding employment.

Natural disasters such as floods, hurricanes, droughts, and other events have been major causes of homelessness. As a result, individuals and families are displaced from their permanent homes because of property destruction, loss of belongings, and limited access to essential services such as food, electricity, and communication networks. Displacement makes the situations of individuals and families in poverty even worse. Homes in some areas may be washed away by sudden heavy rains or floods. People may be forcefully evacuated by the authorities to avoid further losses [17].

Chronic mental illness and substance use/abuse are two of the major causes of homelessness worldwide. India is not an exception. Poor mental health can potentially lead to loss of employment, relationship conflicts, social problems, addiction to substances, chemical dependency, etc. It is devastating for individuals and families living in poverty or below the poverty line. In 2017, the Delhi government and the Drug Dependence Treatment Centre, AIIMS, reported that around 7,900 street children were found to be addicted to inhalants; 9,000 abused alcohol; 5,600 consumed cannabis; and over 1,200 consumed heroin and opioids [15]. Although research is limited, the Ministry of Health and Family Welfare in India reported in 2017 that 6–7% of people in India faced some sort of mental illness.

In some societies in India, domestic violence is still at its peak [18]. One of the common reasons behind it is the dowry system [19]. The dowry system refers to the custom of the bride’s family offering cash, movable property,

or goods to the groom upon marriage. Communities in villages with this tradition and culture demand dowry during marriage. In fact, in some cases, dowry is a prerequisite to get married. Families who fail to fulfill this demand, and women from these families, tend to be subjected to domestic violence and mental torture by the husband’s family. This results in women leaving or abandoning their homes. They cannot even return to their parental homes since there is a popular traditional saying “Betiya para ya dhan hoti hai”, meaning that daughters are someone else’s wealth, an expression of patriarchal family values. When daughters are born, it is believed that they will not carry the family line forward since they have to marry and leave their parents’ house. It is expected that boys will take on the responsibility for continuing the family generation. This is how women are raised in families in areas that are deeply rooted in their traditions and culture. In such situations, women often end up staying in temporary shelters and utilizing voluntary services.

Land ownership in rural areas plays a key role in the socioeconomic development of societies that fall under these religious categories. Dalits and other backward classes are commonly subjected to losing land in rural areas, either for governmental projects or under the umbrella of city development. The government generally compensates people when taking their land. However, this leaves a long-lasting impact, because the sale of property affects their financial stability for the future. The interesting fact about landownership is that it is not necessarily related to government projects. Those in the higher socioeconomic classes also purchase lands for investment. Looking at the caste hierarchies and disparities in India, the upper-class lobby, which includes Brahmins and other Hindu castes, holds a significant share in land ownership. Poverty in India is a generational buildup of a variety of circumstances in individuals’ and families’ lives that either leads to success or living below the poverty level for years and years. The buying and selling of land is one aspect of inequality that increases the poverty level.

People in urban and rural communities have different approaches and responses to addressing homelessness in India. The ideology of feeding the hungry is quite popular and also an important part of religious practice. During major festivals, for example, Navratri, Diwali, Ganesh Chaturthi, Buddha Purnima, Rama Navami, Ambedkar Jayanti, and many more, the communities organize Langar Seva, the custom of free food distribution to the people who attend festivals. For homeless people, it is a great opportunity to obtain food, often something long-desired. Some community and society groups, either on a monthly basis or every certain number of months, provide donations in cash and non-cash resources to individuals on the streets or in shelter organizations. These could be clothes, amenities, food, organizational programs that are beneficial to individuals and families, and educational materials for children. These are all short-term solutions that meet the immediate needs of the people, rather than sustainable solutions to poverty. We still need long-term goals and preparation to work toward ending poverty and homelessness, and the government plays a significant role in the process.

## Actions to eliminate homelessness

Both central and local governments, along with non-governmental and community organizations, are aware of the causes of homelessness and have taken a range of measures to reduce it. The Indian government launched the Antyodaya Anna Yojana (AAY) initiative for its poorest citizens, those living in shelters and migrants. Under this scheme, food grains are provided at highly subsidized rates to the BPL (Below Poverty Line) card holder/sections. This scheme is targeted to reduce hunger among the poorest of the poor in India. Cardholders get rice, wheat, pulses, and fuel at lower prices. The card also provides access to health, education, and housing benefits programs intended for low-income families. Furthermore, in the occurrence of natural disasters or economic downturns, the scheme provides cardholders with immediate assistance and safety-net support. The subsidized scheme is operated throughout the country with the help of local authorities that reach out to families or vice versa [20].

NGOs in different states, cities, and districts in India play a significant role in supporting individuals and families living in shelters and on the streets, those who are migrants, and those living below the poverty level. Some NGOs operate independently of the government, operating social missions and providing volunteer services. Salam Baalak Trust, in Delhi, runs four shelters that can accommodate up to 220 children. Some of the services they provide include food, education, and healthcare. This NGO also offers skill development classes that can be helpful for children for future employment [21].

Mental health practice and the awareness around it are still limited in some parts of India. Promoting mental health and education among students, communities, and NGOs by organizing outreach services, community workshops, campaigns, educational seminars, etc., would be helpful to serve homeless individuals and families [22, 23]. Graduate programs in fields such as psychology could incorporate field practicums focusing on homelessness and mental health, providing students with opportunities to reach out to homeless individuals and meet them where they are.

The current Modi government has come up with a few new schemes since 2016 to boost employment in India. However, there is limited data supporting the success of these programs. Make in India is one of the programs created to generate employment in sectors like manufacturing. However, some economists argue that strict land acquisition laws and inflexible labor regulations make it challenging for investors [24]. Digital India is another scheme that focuses on automation and encourages entrepreneurs to create home-based jobs and online businesses. However, at present, India is a developing country and is still moving towards technical advancement. Many IT companies, for example, Tech Mahindra, HCL Technologies, and WIPRO, have slowed the hiring of new employees. This is also one of the barriers to promoting Digital India schemes. The Modi government also introduced a program called Start-up India, involving banks that were encouraged to provide finance to entrepreneurs to start their businesses. Pre- and post-COVID-19, due to this

program, many employees left their jobs and turned to entrepreneurship; however, as many start-ups failed, they became unemployed [24].

Those affected by migration, natural disasters, or living below the poverty line often lack shelter to make a decent living and formal identity to acquire government services. The Indian government provides old-age assistance, and the Public Distribution System offers food and unemployment allowances through a program under the Mahatma Gandhi National Rural Employment Guarantee Scheme (MNREGA). Moreover, the Shelter for Urban Homeless (SUH) scheme provides shelter to impoverished urban populations. Some of the provisions in the program include all-weather permanent shelters open 24 hours a day and a permanent community center for at least 100 people for every 1 lakh population. Each shelter caters to 50–100 individuals, depending on local conditions [25].

## Help for families

Families living in poverty can hardly envision their and their children's future due to a lack of resources and support. The government established a scheme to alleviate poverty and help families build strong and permanent houses with basic amenities. The initiative is popularly known as "Pradhan Mantri Awaas Yojana Gramin (PMAY-G)"; it was previously called "Indira Awaas Yojana (IAY)", named after the late former Prime Minister of India, Indira Gandhi. This scheme aims to provide houses for families living in dilapidated homes and without permanent housing. The PMAY-G assists families by bridging the housing deficit and providing physical, emotional, and mental stability. To learn more about this program and how it helps families to become stronger in society, I reached out to Shubham, a young adult from the state of Maharashtra, India. Shubham's father died when he was in college, and he was the sole breadwinner in the house. He had to leave his dreams behind and begin earning money for the family. His household was among those in Maharashtra that benefited from the PMAY-G scheme. Shubham explained: "Having a permanent house means a lot to me. When I saw that my house was built and ready, it felt like thousands of pounds had been removed from my shoulders. I am the only son at home, and I have two sisters, so I was worried about how I would manage my salary to get the house and then provide support for my sisters' marriages in the era of inflation." This was his first response; it made me even more curious to explore his experiences revolving around the scheme and government support. I attempted to focus on the additional aspects that had to be covered, such as emotional and mental health balance related to housing. He stated: "When I was a teenager, I did not understand how my father struggled and worked hard to carry the family. I would not have understood the pain of my father if he had been alive and built a house for us that I am feeling now. My sleep has never been peaceful since my father's death. Now it has been a few months since I have my home, and I can sleep without being worried about building a house. This is a huge help for me and my family." Shubham's story was overwhelming; he spoke frankly about the practical effect of the PMAY-G program.

There are certain qualifications and requirements that a family must fulfill before obtaining assistance from the government under this scheme. These include household income criteria or inclusion in groups such as the Economically Weaker Section (EWS), Low Income Group (LIG), Scheduled Castes, Scheduled Tribes, and Other Backward Classes. Once families receive approval for housing, they must start building the foundation of the house and follow up with the authority to receive funds for completing the house. The reason is that even though the state and the central government provide funds to families, they receive money in installments once the level of construction of the house is provided as proof.

### **Education as a fundamental condition to break the cycle of poverty**

One major barrier to education is the lack of resources to obtain quality schooling without having to worry about financial burdens. In many rural or urban-rural areas in India, ZP (Zilla Parishad) schools have been established to provide education for children from the 6th to the 10th grade. These schools are run by state and local authorities that provide services like uniforms, stationery for schooling purposes, mid-day meals, and affordable education without any investment from families. ZP schools are known to be one of the best education services for people in poverty. Their teachers are well-trained and capable of working with children facing significant challenges. Basic education helps develop crucial life skills such as literacy, time management, communication, and decision-making. It also provides an avenue for the children to see a bigger picture in their lives in terms of their careers. Non-governmental organizations outside the ZP take the initiative to provide additional resources and services to the children in poor families. The organization is known as “Sparsh”, which means “touch” in English, and has established multiple initiatives to serve children in underprivileged families. With the vision of a “healthy and compassionate community”, the organization invests in programs like nutrition, education, medical care, vocational training, and infrastructure development. Among its key initiatives is the digitalization of Zilla Parishad (ZP) schools. Digitalization in rural schools means enhancing education methods through the introduction of technology, tablets, computers, online learning, and teaching in science and mathematics. The goal is to offer a means to obtain quality education through the use of creative teaching strategies [26]. However, providing services is of no use if the target population is not engaged. The organization observed a lack of motivation in children, leading to increased absenteeism and poor reading and writing skills. Digitalized innovative teaching methods have proven attractive among children and a way for them to access quality education. Discussing the outcome of this initiative, Sparsh [26] emphasized that since 2016, they have successfully digitalized more than 110 schools, helping more than 12,000 students and more than 425 teachers.

Education brings employment opportunities that could eliminate staying on the streets or elsewhere and finding a place to make a comfortable living. One way the most vulnerable can enter the education system is through

reservation benefits. The reservation scheme ensures representation of historically marginalized communities in education, employment, and politics. The reservation/quota provides a chance to underprivileged communities like the scheduled caste (SC), scheduled tribe (ST), and other backward castes (OBC) to get enrolled in government/public schools to receive primary and higher education. It is important to note that the main cause of reservations in India is the caste system. Historically, because of the high cost of schooling and higher education, which prevented especially those from underprivileged communities from affording it, on the other hand, white privilege was widespread in the country, which gave the upper-class power and freedom. As a result, the underprivileged communities faced discrimination across all areas of their lives, including education. The policy of education reservation/quota was created to provide justice and accessibility to these communities [27].

Social activists and non-governmental organizations can help children or families take advantage of the reservations. Organizations, businesses, and possibly community stakeholders can work together to acquire resources for people living below the poverty line and those who are homeless. Such efforts may not only address systemic barriers in the country but also help to reduce discrimination against this population.

### **Demolition of slums**

Has the Indian government shown progress in reducing homelessness or uplifting people in poverty? In some cases, government authorities have instead destroyed livelihoods, displacing the poor, and forcing people to leave the place where they once used to have a bed. One of the prime examples of such incidents was the G20 Summit hosted in the capital city of New Delhi in 2023. People living in slums faced nothing less than a traumatic event in their lives when bulldozers by the intergovernmental groups accompanied by law enforcement started demolishing shelters, small houses, and stores, and forcing people to vacate the area. It is certainly true that not all families had registered ownership of their homes, meaning an entry in the official governmental records and documents. The buyer guarantees that the transaction is accepted and enforced by law and establishes legal possession of the property by registering it. Protecting the buyer's rights and interests in the property requires taking this crucial step; however, there should have been an appropriate legal course of action that considered the future of the families living in this location. In fact, some of the stories of individuals and families from the region describe how local authorities took them to bus stations to remove them from their homes. Such incidents were very unfortunate and traumatic for the individuals and families affected. The “need” for a venue for the G20 summit was the reason given for this significant displacement of the poorest in society. Protest was the only way to advocate for the people suffering from this demolition. The entire globalization movement and groups opposing this displacement were highlighted [28]. Those who lost their homes sought shelter wherever they could, on streets, in temples, or on playgrounds, further increasing the numbers of the unhoused.

This disregard for people's efforts to make their existence livable is shocking. What is missing from this picture of slum demolition is recognition of people's energy and resilience in rebuilding their shelters against the destructive power of government. The devastation of slums makes people's desire to improve their lives invisible and easy to dismiss. This is why our next study focuses on a comparative analysis of how different countries approach the problem of the existence of slums.

### Lessons from the U.S.

Through his involvement in community services in India, Lanjewar explored multiple governmental facilities and programs designed to help individuals and families living below the poverty line. He experienced various dimensions of support provided by the Indian government towards basic needs, education, healthcare, and housing. Lanjewar noticed the holistic approach and community collaboration to reach the shared goals of the communities. Diversity is a major question for the Indian government, which participates in inclusive practices by implementing policies and advocacy that are beneficial to underserved groups like minorities. Lanjewar completed a master's degree in social work from one of the prestigious schools of social work in the United States and participated in community initiatives as well as clinical social work. His work with communities in the USA introduced him to some of the American governmental programs supporting individuals and families living in poverty and facing homelessness.

Social work practice with homeless veterans and others in the United States involves an introduction to multiple American government programs and policies [29]. One of them is the Section 8 Housing Choice Voucher, a federal program that provides rental assistance to low-income families, people with disabilities, and the elderly. However, applicants face long waiting lists before obtaining rental assistance. During his practice, Lanjewar observed clear differences between the processes for veterans and those for others. The HUD VASH department at the Cleveland VA Medical Center does a commendable job of helping veterans find and maintain housing by providing intensive case management. As a designated special population, veterans benefit from resources and dedicated people to help them. In contrast, the process is very different for non-veterans. It is not easy for homeless individuals and families to reach out to community organizations and seek case management help to obtain housing. There are significant barriers, such as limited transportation, education, guidance, and untreated mental health issues; in addition, case managers are overwhelmed with caseloads, a lack of documentation, stereotypes and stigma, and other challenges.

Sometimes, the city housing authority itself becomes a barrier when treating individuals and families coming from different walks of life. During his practice at the VA, Lanjewar noticed that veterans receive the special attention that they deserve, with dedicated teams coordinating with the VA team to discuss access to services [30], housing status, process, needs, etc. But when Lanjewar worked with homeless populations in community organizations, he noticed completely opposite scenarios, in

which individuals had to wait weeks to get an appointment with representatives (mostly case managers) of the housing authority, faced long-standing waiting lists, received no confirmation of successful admission to the program for months and months, had difficulty finding housing, and lacked housing navigation guidance, among many more challenges. There are numerous factors contributing to each process and a great deal of variability in people's situations; this description simply comes from his experiences working directly with clients.

Homelessness is growing faster in the United States each year, affecting different demographics, individuals and families, immigrants and refugees. It remains a significant problem to solve, requiring considerable effort, resources, policies, civic engagement, and, most importantly, the involvement of the government as much as possible. People do not deserve to be homeless. Housing is a basic human right and a critical steppingstone to obtaining various resources to maintain well-being. We learned that discrimination on a systemic level is a significant problem. Populations are categorized by their social status, race, and the agencies that refer them; no matter the population, homeless individuals face a substantial gap in services. As discussed earlier, the treatment of veterans and others at housing agencies looks different in terms of priorities given, responsiveness, and availability of case workers. The general population is at a clear disadvantage. To combat systemic discrimination, authorities must ensure equal access to services, people/representatives in place to attend to homeless individuals, and families' requests and facilitate housing needs. Culturally competent services are especially impactful when working with diverse groups of people. Furthermore, working with homeless populations is heavily based on trust. Developing relationships with them and advocating for their housing rights could bring significant changes in their lives, while treating them unethically will not.

### Conclusion

Community social workers, activists, and NGOs frequently advocate for homeless people to acquire their rights which are getting housed and helping them build better lives without facing discrimination. Poverty and homelessness are also hot topics for politicians, often used to attract voters. They remember to include this population in their manifestos, but unfortunately, not everyone works for them, and they are just a source of gaining empathy from citizens by showing care for the homeless. Using unhoused people as a tool to be elected does increase the voting percentages, but unhoused people are left to suffer. They struggle to access the benefits that they need to survive and achieve a decent standard of living.

Homelessness in India does not occur in isolation. Families face generational poverty that impacts their mental and physical health, contributes to behavioral issues, medical conditions, and societal differences such as discrimination, racism, family problems, lack of education, and lack of support in the community. Individuals and families are generally religious and believe in God to be the last option to solve their problems. They stay wherever they get a place to sleep and are mostly found on the

streets or temple grounds. Further, migrant communities often settle in one place, build shelters with a plastic sheet roof, and try to make a living. Eventually, the number of people migrating to the same place increases because of the invitation to find a job by family members or relatives, and they make their living in the same place, leading to the formation of slums. The tradition of helping each other is deeply rooted in Indian families. As discussed earlier, this is one of the reasons why people in poverty may have a roof over their head but the registry of a raw house. A raw house refers to a dwelling that is incomplete; it may have walls but no roof and be covered with a plastic sheet, and it may lack a primary source of water, electricity, plumbing, sewage, a foundation, interior or exterior, and security. On the other hand, authorities could take the initiative to convert slums into structured housing blocks and invest in reformed housing societies, rather than resorting to demolition and leaving people with nowhere to go. Stable housing is a fundamental need that allows individuals to obtain other resources that are important for future development, such as healthcare, including mental health services, and education.

Overall, homelessness in India is a complex issue and needs a comprehensive approach from different types of stakeholders at various levels to eliminate or at least reduce homelessness to some degree. It is very important to modify and change the perception of citizens toward homelessness and start providing support.

## References

1. Speak S, Tipple G. Perceptions, persecution and pity: The limitations of interventions for homelessness in developing countries. *International Journal of Urban and Regional Research*, 2006; 30: 172–188
2. Parsell C, Sharma N, Kuskoff E. Ending homelessness through permanent supportive housing: a cost offset update. *Life Course Centre Working Paper Series*. Institute for Social Science Research, The University of Queensland, Australia, 2023; 27. doi: 10.14264/31b3388
3. Zhao E. The key factors contributing to the persistence of homelessness. *International Journal of Sustainable Development & World Ecology*, 2023; 30: 1–5
4. Ghosh S. Understanding homelessness in neoliberal city: A study from Delhi. *Journal of Asian and African Studies*, 2020; 55: 285–297. doi: 10.1177/0021909619875775
5. Nuti SV, Velasquez D, Adams LD, O'Connell JJ. Precision permanent supportive housing: A data-driven approach to addressing chronic homelessness. *Health Affairs Forefront*, 2024. doi: 10.1377/forefront.20240625.514007
6. Montgomery AE, Hill LL, Kane V, Culhane DP. Housing chronically homeless veterans: Evaluating the efficacy of a housing first approach to HUD-VASH. *J. Community Psychol*, 2013; 41: 505–514. doi: 10.1002/jcop.21554
7. Evans WN, Kroeger S, Palmer C, Pohl E. Housing and urban development-veterans affairs supportive housing vouchers and veterans' homelessness, 2007–2017. *Am J Public Health*, 2019; 109: 1440–1445. doi: 10.2105/AJPH.2019.305231
8. Kotlarska-Michalska A, Farkas KJ, Romaniuk JR (eds). *The invisible groups in Poland*. Wydawnictwo Nauk Społecznych i Humanistycznych, Poznań, Uniwersytet im. Adama Mickiewicza, 2019
9. Hindustan Times. There are 1.77 million homeless in India, but the State is blind to them. *Hindustan Times*, 2017. <https://www.hindustantimes.com/editorials/there-are-1-77-million-homeless-in-india-but-the-state-is-blind-to-them/story-ypUh96FiXsxfZbrts88GnK.html> (access: 28.03.2025)
10. Bandavath A. Homelessness in India. *CounterCurrents.org*. 2020. <https://countercurrents.org/2020/12/homelessness-in-india/> (access: 28.03.2025)
11. UCA News. Indian poverty linked to religion and caste. *Union of Catholic Asian News*, 2019. <https://www.ucanews.com/news/indian-poverty-linked-to-religion-and-caste/85420> (access: 28.03.2025)
12. Smith SJ (ed). *Rural homelessness in India*. International Encyclopedia of Housing and Home, 2012
13. The Wire. Homelessness amid COVID-19: Miseries untold and promises shattered. *The Wire*, 2020. <https://thewire.in/uncategorised/homelessness-amid-covid-19-miseries-untold-and-promises-shattered> (access: 28.03.2025)
14. GoEco. Volunteer with the street children in India. *GoEco*. 2022. <https://www.goeco.org/article/street-children-of-india/> (access: 28.03.2025)
15. Rashmi, Mallikarjun KS. The homelessness crises in India: Understanding the cases and solutions. *Journal of Emerging Technologies and Innovative Research (JETIR)*, 2023;10: f639–f643
16. Basu K. The post-pandemic whiplash awaiting the World's poor. *The Bookings Institution*, 2021. <https://www.bookings.edu/articles/the-post-pandemic-whiplash-awaiting-the-worlds-poor/> (access: 28.03.2025)
17. Ngashangva C, Arasu S. Heavy rain, landslides have killed at least 72 people this week in India's Himalayas. *Indeastream Public Media*, 2023. <https://www.pbs.org/newshour/world/heavy-rain-landslides-have-killed-at-least-72-people-this-week-in-indias-himalayas> (access: 28.03.2025)
18. Koul P. Violence, homelessness and gender: A socio-legal issue in India. Part 2 *Indian J. Integrated Rsch L*, 2022; 2: 1
19. Saravanan V. An analysis on dowry system as violence in India. *Indian Journal of Law & Legal Research*, 2021; 3: 1
20. Ojaank. How is BPL ration card made? Its holders get so many facilities. *Daily Current Affairs*. Ojaank Ias, 2024. <https://www.ojaank.com/blog/detail/how-is-bpl-ration-card-made-its-holders-get-so-many-facilities> (access: 28.03.2025)
21. Valson S. Prevention of homelessness: How is the problem treated legally. *Ipleaders*, 2021. <https://blog.ipleaders.in/prevention-homelessness-problem-treated-legally/> (access: 28.03.2025)
22. Ul Hassan F, Nagavarapu LS, Prasad KM, et al. Homelessness in mental illness: Opportunities & prospects in the Indian context. *Asian J Psychiatr*, 2019; 45: 28–32. doi: 10.1016/j.ajp.2019.08.011
23. Kaur R, Pathak RK. Homelessness and mental health in India. *Lancet Psychiatry*, 2016; 3: 500–501. doi: 10.1016/S2215-0366(16)30050-5
24. Naik BR. Role and initiatives taken by government to handle unemployment in India. *Online Anveshana's International Journal of Research in Regional Studies, Law, Social Sciences, Journalism, and Management Practices*, 2016
25. Observer Research Foundation. *Sheltering the Urban Homeless*. ORF, 2022. <https://www.orfonline.org/expert-speak/sheltering-the-urban-homeless> (access: 28.03.2025)
26. Sparsh. Digitalisation of Zilla Parishad (ZP) Schools. *Sparsh Trust*, 2022. <https://sparshtrust.org/our-initiatives/digitalisation-of-zilla-parishad-schools/> (access: 28.03.2025)

- 
27. Sidhu M. Reservation in Indian education. Unique get together society. children, family, community, 2021. <https://www.uniquegettogethersociety.com/post/reservation-in-indian-education> (access: 28.03.2025)
  28. Dubey P. India makes way for G20 Summit by displacing homeless people. Toward Freedom, 2023. <https://towardfreedom.org/story/archives/asia-archives/india-makes-way-for-g20-summit-by-displacing-homeless-people/> (access: 28.03.2025)
  29. Evans WN, Phillips DC, Ruffini K. Policies to reduce and prevent homelessness: What we know and gaps in the research. *J Pol Anal Manage*, 2021; 40: 914–963. doi: 10.1002/pam.22283
  30. Romaniuk JR. Veterans' access to health care. *NASW Health Section Connection*, 2015; 4: 7–8



# PHEOCHROMOCYTOMA AND PARAGANGLIOMA IN CHILDREN AND ADOLESCENTS

Guzy chromochłonne i przyzwojaki  
u dzieci i młodzieży



Piotr Skrzypczyk<sup>1</sup>, Aneta Michalczywska<sup>1</sup>, Urszula Ambroziak<sup>2</sup>

1. Department of Pediatrics and Nephrology, Medical University of Warsaw, Poland
2. Department of Internal Medicine and Endocrinology, Medical University of Warsaw, Poland

Piotr Skrzypczyk – 0000-0002-1959-8255  
Aneta Michalczywska – 0009-0003-1353-2575  
Urszula Ambroziak – 0000-0002-8778-1959

## Abstract

Pheochromocytomas and paragangliomas are rare neuroendocrine tumours that are an important cause of secondary hypertension. Pheochromocytomas and paragangliomas manifest with a varied clinical picture, including life-threatening hypertensive crises. Persistent, sustained hypertension, the incidence of which far exceeds paroxysmal hypertension, is the predominant clinical manifestation. In the paediatric population, 70–80% of tumours have a genetic background. Hereditary pheochromocytomas and paragangliomas are manifested by early tumour development, bilaterality, multifocality, mainly extra-adrenal localization, and an increased risk of recurrence. Measurement of free metanephrines (MNs) in plasma is considered the gold diagnostic standard due to its high sensitivity and reliable reference values in children. Nuclear medicine plays a key role in the diagnosis of pheochromocytomas and paragangliomas, with high sensitivity and specificity. They are used to assess regional extent, multifocality, and the presence of metastases. Surgical resection preceded by appropriate preoperative preparation is the primary therapeutic approach. Genetic testing and implementation of genetic counselling are recommended in all paediatric patients with confirmed pheochromocytomas and paragangliomas. Scientific evidence and clinical studies on pheochromocytomas and paragangliomas in the paediatric population are limited. The diagnostic and therapeutic process is challenging, often requiring a multidisciplinary approach. The purpose of this paper was to present the clinical picture, genetic background, diagnosis, and treatment of pheochromocytomas and paragangliomas in children and adolescents.

## Streszczenie

Guzy chromochłonne i przyzwojaki to rzadkie nowotwory neuroendokrynne, będące istotną przyczyną wtórnego nadciśnienia tętniczego. Manifestują się zróżnicowanym obrazem klinicznym, obejmującym zagrażające życiu przełomy nadciśnieniowe. Dominującym objawem klinicznym jest utrzymujące się utrwalone nadciśnienie tętnicze, którego częstość występowania znacznie przewyższa nadciśnienie napadowe. W populacji pediatrycznej 70–80% nowotworów ma podłoże genetyczne. Dziedziczne guzy chromochłonne i przyzwojaki objawiają się wczesnym rozwojem guza, obustronnym występowaniem, wielogniskowością, lokalizacją głównie pozanadnerczową oraz zwiększonym ryzykiem wznowy. Pomiar stężenia wolnych metoksykatecholamin w osoczu jest uznawany za złoty standard diagnostyczny ze względu na jego wysoką czułość i wiarygodne wartości referencyjne u dzieci. Badania z zakresu medycyny nuklearnej odgrywają kluczową rolę w diagnostyce tych nowotworów, cechując się wysoką czułością i swoistością. Są one stosowane w ocenie zasięgu regionalnego, wielogniskowości oraz obecności przerzutów. Podstawową metodą terapeutyczną jest resekcja chirurgiczna, poprzedzona odpowiednim przygotowaniem okołoperacyjnym. U wszystkich pacjentów pediatrycznych z potwierdzonym rozpoznaniem rekomenduje się przeprowadzenie badań genetycznych i wdrożenie poradnictwa genetycznego. Dowody naukowe oraz badania kliniczne dotyczące guzów chromochłonnych i przyzwojaków w populacji dziecięcej są ograniczone. Proces diagnostyki i leczenia stanowi wyzwanie, często wymagając wielospecjalistycznego podejścia. Celem pracy jest przedstawienie obrazu klinicznego, podłoża genetycznego, diagnostyki oraz leczenia guzów chromochłonnych i przyzwojaków u dzieci i młodzieży.

**Keywords:** children; arterial hypertension; pheochromocytoma; paraganglioma; catecholamines

**Słowa kluczowe:** dzieci; nadciśnienie tętnicze; guz chromochłonny; przyzwojak; katecholaminy

DOI 10.53301/lw/208535

Received: 24.06.2025

Accepted: 23.07.2025

Published: 30.12.2025

## Corresponding author:

Piotr Skrzypczyk  
Department of Pediatrics and Nephrology,  
Medical University of Warsaw,  
63a Żwirki i Wigury, 02-091 Warsaw, Poland  
e-mail: pskrzyp@gmail.com

## Introduction

Pheochromocytoma (PCC) is a neuroendocrine tumour originating from the chromaffin cells of the adrenal medulla and characterized by overproduction of at least one catecholamine, such as adrenaline, noradrenaline, and dopamine. Paraganglioma (PGL) is also a tumour arising from chromaffin cells, but it develops in extra-adrenal locations, most commonly within the thoracic, abdominal and pelvic sympathetic ganglia. PGLs may also originate from parasympathetic paraganglia of the head, neck, and mediastinum. Parasympathetic PGLs typically do not produce catecholamines. According to current guidelines from scientific societies, pheochromocytomas (PCC) and paragangliomas (PGL) are collectively classified as PPGLs [1].

PPGLs can lead to secondary hypertension (HT) in children. Although primary HT, increasingly linked to lifestyle factors and the rising prevalence of obesity, is increasingly commonly diagnosed in the paediatric population, secondary causes of HT should always be thoroughly evaluated and excluded in every child.

Data on PPGLs in children and adolescents remain limited. As a result, some clinical recommendations continue to rely on experience derived from adult patients, even though paediatric PPGLs have a distinct phenotype [2]. Due to the hereditary nature of these tumours, bilateral, multifocal, and extra-adrenal lesions are more likely to occur in children than in adults [3]. This paper is a literature review presenting the differences in clinical presentation, diagnostic approach, and management of paediatric PPGLs, with particular emphasis on the most recent guidelines.

## Epidemiology

PPGLs are rare tumours. Their incidence is estimated at 0.4–9.5 cases per million people per year in adults and 1–2 cases per million per year in children [4]. Among hypertensive adults, PPGLs account for approximately 0.2–0.6% of cases, whereas they occur in about 0.5–1.7% of HT children [5]. In the general population, pheochromocytomas are more common than paragangliomas, accounting for approximately 80–85% vs 15–20%, respectively. Extra-adrenal tumour locations predominate in children, occurring in roughly 66% of cases. The incidence of previously undiagnosed PPGLs identified in autopsy studies is estimated at 0.05–0.1% [6].

## Genetic background

PPGLs have a strong genetic basis, with one of the highest heritability rates among all cancers [7]. Approximately 40% of all cases arise from germline mutations. In the paediatric population, this proportion is significantly higher and is estimated to reach 70–80%. Hereditary PPGLs are characterized by early onset, bilaterality (20–40%), multifocality (30–70%), and an increased risk of recurrence (30%) [8].

To date, eight genes responsible for syndromic PPGL have been described: *RET*, *VHL*, *NF1*, *SDHA*, *SDHAF2*, *SDHB*, *SDHC*, and *SDHD*. These are autosomal dominant genes. Furthermore, more than 20 susceptibility genes have

been identified, including *FH*, *MAX*, *MDH2*, *SLC25A11*, *DLST*, *DNMT3A*, *TMEM127*, *HIF2A*, *EPAS1*, *EGLN1*, *EGLN2*, *IDH1*, *IDH2*, *IDH3B*, *CSDE1*, *FGFR1*, *PHD1*, *PHD2*, *GOT2*, *HRAS*, *MERTK*, *MET*, *KIF1B*, *H3F3A*, *BRAF*, *SUCLG2*, *H3-3A*, *MAML3*, *WNT4*, *DVL3*, *CHGA*, *ATRX*, *IRP1* [7, 9].

The most frequently described pathogenic variants are those affecting the *SDH* genes (*SDHA*, *SDHB*, *SDHC*, *SDHD*, and *SDHAF2*), which encode subunits of the mitochondrial succinate dehydrogenase complex involved in cellular energy production [9]. Germline mutations within these genes account for approximately 20% of all PPGL cases and may also predispose to other types of tumours [2].

PPGL is frequently associated with hereditary syndromes such as multiple endocrine neoplasia type 2 (*MEN2A* and *MEN2B*), von Hippel–Lindau syndrome (*VHL*), neurofibromatosis type 1 (*NF1*), and, less commonly, Carney triad and Carney–Stratakis syndrome. Clinical manifestations linked to mutations in genes predisposing to PPGL are summarized in Table 1. It is important to note that clinical presentation may vary considerably even among family members carrying the same mutation due to variable expression.

Most PPGLs are benign in the general population. In children, however, available data suggest that between 2.4% and 85.7% of tumours may exhibit malignant behaviour, which is largely attributed to the strong genetic background of the disease [2]. Pathogenic *SDHB* variants are the most frequently reported genetic alterations associated with malignant PPGL. Additionally, mutations in *FH* and *SLC25A11* have also been linked to an increased risk of malignancy [10, 11].

The historically used “10% rule” in PPGL, where it was thought that 10% of tumours are hereditary, malignant, bilateral, or extra-adrenal, is no longer applicable in current clinical practice [6].

## Clinical picture

Symptoms of PPGL arise primarily from catecholamine overproduction and from the pressure exerted by the tumour on adjacent structures (the so-called mass effect). These manifestations may be episodic, reflecting the paroxysmal pattern of catecholamine release typical of these tumours. These episodes may occur spontaneously or be triggered by a variety of factors, including physical exertion, abdominal muscle tension, large meals, alcohol, stress, and certain medications such as glucocorticoids, dopaminergic receptor antagonists, norepinephrine reuptake inhibitors tricyclic antidepressants, monoamine oxidase inhibitors, sympathomimetics, peptide hormones, anaesthetics,  $\beta$ -blockers, and opioids [12].

Table 2 shows the prevalence of clinical manifestations of PPGL in children.

The mean age at diagnosis in the paediatric population ranges from 11 to 13 years [6, 13].

Persistent HT is the most common symptom (93%), significantly more frequent than paroxysmal HT (7%) [6]. The typical triad of paediatric symptoms includes palpi-

**Table 1.** Hereditary paraganglioma-pheochromocytoma syndromes [2, 6, 7, 9, 12]

Gene	Syndrome	Clinical manifestations
<i>RET</i>	Multiple endocrine neoplasia type 2	MEN2A: pheochromocytoma, medullary thyroid carcinoma, primary hyperparathyroidism, cutaneous lichen amyloidosis MEN2B: pheochromocytoma, medullary thyroid carcinoma, mucocutaneous neuromas, intestinal ganglioneuromatosis
<i>VHL</i>	Von Hippel-Lindau syndrome	pheochromocytoma, hemangioblastoma (of the cerebellum, brainstem, spinal cord), retinal haemangiomas, clear cell renal cell carcinoma, renal cysts, neuroendocrine tumours and cystadenomas of the pancreas, endolymphatic sac tumours, epididymal cystadenomas, cystadenomas of the broad ligament of the uterus
<i>NF1</i>	Neurofibromatosis type 1	PPGL, neurofibromas, multiple cafe-au-lait spots, freckles in the armpits and groin, Lisch nodules of the iris, skeletal malformations, CNS gliomas, macrocephaly, cognitive deficits, GIST
<i>SDHA, SDHAF2, SDHB, SDHC, SDHD</i>	Pheochromocytoma and paraganglioma syndrome	PPGL, GIST, papillary thyroid cancer, clear cell renal cell carcinoma
(gene unknown)	Carney triad	paragangliomas, GIST, pulmonary chondromas
<i>FH</i>	Hereditary leiomyomas and renal cell carcinoma	Pheochromocytoma (rare), uterine fibroids, clear cell renal cell carcinoma
<i>EPAS1</i>	Multiple paragangliomas with concomitant polycythemia	PPGL, polycythaemia, vascular malformations, somatostatinoma, ocular manifestations
<i>TMEM127</i>		PPGL, clear cell renal cell carcinoma
<i>MAX</i>		PPGL, pituitary neuroendocrine tumour
<i>H3F3A</i>		PPGL, giant cell tumour of bone (GCTB)
<i>EGLN2</i>		PPGL, polycythaemia, normal or mildly elevated erythropoietin (EPO)
<i>DLST</i>		PPGL, pituitary adenoma, endometrial cancer
PPGL – pheochromocytoma and paraganglioma; MEN – multiple endocrine neoplasia; GIST – gastrointestinal stromal tumour		

tations, excessive sweating, and headaches (54%) [6, 14]. Abdominal pain, nausea, vomiting, polyuria, and polydipsia are also relatively common symptoms [15]. Other characteristic features include pallor, muscle tremor, anxiety and panic attacks, as well as orthostatic hypotension [15]. Although diabetes and prediabetes may occur as metabolic consequences of a hyperadrenergic state, they are rare in the paediatric population [6, 12].

The unique clinical presentation of PPGL in children is likely related to the fact that these tumours are predominantly extra-adrenal and frequently multifocal, metastatic, and recurrent. As already noted, this pattern reflects their strong association with hereditary syndromes in the paediatric population.

Differences in clinical presentation may also result from the secreted catecholamines. Patients with norepinephrine-secreting PPGLs are at higher risk of HT due to its strong affinity for  $\alpha_1$ -adrenergic receptors. In contrast, patients with epinephrine-secreting tumours are more prone to tachycardia and arrhythmias, reflecting the affinity of epinephrine for  $\beta_1$ -adrenergic receptors. Patients with dopamine-secreting tumours may present with normal blood pressure [6, 14]. The release of additional substances by the tumour, such as neuropeptide Y, parathyroid hormone, endothelin, vasoactive intestinal peptide (VIP), chromogranin A, adrenocorticotropic hormone (ACTH), atrial natriuretic peptide (ANP), somatostatin, erythropoietin, and interleukin-6, also contributes to the heterogeneous clinical presentation [15]. Notably, no

**Table 2.** Manifestations of pheochromocytomas and paragangliomas and their rates in children [13]

Manifestations	Rates (%)
Persistent HT	93
Paroxysmal HT	7
Headache	95
Excessive sweating	90
Resting tachycardia, palpitations	35
Visual disturbances	80
Neurological symptoms	65
Weight loss	15
Orthostatic hypotonia	10

direct correlation has been observed between catecholamine levels and blood pressure values [2].

Head and neck paragangliomas are rare in children and do not secrete catecholamines. Their symptoms may result from compression or invasion of adjacent structures, leading to tinnitus, hearing loss, dysphagia, hoarseness, cough, or cranial nerve palsy [12, 14]. Approximately 25% of PPGL cases may not produce excess catecholamines, and therefore be asymptomatic (so-called biochemically silent tumours). It is assumed that the absence of clinical symptoms is due to, among other factors, small tumour size and minimal catecholamine secretion, as well as the type and pattern of secretion, desensitization of adrenergic receptors, and other compensatory mechanisms of the body [16]. In the paediatric population, where hereditary PPGLs predominate and are often multifocal, metastatic, and more aggressive, the vast majority of patients (90%) present with symptoms of the disease [2].

Physical examination is usually unremarkable; however, abnormalities may include pale, clammy skin, dilated pupils, resting tachycardia, or features characteristic of specific genetic syndromes, as outlined in Table 1.

### Cardiovascular risk

Excessive catecholamine levels, which are typical of PPGL, represent a major risk factor for CV complications, including diverse forms of cardiomyopathy. Takotsubo cardiomyopathy, characterized by reversible left ventricular systolic dysfunction and often mimicking acute coronary syndrome, is the most frequently reported manifestation in the clinical literature.

Furthermore, hypertrophic cardiomyopathy may develop in cases of prolonged catecholamine-mediated HT.

Recent studies conducted in a large cohort of PPGL patients have provided new insights into the effects of chronic catecholamine exposure on the myocardium. Pre- and postoperative analyses of left ventricular morphology as well as systolic and diastolic function demonstrated that catecholamine excess can lead not only to left ventricular hypertrophy but also to impaired systolic function and subclinical diastolic dysfunction. Importantly, changes in cardiac structure and function were observed independently of blood pressure (both office measurements and ambulatory monitoring) as well as other traditional CV risk factors. This indicates that catecholamines exert a direct toxic effect on the myocardium, extending beyond their pressor activity. The potential reversibility of these cardiomyopathic changes following effective treatment, most commonly surgical removal of the catecholamine-secreting tumour, is a key finding of this research. This underscores the importance of early diagnosis and timely therapeutic intervention in PPGL patients to prevent cardiac complications and promote their reversal [17].

### Health and life threats

PPGLs represent a significant risk factor for complications and can pose a threat to patients' lives. Acute clinical deterioration may occur as a result of tumour necro-

sis, which leads to a massive release of catecholamines into the bloodstream. This can manifest as hypertension or hypotension, hyperthermia, encephalopathy, and multi-organ failure. Additionally, patients with PPGL are at risk of experiencing sudden and difficult-to-control increases in blood pressure during general anaesthesia or surgical procedures [2].

### Laboratory diagnosis

Assessment of plasma metanephrine (metanephrine, normetanephrine, and 3-methoxytyramine) is the recommended diagnostic screening method for PPGL [9]. Many studies have demonstrated that free plasma metanephrines (MNs) provide superior diagnostic accuracy, with sensitivity and specificity ranging from 97% to 100%, compared with plasma or urine catecholamines or their metabolites (such as homovanillic or vanillylmandelic acid) [6]. There are no reliable reference ranges for urinary metanephrine excretion available in children, and the use of adult norms may result in false-positive findings. For this reason, plasma testing is necessary. To obtain optimal results, it is recommended that the patient fast and remain in a supine position for at least 30 minutes before blood collection. However, it should be noted that this may be challenging in the youngest patients [18]. Furthermore, correct interpretation of the obtained results requires the use of age-specific reference ranges [19]. Clonidine suppression and glucagon stimulation tests are rarely used in adults due to their suboptimal sensitivity, and they are neither validated nor routinely performed in the paediatric population [6]. It is also worth emphasizing that other markers, such as chromogranin A or neuron-specific enolase, are not currently recommended.

In some patients, laboratory workup may reveal signs of hyperfiltration (decreased creatinine and increased glomerular filtration rate) arising from catecholamine excess, as well as activation of the renin-angiotensin-aldosterone system (RAAS) due to catecholamine-mediated renal vasoconstriction, which manifests as elevated renin (or increased plasma renin activity) and increased aldosterone concentrations.

### Diagnostic imaging

Imaging plays a key role in the diagnosis of PPGL (Tab. 3). It enables confirmation of positive or borderline biochemical results, precise localization of the tumour, and assessment of its extent. Imaging is also essential for planning the optimal surgical approach, particularly in cases of multifocal or metastatic disease, as well as for monitoring therapeutic efficacy [20].

Ultrasonography (US) is considered a useful tool in the diagnosis of PPGL. Due to its wide availability and low cost, it can aid tumour detection [15]. However, it is important to note that a negative US result does not exclude PPGL.

Magnetic resonance imaging (MRI) is the imaging modality of choice in paediatric patients with suspected PPGL. It is preferred for screening because, unlike other techniques, it does not involve exposure to ionizing radiation [8, 20]. MRI allows for precise detection and assessment of metastatic PPGLs and tumours located

**Table 3.** Sensitivity, specificity, and limitations across different imaging modalities for pheochromocytomas and paragangliomas [2, 6, 8, 15, 21, 23, 25, 26]

Imaging modalities	Sensitivity	Specificity	Limitations
Ultrasonography (US)	76% (Reisch et al. 2006) [25]		
Computed Tomography (CT)	Small tumours: 90–92% Large tumours: 100% (Reisch et al. 2006) [25]  90% (Lumachi et al. 2006) [26]  88–100% (Lenders et al. 2014) [1]	93% (Lumachi et al. 2006) [26]	Detects tumours $\geq 5$ mm.
Magnetic resonance imaging (MRI)	93.3% (Lumachi et al. 2006) [26]  Paragangliomas of the head and neck: 90–95% (Lenders et al. 2014) [1]	93% (Lumachi et al. 2006) [26]	Sedation may be needed in paediatric patients to maintain immobility (longer duration of the exam)  CT is the preferred imaging modality for lung metastases.
I-123 MIBG scintigraphy	75–90% (Reisch et al. 2006) [25]  90.6% (Lumachi et al. 2006) [26]  Pheochromocytomas: 85–88% Paragangliomas: 56–75% (Lenders et al. 2014) [1]	100% (Reisch et al. 2006) [25]  100% (Lumachi et al. 2006) [26]  Pheochromocytomas: 70–100%. Paragangliomas: 84–100% (Lenders et al. 2014) [1]	Thyroid blockade is needed to prevent unwanted tracer accumulation.  Discontinuation of certain groups of medications is required, including vasoconstrictors, calcium channel blockers, and labetalol, due to their potential impact on the test results or interactions with the substances used.  Extended: 18 to 24 hrs.
Positron emission tomography (PET), using 18 F-fluorodeoxyglucose (18 FDG)	74–100% (Lenders et al. 2014) [1]  66–78% (Krokhmal et al. 2022) [23]		Difficult detection of lesions $< 3$ to 5 mm.  A positive test is not specific for PPGL, as the imaging reflects glucose uptake and metabolism by cells, including other tumour cells with high glucose demand.
<sup>68</sup> Ga-DOTATATE PET	72–100% (Krokhmal et al. 2022) [23]		Risk of false negative results in the absence of somatostatin receptors.

in the head and neck region. It is also recommended for patients with contraindications to other imaging modalities.

Computed tomography (CT) is recommended as a second-line imaging modality in the diagnosis of PPGL, primarily due to the associated exposure to ionizing radiation. Nonetheless, it offers excellent spatial resolution in the chest, abdomen, and pelvis and enables the detection of tumours  $\geq 5$  mm. The appearance of a PPGL on a CT scan is variable; tumours may be homogeneous or heterogeneous, may exhibit necrosis with calcifications, and may present as solid or cystic lesions [1]. A characteristic feature of PPGL is a density typically  $\geq 10$  Hounsfield units [2].

Nuclear medicine techniques are employed in cases of strong clinical suspicion of PPGL, in which the lesion cannot be localized using first-line imaging, as well as in situations suggesting multifocal or metastatic disease. These include [<sup>123</sup>I]-metaiodobenzylguanidine (MIBG) scintigraphy, somatostatin receptor scintigraphy using [<sup>99m</sup>Tc]-octreotide (a somatostatin analogue), and posi-

tron emission tomography (PET-CT) with radiotracers such as [<sup>18</sup>F]-fluorodeoxyglucose (FDG), [<sup>18</sup>F]-fluorodihydroxyphenylalanine (FDOPA), and the somatostatin analogue [<sup>68</sup>Ga]-DOTATATE [6]. The decision to use these modalities in paediatric patients requires individualized assessment and must be carefully weighed against the potential risks and anticipated diagnostic benefits [18].

[<sup>123</sup>I]-MIBG scintigraphy is particularly valuable for evaluating sporadic pheochromocytomas and metastatic disease, especially when treatment with [<sup>131</sup>I]-MIBG is being considered. It is also recommended in situations with an increased risk of metastasis or recurrence, such as large primary or extra-adrenal tumours [2]. An additional advantage of [<sup>123</sup>I]-MIBG scintigraphy is its ability to detect lesions that may not be visible on CT or MRI. However, it should be noted that not all PPGLs demonstrate sufficient uptake of this radiotracer, which may limit the sensitivity of the method.

[<sup>18</sup>F]-FDG PET is also used in the diagnosis of PPGL, providing high sensitivity in detecting small or highly metabolic lesions [21]. Although its overall detection rate

is comparable to that of other nuclear medicine techniques, [<sup>68</sup>Ga]-DOTATATE PET offers higher specificity and superior contrast between pathological lesions and surrounding tissues, making it particularly valuable in identifying multifocal or metastatic disease [21]. Recent scientific studies confirm the superiority of [<sup>68</sup>Ga]-DOTATATE PET over [<sup>18</sup>F]-FDG PET in detecting metastatic PPGL associated with *SDHB* gene mutations [8]. The [<sup>68</sup>Ga]-DOTATATE PET modality has also been approved for use in paediatric patients by the U.S. Food and Drug Administration (FDA) [21].

### Pharmacotherapy

PPGL patients are put on pharmacological treatment to control symptoms, particularly in the immediate preoperative period (Tab. 4).

### Perioperative management

Surgical removal of PPGL is associated with a substantial risk of intraoperative haemodynamic instability and cardiovascular complications. To mitigate this risk, current guidelines recommend systemic administration of preoperative  $\alpha$ -blockers for all patients, including those who are normotensive or have biochemically silent tumours [22]. Beta-blockers may be introduced only after adequate alpha blockade has been achieved, in order to prevent reflex tachycardia and catecholamine-induced tachyarrhythmias [6]. Preoperative management should be initiated at least 7–14 days before the planned surgical intervention. The primary goal is to achieve adequate normalization of blood pressure (BP) and heart rate. BP levels should be reduced to <130/80 mmHg in adolescents aged  $\geq 16$  years and to less than the 95th percentile for age, sex, and height (optimally toward the 50th

percentile shortly before surgery) in younger children. Current guidelines emphasize that achieving the desired haemodynamic targets may take more than a few weeks in some paediatric patients [1]. The prolonged preparatory phase is likely related to the substantial catecholamine burden, as large or multiple tumours result in chronically elevated catecholamine levels, as well as the need for careful titration of medications and the generally higher sympathetic nervous system activity observed in children [6]. Adequate preoperative fluid intake and a high-sodium diet are essential in PPGL patients to prevent severe hypotension following tumour resection. Hyperfiltration, which is observed in many patients, contributes to sodium and water depletion. Sudden cessation of exposure to high catecholamine levels following tumour removal may lead to a marked drop in blood pressure. Preoperative fluid supplementation and a high-sodium diet aim to expand intravascular volume, thereby stabilizing BP levels and reducing the risk of postoperative hypotension [1]. Long-term, continuous monitoring is required after surgery.

### Surgical treatment

Surgery remains the treatment of choice for PPGL, and operative management is planned individually for each patient, taking into account multiple clinical and anatomical factors. However, it is important to emphasize that even seemingly complete tumour resection does not eliminate the risk of residual disease or future recurrence [2].

The preferred surgical approach for small pheochromocytomas (up to 5–6 cm) is laparoscopic resection, whereas larger tumours (> 5–6 cm) and paragangliomas are typically managed with open laparotomy. This is due to their higher risk of malignancy and their frequent location in anatomically challenging regions [6, 18]. The choice of

**Table 4.** Preoperative treatments used for HT in children with pheochromocytomas and paragangliomas [2, 6]

Treatment	Dosage	Maximum recommended dose
Phenoxybenzamine	0.2 mg/kg/day (max 10 mg/dose) Increase the dose by 0.2 mg/kg/day every 4 days. Target dose: 0.4–1.2 mg/kg/day $\div$ 6–8 hrs	2–4 mg/kg/day (60 mg/day)
Doxazosin	1–2 mg/day Increase the dose by 2–4 mg/day. Target dose: 2–4 mg/day $\div$ 8–12 hours	4–16 mg/day
Prazosin	0.05–0.1 mg/kg/day $\div$ 8 hours	0.5 mg/kg/day (20 mg/day)
Terazosin	1 mg/day Increase the dose to 1–4 mg/day	20 mg/day
Propranolol*	1–2 mg/kg/day $\div$ 6–12 hours. Increase the dose to 4 mg/kg/day $\div$ 6–12 hours	640 mg/day
Atenolol*	0.5–1 mg/kg/day $\div$ 12–24 hours. Increase the dose to 2 mg/kg/day $\div$ 12–24 hours	100 mg/day
Metoprolol*	1–2 mg/kg/day $\div$ 12–24 hours. Increase the dose to 2 mg/kg/day $\div$ 12–24 hours	200 mg/day
Labetalol*	1–3 mg/kg/day $\div$ 8–12 hours. Increase the dose to 10–12 mg/kg/day $\div$ 8–12 hours	1200 mg/day
Bisoprolol*	Start with a dose of 1.25 mg to 5 mg/day	10 mg/day
Amlodipine	0.06–0.1 mg/kg/day $\div$ 12–24 hours. Increase the dose to 0.3 mg/kg/day $\div$ 12–24 hours	0.6 mg/kg/day (10 mg/day)
Metyrosine	20 mg/kg/day $\div$ 6 hours. Increase the dose to 60 mg/kg/day $\div$ 6 hours	2500 mg/day

\*  $\beta$ -blockers can be used only after blocking  $\alpha$ -receptors, beta-1 blockers are preferred

surgical technique is additionally influenced by the results of genetic testing, the surgeon's experience, and the estimated probability of malignancy.

### Metastases

There are no specific biochemical or histopathological PPGL markers reliably predicting malignant behaviour. According to the World Health Organization (WHO), PPGLs are classified as malignant only when they spread to sites where chromaffin tissue is not normally found, such as the bones, lymph nodes, lungs, or liver. In such cases, lesions identified in these locations cannot represent a primary tumour site [20]. Malignant transformation is relatively rare in pheochromocytomas (10–15%) but more common in paragangliomas (35–40%). As previously noted, malignant tumours are more common in children [23].

Molecularly targeted therapies are gaining importance in the management of metastatic PPGLs in adults; however, their use in paediatric patients remains largely investigational and is currently limited to clinical trial settings [18, 22].

Surgical resection remains the preferred treatment approach. If complete tumour removal is not possible, debulking surgery or metastasectomy may be considered in children with metastatic PPGL to alleviate symptoms associated with catecholamine excess [18]. In selected patients with slow disease progression, low tumour burden, or oligometastatic involvement, active surveillance may also be an appropriate management strategy [18].

Radioisotope therapy may be used in patients with moderate or slow disease progression, moderate to high tumour burden, and positive [<sup>131</sup>I]MIBG imaging or somatostatin receptor scintigraphy. It uses [<sup>131</sup>I]MIBG or somatostatin analogues, respectively [22]. Notably, [<sup>131</sup>I]MIBG therapy was approved by the FDA in 2018 for children with metastatic PPGL aged > 12 years of age [18].

Tyrosine kinase inhibitors or temozolomide may be considered as first-line treatment in adults with slowly or moderately progressive tumours not eligible for [<sup>131</sup>I]MIBG therapy [22]. Although tyrosine kinase inhibitors are gaining popularity in the management of various paediatric malignancies, they have not yet been approved for use in children with metastatic PPGL [18].

In cases of rapidly progressing metastatic PPGL, combination chemotherapy with cyclophosphamide, vincristine, and dacarbazine (CVD regimen) may be the treatment of choice [22]. However, it should be noted that there are no prospective clinical trials confirming the efficacy of the CVD regimen in the paediatric population [18].

It is also important to note that most of the aforementioned therapies are palliative. Targeted gene therapy, tailored to the specific genetic architecture of PPGL, remains an area requiring further research [6].

### Monitoring

Given that 70–80% of paediatric PPGL patients have a mutation, these patients require ongoing monitoring.

Surveillance guidelines for individuals with a genetic predisposition or a history of PPGL vary depending on the specific mutation. Children and adolescents diagnosed with PPGL have an increased risk of recurrent, multifocal, and malignant disease requiring long-term follow-up [6].

Regular monitoring of BP and plasma metanephrines is essential [12]. Intensified surveillance similar to that used in high-risk adult patients (those with tumours linked to a genetic predisposition, tumours >5 cm, or extra-adrenal locations) is recommended in children. It should be noted that paediatric patients with PPGL require follow-up extending into adulthood [24].

Although *SDHx* mutations are often associated with biochemically silent PPGL, thorough surveillance is strongly recommended. This includes annual clinical evaluations beginning at diagnosis, or from the age of 5 years in asymptomatic *SDHB* mutation carriers and from the age of 10 years in asymptomatic *SDHA/C/D* mutation carriers [18]. Since *SDHB* mutation carriers have a markedly increased risk of malignancy, they require particularly intensive monitoring, including regular abdominal MRI every 18 months and MRI of the neck, chest, and pelvis every 3 years. Although patients with *SDHB* mutations develop metastases as early as 5 years from diagnosis, studies have shown good 20-year prognosis and survival. Metastases in paediatric patients with *SDHB* mutations are most likely to appear first in the bones followed by lymph nodes, lungs, and liver. A tumour size ≥ 5 cm and multifocal or recurrent tumours warrant closer follow-up for earlier detection of metastases. In contrast, surveillance protocols for carriers of mutations in the other succinate dehydrogenase subunits remain less clearly defined [6]. Individuals with *RET* or *VHL* mutations require annual plasma or urinary metanephrine screening starting at 5 years of age, whereas patients with *NF1* should undergo screening every 3 years, starting between 10 and 14 years of age [18].

### Genetic counselling

Genetic testing is essential for both patients diagnosed with PPGL and their asymptomatic family members who may carry the same genetic mutation. Surveillance strategies should be tailored based on the specific gene and the patient's relationship to the affected relative.

International guidelines recommend genetic testing for first-degree relatives in all hereditary PPGL syndromes, as well as for second-degree relatives in cases of *SDHD*- and *SDHAF2* mutations. Furthermore, genetic testing can be considered for second-degree relatives of individuals with *SDHB*, *SDHA*, *SDHC*, *TMEM127*, *MAX*, or other PPGL-linked gene mutations, especially in metastatic cases. While first-degree relatives typically require continuous surveillance, second-degree relatives or those with genes associated with low phenotypic penetrance may only require a single screening evaluation [12].

The optimal age for initiating genetic testing varies based on the specific gene mutation and the nature of required surveillance. For von Hippel–Lindau (*VHL*) syndrome, testing is recommended beginning at 5 years of age.

For other hereditary PPGL syndromes, the ideal starting age has not been clearly established. Current proposals suggest a minimum age of 5 years for *SDHB*-associated PPGL and 10 years for PPGL associated with *SDHA*, *SDHC*, and *SDHD* mutations [12]. Comprehensive genetic testing using next-generation sequencing (NGS) panels is recommended in children diagnosed with PPGL due to the heterogeneity of clinical presentation and the absence of a clear genotype-phenotype correlation. In contrast, family members of patients with a known mutation may undergo targeted testing using conventional Sanger sequencing [18].

## Conclusions

Excess catecholamines in patients with PPGL give rise to a diverse clinical presentations, including life-threatening hypertensive crises, and significantly increased cardiovascular risk. Measurement of free plasma MNs is considered the gold diagnostic standard due to its high sensitivity and specificity, as well as the availability of reliable, age-adjusted reference intervals in the paediatric population. Nuclear medicine techniques allow visualization of lesions that may be undetectable with other imaging methods. Surgical resection, preceded by appropriate perioperative preparation, remains the primary treatment for PPGL. About 70–80% of paediatric patients with PPGL have a mutation. Genetic predisposition significantly increases the risk of recurrence, multifocal disease, and malignant transformation, underscoring the need for lifelong clinical surveillance. Consequently, genetic counselling and testing are recommended for all children and adolescents with PPGL, as well as their at-risk family members.

## References

- Lenders JW, Duh QY, Eisenhofer G, et al. Pheochromocytoma and paraganglioma: an endocrine society clinical practice guideline. *J Clin Endocrinol Metab*, 2014; 99: 1915–1942. doi: 10.1210/jc.2014-1498. Erratum in: *J Clin Endocrinol Metab*, 2023; 108: e200. doi: 10.1210/clinem/dgad064
- Casey RT, Hendriks E, Deal C, et al. International consensus statement on the diagnosis and management of pheochromocytoma and paraganglioma in children and adolescents. *Nat Rev Endocrinol*, 2024; 20: 729–748. doi: 10.1038/s41574-024-01024-5. Erratum in: *Nat Rev Endocrinol*, 2024; 20: 760. doi: 10.1038/s41574-024-01034-3. Erratum in: *Nat Rev Endocrinol* 2025; 21: 656. doi: 10.1038/s41574-025-01167-z
- Pamporaki C, Hamplova B, Peitzsch M, et al. Characteristics of Pediatric vs Adult Pheochromocytomas and Paragangliomas. *J Clin Endocrinol Metab*, 2017; 102: 1122–1132. doi: 10.1210/jc.2016-3829
- Al Subhi AR, Boyle V, Elston MS. Systematic Review: Incidence of Pheochromocytoma and Paraganglioma Over 70 Years. *J Endocr Soc*, 2022; 6: bvac105. doi: 10.1210/jendso/bvac105
- Stachowicz-Stencel T, Pasikowska N, Synakiewicz A. Pheochromocytoma and paraganglioma in children and adolescents. *Acta Biochim Pol*, 2023; 70: 487–493. doi: 10.18388/abp.2020\_6955
- Jain A, Baracco R, Kapur G. Pheochromocytoma and paraganglioma—an update on diagnosis, evaluation, and management. *Pediatr Nephrol*, 2020; 35: 581–594. doi: 10.1007/s00467-018-4181-2
- Cascón A, Calsina B, Monteagudo M, et al. Genetic bases of pheochromocytoma and paraganglioma. *J Mol Endocrinol*, 2023; 70: e220167. doi: 10.1530/JME-22-0167
- Shah MH, Goldner WS, Benson AB, et al. Neuroendocrine and Adrenal Tumors, Version 2.2021, NCCN Clinical Practice Guidelines in Oncology. *J Natl Compr Canc Netw*, 2021; 19: 839–868. doi: 10.6004/jnccn.2021.0032
- Buffet A, Burnichon N, Favier J, Gimenez-Roqueplo AP. An overview of 20 years of genetic studies in pheochromocytoma and paraganglioma. *Best Pract Res Clin Endocrinol Metab*, 2020; 34: 101416. doi: 10.1016/j.beem.2020.101416.
- Castro-Vega LJ, Buffet A, De Cubas AA, et al. Germline mutations in FH confer predisposition to malignant pheochromocytomas and paragangliomas. *Hum Mol Genet*, 2014; 23: 2440–2446. doi: 10.1093/hmg/ddt639
- García-Carbonero R, Matute Teresa F, Mercader-Cidoncha E, et al. Multidisciplinary practice guidelines for the diagnosis, genetic counseling and treatment of pheochromocytomas and paragangliomas. *Clin Transl Oncol*, 2021; 23: 1995–2019. doi: 10.1007/s12094-021-02622-9
- Lenders JWM, Kerstens MN, Amar L, et al. Genetics, diagnosis, management and future directions of research of pheochromocytoma and paraganglioma: a position statement and consensus of the Working Group on Endocrine Hypertension of the European Society of Hypertension. *J Hypertens*, 2020; 38: 1443–1456. doi: 10.1097/HJH.0000000000002438
- Barontini M, Levin G, Sanso G. Characteristics of pheochromocytoma in a 4- to 20-year-old population. *Ann N Y Acad Sci*, 2006; 1073: 30–37. doi: 10.1196/annals.1353.003
- Calsina B, Piñero-Yáñez E, Martínez-Montes ÁM, et al. Genomic and immune landscape Of metastatic pheochromocytoma and paraganglioma. *Nat Commun*, 2023; 14: 1122. doi: 10.1038/s41467-023-36769-6
- Buffet A, Morin A, Castro-Vega LJ, et al. Germline Mutations in the Mitochondrial 2-Oxoglutarate/Malate Carrier SLC25A11 Gene Confer a Predisposition to Metastatic Paragangliomas. *Cancer Res*, 2018; 78: 1914–1922. doi: 10.1158/0008-5472.CAN-17-2463
- Hanafy AK, Mujtaba B, Roman-Colon AM, et al. Imaging features of adrenal gland masses in the pediatric population. *Abdom Radiol (NY)*, 2020; 45: 964–981. doi: 10.1007/s00261-019-02213-x
- Dobrowolski P, Januszewicz A, Klisiewicz A, et al. Left ventricular structural and functional alterations in patients with pheochromocytoma/paraganglioma before and after surgery. *JACC Cardiovasc Imaging*, 2020; 13: 2498–2509. doi: 10.1016/j.jcmg.2020.07.017
- Turin CG, Crenshaw MM, Fishbein L. Pheochromocytoma and paraganglioma: germline genetics and hereditary syndromes. *Endocr Oncol*, 2022; 2: R65–R77. doi: 10.1530/EO-22-0044
- Peitzsch M, Mangelis A, Eisenhofer G, Huebner A. Age-specific pediatric reference intervals for plasma free normetanephrine, metanephrine, 3-methoxytyramine and 3-O-methyl-dopa: Particular importance for early infancy. *Clin Chim Acta*, 2019; 494: 100–105. doi: 10.1016/j.cca.2019.03.1620
- Constantinescu G, Preda C, Constantinescu V, et al. Silent pheochromocytoma and paraganglioma: Systematic review and proposed definitions for standardized terminology. *Front Endocrinol (Lausanne)*, 2022; 13: 1021420. doi: 10.3389/fendo.2022.1021420
- Jiang J, Zhang J, Pang Y, et al. Sino-European Differences in the Genetic Landscape and Clinical Presentation of Pheochromocytoma and Paraganglioma. *J Clin Endocrinol Metab*, 2020; 105: dgaa502. doi: 10.1210/clinem/dgaa502

22. Sarathi V, Pandit R, Patil VK, et al. Performance of plasma fractionated free metanephrines by enzyme immunoassay in the diagnosis of pheochromocytoma and paraganglioma in children. *Endocr Pract*, 2012; 18: 694–699. doi: 10.4158/EP12050.OR
23. Krokhmal AA, Kwatra N, Drubach L, et al. (68) Ga-DOTATATE PET and functional imaging in pediatric pheochromocytoma and paraganglioma. *Pediatr Blood Cancer*, 2022; 69: e29740. doi: 10.1002/pbc.29740
24. Muth A, Crona J, Gimm O, et al. Genetic testing and surveillance guidelines in hereditary pheochromocytoma and paraganglioma. *J Intern Med*, 2019; 285: 187–204. doi: 10.1111/joim.12869
25. Reisch N, Peczkowska M, Januszewicz A, Neumann HP. Pheochromocytoma: presentation, diagnosis and treatment. *J Hypertens*, 2006; 24: 2331–2339. doi: 10.1097/01.hjh.0000251887.01885.54
26. Lumachi F, Tregnaghi A, Zucchetto P, et al. Sensitivity and positive predictive value of CT, MRI and 123I-MIBG scintigraphy in localizing pheochromocytomas: a prospective study. *Nucl Med Commun*, 2006; 27: 583–587. doi: 10.1097/00006231-200607000-00006



# ASSESSMENT OF PREPAREDNESS OF INTERN PHYSICIANS IN MAZOWIECKIE VOIVODESHIP FOR CIVIL-MILITARY COOPERATION IN THE EVENT OF A POTENTIAL ARMED CONFLICT

Ocena poziomu przygotowania lekarzy stażystów województwa mazowieckiego z zakresu współpracy cywilno-wojskowej na wypadek ewentualnego konfliktu zbrojnego




Sławomir Piotr Paszek<sup>1</sup>, Marcin Rabijewski<sup>2</sup>, Anna Kurek<sup>2</sup>, Hubert Goetz<sup>2</sup>, Zofia Czaplińska-Paszek<sup>3</sup>

1. Department of Emergency Medicine, Medical University of Warsaw, Poland
2. Department of Emergency Medicine/Student Scientific Club of Battlefield Medicine, Medical University of Warsaw, Poland
3. St. Anne's Hospital, Stocer Rehabilitation Center, Poland

Sławomir Piotr Paszek –  0009-0009-5059-3426

Marcin Rabijewski –  0009-0008-0789-5157

Anna Kurek –  0009-0006-1331-3649

Hubert Goetz –  0009-0007-2384-0589

Zofia Czaplińska-Paszek –  0000-0003-2429-8262

## Abstract

**Introduction and objective:** The current geopolitical situation and ongoing international armed conflicts prompt reflection on the adequacy of medical personnel's preparedness, particularly in the context of their potential involvement in an actual armed confrontation. For this reason, we sought to assess the competencies of medical interns—individuals at the outset of their professional careers who have most recently completed the current medical curriculum. **Materials and methods:** For this purpose, we have prepared a form consisting of 10 closed single-choice questions to assess the knowledge of the procedures developed by the Tactical Combat Casualty Care (TCCC) Committee. **Results:** The mean score obtained by interns was less than 30% of correct answers. Additionally, we were able to identify the areas posing the greatest difficulty for respondents, such as antibiotic therapy and haemorrhage taming. **Conclusions:** We recommend considering an expansion of the medical curriculum to include content related to TCCC, as well as drawing on international experience to explore opportunities for collaborative training.

## Streszczenie

**Wprowadzenie i cel:** Obecna sytuacja geopolityczna oraz trwające konflikty zbrojne o zasięgu międzynarodowym skłaniają do refleksji na temat poziomu przygotowania kadr medycznych na wypadek konieczności ich udziału w realnym konflikcie zbrojnym. Z tego powodu autorzy postanowili poddać ocenie kompetencje lekarzy stażystów, a więc osób rozpoczynających karierę zawodową, realizujących aktualny program nauczania. **Materiał i metody:** Opracowano autorski formularz składający się z 10 zamkniętych pytań jednokrotnego wyboru, mający ocenić znajomość procedur opracowanych przez Komitet Tactical Combat Casualty Care (TCCC). **Wyniki:** Średni wynik uzyskany przez lekarzy stażystów wyniósł niespełna 30% poprawnych odpowiedzi. Dodatkowo udało się ustalić obszary, które stanowią największą trudność dla respondentów, takie jak antybiotykoterapia czy tamowanie krwotoków. **Wnioski:** Uzyskane wyniki wskazują na potrzebę rozważenia rozszerzenia programu nauczania na kierunku lekarskim o treści obejmujące zagadnienia z zakresu TCCC, a także wykorzystania zagranicznych doświadczeń w celu rozwijania współpracy szkoleniowej o zasięgu międzynarodowym.

**Keywords:** combat medicine; postgraduate medical internship; civil-military cooperation; injured as a result of military operations; combat injuries

**Słowa kluczowe:** medycyna pola walki; podyplomowy staż lekarski; współpraca cywilno-wojskowa; poszkodowani w wyniku działań zbrojnych; obrażenia bojowe

DOI 10.53301/lw/203067

Received: 11.03.2025

Accepted: 18.03.2025

Published: 30.12.2025

## Corresponding author:

Sławomir Piotr Paszek  
Department of Emergency Medicine,  
Medical University of Warsaw,  
4 Lindleya, 02-005 Warsaw, Poland  
e-mail: slawomir.paszek@wum.edu.pl

## Introduction

Training in combat medicine is not formally integrated into medical curricula, including university-level medical programmes. To date, the Armed Forces have employed medical personnel educated in civilian institutions and later adapted to operational needs through postgraduate training aligned with the specific demands of military service. The only exception is the education of cadets of the Military Academy of Land Forces studying at the Military Medical College of the Medical University of Łódź, who fulfil their military service obligations concurrently with their medical training. Given the dynamic geopolitical environment, there is a growing rationale for ensuring that civilian physicians are appropriately equipped to function in the event of armed conflict. Battlefield medical care protocols differ markedly from civilian standards, particularly in terms of capabilities, objectives, and priorities. Familiarity with prehospital procedures used in combat settings may significantly influence therapeutic decisions, even when those decisions are made by a civilian physician in a civilian hospital. At present, the Military Health Service would be insufficient to meet the healthcare demands of the armed forces in the event of a large-scale armed conflict involving entire divisions. This issue was already raised in 2017 by physicians from the Military Institute of Medicine [1]. Their analysis demonstrated that if the Polish Armed Forces were to sustain casualties typical of a symmetrical armed conflict, the healthcare system would be unable to cope. These findings highlight the need for fundamental changes in the educational model and functioning of medical personnel, including those working in civilian settings, to ensure adequate preparedness for potential military contingencies. For this reason, the Warsaw District Medical Chamber has initiated a tactical combat casualty care (TCCC) training programme for physicians within its jurisdiction [2]. Comparable forms of training have recently gained increasing popularity in other NATO member states, both among medical students [3] and practicing healthcare professionals [4].

## Aim

The aim of this study is to assess the level of knowledge among interns regarding procedures used in the Armed Forces of the Republic of Poland and other NATO member states for the management of casualties of armed conflict in accordance with TCCC guidelines. The findings are considered in the context of potential civil–military cooperation, in which civilian physicians without prior military training may be required to provide medical care to soldiers and civilians injured as a result of military operations.

## Methods

The study was conducted between July 1 and September 30, 2023, using a proprietary questionnaire comprising 10 closed, single-choice questions. The questionnaire was administered to a cohort of 156 medical interns who graduated in 2022 and were attending mandatory emergency care training organized by the Department of Emergency Medicine at the Medical University of Warsaw.

Participants were informed of the study's objectives and provided voluntary consent by completing an anonymous questionnaire. The questionnaire assessed knowledge of current TCCC guidelines, which have been translated into Polish and made available on the website of the Military Medical Training Center in Łódź. The questions addressed issues not included in the standard medical school curriculum nor in the postgraduate internship programme.

## Results

The study group consisted of 156 interns. The mean proportion of correct responses was 30%. Only one item yielded a correctness rate of  $\geq 50\%$  (question 7, concerning the oral administration of moxifloxacin). Question 1, which also addressed battlefield antimicrobial therapy, proved most challenging, with only 6% of participants selecting the correct answer. The median score was 32%. The results, including the distribution of correct responses, are presented in Table 1.

The most challenging questions were those on antimicrobial therapy (questions 1 and 7), for which the mean percentage of correct responses was 28.5%. Slightly higher scores were observed for questions addressing haemorrhage control (questions 4, 6, and 10), with participants achieving an average correctness rate of 30%. In turn, questions on pain management (questions 2 and 5) were answered correctly by an average of 31% of respondents. Across all items assessing knowledge of medications or their dosages (questions 1, 2, 3, 5, 7, and 10), the mean percentage of correct responses was 31.67%. Figure 1 below presents the distribution of correct answers for each individual question and compares these values with the overall test performance.

## Discussion

The survey findings demonstrate a markedly insufficient level of knowledge among trainee physicians regarding broadly understood battlefield medicine and TCCC guidelines. Only one survey item was answered correctly by at least half of the respondents. Most interns affiliated with the Warsaw District Medical Chamber are graduates of the Medical University of Warsaw, where, beginning in the 2024/2025 academic year, pilot instructional sessions addressing the aforementioned topics were introduced for fifth-year medical students as part of a one-day module in Orthopaedics and Traumatology of the Musculoskeletal System. Consequently, these sessions were not available to the 2022 graduates who were completing their postgraduate medical internship at the time this study was conducted.

Russia's invasion of Ukraine in 2022 revealed significant shortcomings in the preparedness of NATO member states for a symmetric armed conflict. The pattern of battlefield injuries differs profoundly when confronting a peer adversary. During the Global War on Terror (GWOT), the majority of casualties resulted from improvised explosive devices and small-arms fire. In contrast, approximately 70% of injuries among Ukrainian soldiers represented polytrauma caused by artillery and missile strikes [5], requiring a completely different therapeutic

**Table 1.** Questionnaire with possible answers and score

Questions and possible answers	Correct	n	%
1. The casualty has most likely received the following antibiotics as part of typical battlefield antimicrobial regimen:			
Ciprofloxacin	No	35	14%
Ertapenem	Yes	16	6%
Ceftriaxone	No	112	43%
Amoxicillin	No	97	37%
2. A conscious male patient (GCS 15) following traumatic mid-humeral amputation, secured with a tactical tourniquet, and presenting with third-degree burns covering approximately 30% TBSA, sustained as a result of an explosive detonation. Estimated blood loss: 1600 mL. HR: 145/min, BP: 95/50 mmHg, SpO <sub>2</sub> : 92%, RR: 14/min. Pain: NRS 8 after self-administration of a standard dose of morphine from a pre-filled syringe. Estimated patient body weight: 75 kg. Select correct pain management:			
IO fentanyl 200 mg	No	27	10%
IV fentanyl 2 mg	No	107	41%
IO ketamine 100 mg	Yes	38	15%
IV ketamine 1 mg	No	97	34%
3. The IZAS-05 kit (pre-filled syringes for self-administration in the event of exposure to weapons of mass destruction) does not include:			
Naloxone	Yes	85	33%
Atropine	No	17	6%
Diazepam	No	101	39%
Pralidoxime	No	57	22%
4. The time limit after which the tourniquet must not be removed (without patient monitoring or diagnostic laboratory workup) is:			
2 hours	No	56	22%
4 hours	No	92	35%
6 hours	Yes	102	39%
8 hours	No	10	4%
5. Which of these is used in the form of a lollipop?			
Ketamine	No	76	29%
Fentanyl	Yes	122	47%
Meloxicam	No	47	18%
Acetaminophen	No	15	6%
6. Massive haemorrhage from a penetrating axillary wound (damaged axillary artery), unsuccessfully treated on the battlefield with wound packing and a haemostatic dressing. Estimated blood loss 2,500 mL, bleeding continues (soaking dressing). The patient has developed shock and is unconscious (GCS 8), with blood pressure 58/35 mmHg, heart rate 48/min, absence of a peripheral pulse; is intubated and was put on ventilatory support. Surgical repair of the damaged vessel will be possible in no fewer than 20 minutes. Until then, the recommended management is:			
Adding another layer to the soaking dressing	No	85	33%
Removal of the existing dressing followed by repacking of the wound with a new haemostatic dressing, accompanied by direct manual pressure for 3 minutes	Yes	35	13%
Applying a tourniquet to the limb	No	83	32%
Removal of the ineffective dressing to rapidly prepare the treatment field, followed by compatible whole blood transfusion in accordance with Walking Blood Bank (WBB) protocols	No	57	22%
7. Oral moxifloxacin is recommended for patients with:			
Penetrating eye injury	Yes	133	51%
Internal abdominal injuries as a result of the shock wave from the explosion	No	90	35%
Risk of airway obstruction	No	29	11%
Evident anisocoria and impaired logical contact after head injury, without skin lesions	No	8	3%
8. A 65 kg female patient with second degree burns, 70% TBSA, after evacuation from a burning vehicle. Conscious (GCS 15), BP 130/90 mmHg, HR 150/min, SpO <sub>2</sub> 94%, RR 16/min + expiratory stridor. Pain 10 NRS. The recommended form of initial fluid resuscitation is:			
0.9% IV NaCl at 4500 mL/h	No	79	31%
IV Ringer solution at 700 mL/h	Yes	79	30%
(IV Hextend 1000 mL + 400 mL 0.9% IV NaCl)/h	No	76	29%
IO ME 2275 mL/h + 1500 mL H <sub>2</sub> O orally	No	26	10%

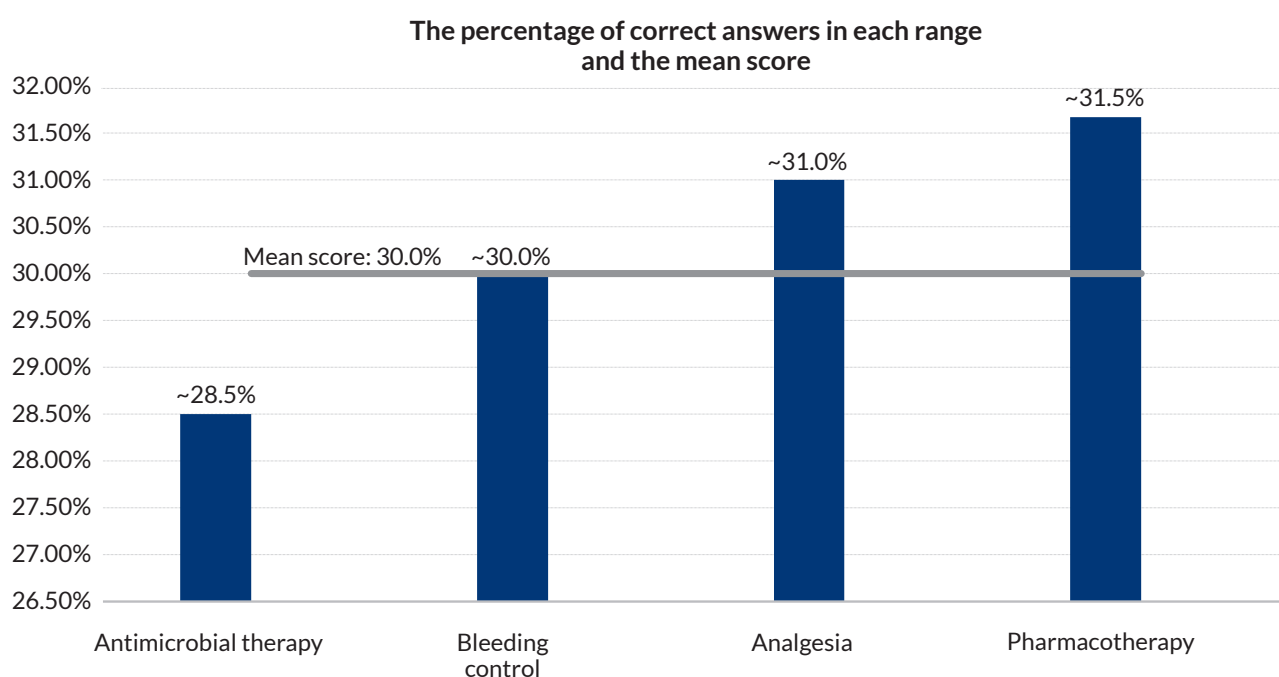
**Table 1 (cont.).** Questionnaire with possible answers and score

Questions and possible answers	Correct	n	%
9. Which treatment is not recommended in a patient with blunt head trauma, impaired consciousness and evident anisocoria?			
Hyperventilation	No	110	42%
Maintaining ET <sub>CO<sub>2</sub></sub> within 30–35 mmHg	No	24	9%
Reducing O <sub>2</sub>	Yes	69	27%
250 mL of 3% IV NaCl	No	57	22%
10. Which of these is a contraindication for tranexamic acid?			
The fact that it can only be administered intraosseously	No	33	13%
No possibility of performing diagnostic imaging	No	8	3%
Cranio-cerebral trauma	No	120	46%
The fact that 5 hours elapsed since the injury	Yes	99	38%
BP – blood pressure; ET <sub>CO<sub>2</sub></sub> – end-tidal carbon dioxide; GCS – Glasgow Coma Scale; H <sub>2</sub> O – water; HR – heart rate; IO – intraosseous; IV – intravenous; IZAS-05 – a set of pre-filled syringes for self-aid in the event of exposure to weapons of mass destruction; NaCl 0,9% – saline; NRS – Numerical Rating Scale; ME – Multiple Electrolytes; RR – respiratory rate; SpO <sub>2</sub> – Peripheral Oxygen Saturation; TBSA – total body surface area			

approach. In contrast to several other NATO member states, there are virtually no training programmes aimed at preparing civilian surgeons for the medical challenges associated with a large-scale armed conflict in Poland. Significant differences may be also seen in battlefield evacuation. For many years, it was typically expected that a wounded soldier could be transported to a medical facility within 1–2 hours. However, the war in Ukraine has demonstrated that during a high-intensity or asymmetric conflict, evacuation times may extend to several or even more than a dozen hours, generating additional clinical and logistical challenges.

A study conducted at one of the largest trauma centres in South Africa demonstrated that, owing to the high volume of injuries resembling those sustained in combat, even a

six-month rotation of surgeons in such a facility would be sufficient to substantially enhance their trauma surgery competencies [6]. Overall, graduates of military universities, compared with graduates of civilian medical schools who completed only a brief course under a military scholarship, rate their preparedness for potential military deployment significantly higher [7]. The competencies of US graduates of civilian universities participating in military scholarship programmes have been compared with those of graduates of the Uniformed Services University, the principal institution responsible for training military physicians. The university reinforces students' competencies for deployment in military operations by providing regular exposure to interactive training within this highly specialized environment. One particularly effective initiative was a comprehensive simulation pro-



**Fig. 1.** Comparison of results across the questionnaire

gramme that replicated the duties of medical personnel during mass casualty events, conducted at this university for 4 years. Every year, several-day classes were organized, the content of which was adapted to the current level of knowledge and practical skills of students in their respective years of study. The training familiarized participants with the principles of teamwork, the challenges inherent to combat medicine, as well as procedural and theoretical approaches that diverge markedly from civilian healthcare standards. It also broadened the theoretical and practical competencies essential for medical care in operational settings. Notably, despite the relatively modest time commitment demanded of students, the programme yielded a substantial improvement in participants' skills and self-satisfaction, which may have contributed to their subsequent declarations of readiness for deployment [8]. This experiment provides an encouraging perspective on the future of medical-military education in Poland, assuming that both the frequency and quality of training are increased. Variations in both baseline curricula and the level of education across specific domains, resulting from the structural characteristics of individual national educational systems, should not preclude Poland from pursuing efforts to expand the competencies of future physicians. This is supported by studies assessing the outcomes of several-day TCCC courses conducted at training centres in Ghana and the United States, which were attended by healthcare professionals (primarily physicians). Despite initial disparities in baseline competence arising from differences in training systems and exposure to military scenarios, post-course assessments of participants' skills, performed using an identical medical simulation, demonstrated comparable results in both groups [9]. International TCCC training initiatives are also implemented and frequently regarded as effective, such as the *Kabul Tuesdays* programme [10], which consisted of weekly high-fidelity simulations of complex clinical scenarios. Consequently, it would be reasonable to consider developing comparable training courses for medical students and physicians in Poland. This suggests that, with appropriate organizational measures, it would be feasible to train Polish physicians, particularly specialists in surgery, orthopaedics, and anaesthesiology, to improve the competencies required for the management of war-related injuries. It also appears advisable to explore opportunities for international training exchanges, given that patients with gunshot wounds and other combat-associated trauma are relatively uncommon in Poland.

## Conclusions

It seems reasonable to expand this study to include participants from other voivodeships, thereby enabling a more comprehensive assessment of knowledge related to the discussed procedures at the national level. The study demonstrated that, although the interns surveyed had a limited ability to administer pharmacotherapy within the context of combat medicine, they would face substantial challenges in managing patients with complex, multi-

organ injuries in life-threatening scenarios. The findings also indicate that early-career physicians lack confidence in managing critically ill patients presenting with injury patterns typical of combat operations.

In light of the current geopolitical context, which implies that a symmetric conflict on the European continent is a realistic possibility, and considering the training experiences of other Allied states, greater emphasis should be placed on military medicine within the curricula of civilian medical universities. International exchange programmes should also be considered, as injuries typical of military operations, such as gunshot wounds, are currently uncommon in Poland, resulting in limited clinical exposure and insufficient experience in managing such cases.

## References

1. Skalski M, Wegner A, Dóczyński M. Służba zdrowia Sił Zbrojnych RP – potrzeba zmian organizacyjnych. *Lekarz Wojskowy*, 2017; 95: 95–98
2. Okręgowa Izba Lekarska w Warszawie. Medycyna pola walki – szkolenia dla lekarzy i lekarzy dentystów. *Monitor Lekarski* [online], 4.11.2024 <https://izba-lekarska.pl/monitor-lekarski/medycyna-pola-walki-szkolenia-dla-lekarzy-i-lekarzy-dentystow/> [access 25.01.2025]
3. Tsai YD, Tsai SH, Chen SJ, et al. Pilot study of a longitudinal integrated disaster and military medicine education program for undergraduate medical students. *Medicine (Baltimore)*, 2020; 99: e20230. doi: 10.1097/MD.00000000000020230
4. Suresh MR, Valdez-Delgado KK, Staudt AM, et al. An assessment of pre-deployment training for army nurses and medics. *Mil Med*, 2021; 186: 203–211. doi: 10.1093/milmed/usaa291
5. Epstein A, Lim R, Johannigman J, et al. Putting medical boots on the ground: lessons from the war in Ukraine and applications for future conflict with near-peer adversaries. *J Am Coll Surg*, 2023; 237: 364–373. doi: 10.1097/XCS.0000000000000707
6. Uchino H, Kong VY, Oosthuizen GV, et al. Can we train military surgeons in a civilian trauma center? *World J Surg*, 2018; 42: 26–31. doi: 10.1007/s00268-017-4149-6
7. Cole R, Dong T, Rudinsky SL, et al. A comparison of uniformed services university and health professions scholarship program graduates' first deployment readiness. *Mil Med*, 2024; 189: e1190–e1195. doi: 10.1093/milmed/usad430
8. Cole R, Egan SJ, Schwartz J, Rudinsky SL. The impact of high-fidelity simulations on medical student readiness. *Mil Med*, 2023; 188(Suppl 3): 7–14. doi: 10.1093/milmed/usac382
9. Polley CC, Adu-Gyamfi R, Mahama-Toure T, et al. A Pilot Study Using a Standardized Trauma Assessment Tool After Tactical Combat Casualty Care Course: A Comparison of the United States and Ghana. *Mil Med*, 2024; 189: e1437–e1442. doi: 10.1093/milmed/usae034
10. Holvelinsky S, Travers T, Stierwalt JB, et al. Addressing differences in knowledge and experience in trauma care capabilities among an international team of military medical care providers in a deployed setting. *Mil Med*, 2025; 190: 24–26. doi: 10.1093/milmed/usae123



# NEPHROLOGICAL PROBLEMS IN CHILDREN WITH TUBEROUS SCLEROSIS COMPLEX – A SINGLE-CENTER EXPERIENCE

Problemy nefrologiczne u dzieci chorujących na stwardnienie guzowate – doświadczenie jednego ośrodka



Anna Maria Wabik<sup>1</sup>, Wiktoria Suszek<sup>2</sup>, Agnieszka Piróg<sup>2</sup>, Mariusz I. Furmanek<sup>3</sup>, Piotr Skrzypczyk<sup>1</sup>

1. Department of Pediatrics and Nephrology, Medical University of Warsaw, Poland
2. Student Scientific Group at the Department of Pediatrics and Nephrology, Medical University of Warsaw, Poland
3. Department of Pediatric Radiology, Medical University of Warsaw, Poland

Anna Maria Wabik – 0009-0007-3339-8157  
 Wiktoria Suszek – 0009-0000-6702-6166  
 Agnieszka Piróg – 0009-0003-5422-8692  
 Mariusz I. Furmanek – 0000-0002-6713-6338  
 Piotr Skrzypczyk – 0000-0002-1959-8255

## Abstract

**Introduction and objective:** Tuberous sclerosis complex is a rare genetic disorder characterized by benign tumours in multiple organs (e.g., brain, kidneys). The affected patients present with kidney tumours, including angiomyolipomas and cysts, rarely other lesions, including renal cell carcinoma. This study aimed to evaluate renal lesions, renal function, and blood pressure in children managed in our Centre between 2018 and 2023. **Materials and methods:** We looked at the presence and size of kidney lesions (ultrasonography, magnetic resonance), genetic findings, blood pressure, and biochemical parameters, including kidney function (GFR calculated from the Schwartz formula) in 55 pediatric patients (28 boys, 27 girls,  $8.1 \pm 4.6$  years). **Results:** Angiomyolipomas were found in 40/55 (72.7%) patients, including fat-poor (atypical) angiomyolipomas in 9 (16.4%) children. The mean angiomyolipoma size was  $13.1 \pm 15.1$  mm; large angiomyolipomas  $\geq 30$  mm were present in 5 (9.1%) children. Cysts were found in 46 (83.6%) children; the mean cyst size was  $10.3 \pm 12.3$  mm. The largest cysts (up to 75 mm) were found in 4 children with contiguous gene syndrome (deletion involving two genes: *TSC2* and *PKD1*). Seven (12.7%) children had arterial hypertension, including 3 out of 4 children with contiguous gene syndrome. Mean GFR was  $111.2 \pm 17.1$  mL/min/1.73 m<sup>2</sup>, and GFR  $< 90$  mL/min/1.73 m<sup>2</sup> was found in 3 (5.5%) children (2 with contiguous gene syndrome). Patients with hypertension had higher triglyceride concentrations, larger kidney longitudinal dimensions, and larger cysts ( $22.6 \pm 27.1$  vs.  $8.0 \pm 5.3$  mm). The size of angiomyolipoma correlated with age ( $r = 0.470$ ,  $p < 0.001$ ) and urinary albumin-creatinine ratio ( $r = 0.444$ ,  $p = 0.001$ ). **Conclusions:** 1. Large renal lesions are common already in children with tuberous sclerosis complex, with the most severe renal manifestations found in patients with contiguous gene syndrome. 2. The size of angiomyolipoma increases with age in children with tuberous sclerosis complex. 3. Large angiomyolipomas are risk factors for elevated urinary albumin excretion. 4. In paediatric patients with tuberous sclerosis complex, large cysts are risk factors for arterial hypertension. 5. Paediatric nephrologists should follow up all pediatric patients with tuberous sclerosis complex.

## Streszczenie

**Wprowadzenie i cel:** Stwardnienie guzowate jest rzadką chorobą genetyczną, charakteryzującą się występowaniem zmian guzowatych w wielu narządach (np. w mózgu, nerkach). U pacjentów występują guzy nerek zwane naczyniakomięśniakotłuszczakami oraz torbiele, rzadko inne zmiany, w tym rak nerki. Celem pracy jest ocena zmian w nerkach, funkcji nerek i ciśnienia tętniczego u dzieci będących pod opieką ośrodka w latach 2018–2023. **Materiał i metody:** W grupie 55 dzieci (28 chłopców, 27 dziewczynek,  $8,1 \pm 4,6$  lat) analizowano obecność i wielkość zmian w nerkach (w badaniu ultrasonograficznym i rezonansie magnetycznym), wynik badania genetycznego, ciśnienie tętnicze oraz parametry biochemiczne, w tym funkcję nerek (GFR według wzoru Schwartza). **Wyniki:** Naczyniakomięśniakotłuszczaki stwierdzono w nerkach u 40 (72,7%) pacjentów, w tym atypowe (ubogotłuszczowe) – u 9 (16,4%). Średnia wielkość guza wynosiła  $13,1 \pm 15,1$  mm; guzy  $\geq 30$  mm wykryto u 5 (9,1%) dzieci. Torbiele nerek rozpoznano u 46 (83,6%) dzieci. Średnia wielkość torbieli wynosiła  $10,3 \pm 12,3$  mm. Największe (do 75 mm) wykryto u 4 dzieci z zespołem genów sąsiadujących (delecja obejmująca geny *TSC2* i *PKD1*). Nadciśnienie tętnicze stwierdzono u 7 (12,7%) dzieci, w tym u 3 z 4 dzieci z zespołem genów sąsiadujących. Średni GFR wynosił  $111,2 \pm 17,1$  ml/min/1,73 m<sup>2</sup>, a GFR  $< 90$  ml/min/1,73 m<sup>2</sup> stwierdzono u 3 (5,5%) dzieci (2 z zespołem genów sąsiadujących). Pacjenci z nadciśnieniem tętniczym mieli wyższe stężenie trójglicerydów, większy wymiar podłużny nerek i większe torbiele ( $22,6 \pm 27,1$  vs.  $8,0 \pm 5,3$  mm). Rozmiar naczyniakomięśniakotłuszczaka korelował dodatnio z wiekiem ( $r = 0,470$ ,  $p < 0,001$ ) oraz wskaźnikiem albuminowo-kreatyninowym w moczu ( $r = 0,444$ ,  $p = 0,001$ ). **Wnioski:** 1. Zmiany w nerkach są powszechne u dzieci ze stwardnieniem guzowatym, a najbardziej nasilone objawy nerkowe występują u pacjentów z zespołem genów sąsiadujących. 2. U dzieci ze stwardnieniem guzowatym wymiar naczyniakomięśniakotłuszczaków

rośnie z wiekiem. 3. Naczyniakomięśniakotłuszczaki o dużym wymiarze są czynnikiem ryzyka zwiększonego wydalenia albumin z moczem u tych chorych. 4. U dzieci ze stwardnieniem guzowatym duży wymiar torbieli stanowi czynnik ryzyka nadciśnienia tętniczego. 5. Wszyscy pacjenci pediatryczni ze stwardnieniem guzowatym powinni być objęci opieką nefrologa dziecięcego.

**Keywords:** children; blood pressure; tuberous sclerosis complex; angiomyolipoma; renal cyst

**Słowa kluczowe:** dzieci; ciśnienie tętnicze; stwardnienie guzowate; naczyniakomięśniakotłuszczak; torbiel nerki

DOI 10.53301/lw/204280

Received: 03.01.2025

Accepted: 23.04.2025

Published: 30.12.2025

**Corresponding author:**

Piotr Skrzypczyk  
Department of Paediatrics and Nephrology,  
Medical University of Warsaw,  
63a Żwirki i Wigury Str., 02-091 Warsaw  
e-mail: pskrzypczyk@wum.edu.pl

## Introduction

Tuberous sclerosis complex (TSC) is a rare genetic multisystem disorder with a prevalence of approximately 1:5800 live births [1]. It is caused by pathogenic *TSC1* (9q34) or *TSC2* variants. The protein products of the *TSC1* (hamartin) and *TSC2* (tuberin) genes form a complex that physiologically inhibits the mTOR (mammalian target of rapamycin) protein kinase, whose proper function is to regulate cell division, differentiation, and migration. Inactivation of the *TSC1* or *TSC2* gene leads to over-activation of the mTOR pathway, which manifests as nodular lesions across virtually all organs. The pathogenic variant is detected *de novo* in 70–80% of patients; in the remaining cases, the disease is inherited in an autosomal dominant manner [2]. The International Tuberous Sclerosis Complex Consensus Group diagnostic criteria for TSC, updated in 2021, are presented in Table 1 [1].

Renal manifestations occur in approximately 80% of individuals with TSC. They are the second most common cause of morbidity and mortality across all age groups and the leading cause of death in patients >30 years of age [3]. Angiomyolipoma (AML) is the most frequent renal complication of TSC. The detection rate of AML increases with age, ranging from 8.8% in children under 2 years to 78.9% in adults over 40 years [4]. AMLs belong to a group of benign tumours derived from perivascular

epithelioid tissue (PEComa, PEC tumours) [5]. They are composed of aneurysmal vessels, smooth muscle fibres, and mature adipose tissue. A fat-poor AML is a variant that is difficult to differentiate from renal cancer [6]. Renal cysts are found in 10–20% of children and 14–45% of adults and are usually asymptomatic. Renal cancer may occur in 6% of patients with TSC, including children. It is characterized by slow growth and very rare distant metastasis [7].

Our Centre has been treating nephrological manifestations in TSC children across Poland since 2018. The aim of this study was to assess changes in renal size and function, as well as blood pressure in a group of children managed in our institution between 2018 and 2023.

## Materials and methods

This retrospective study included 55 children (28 boys and 27 girls) with a confirmed diagnosis of TSC based on the current 2021 Criteria, who received renal treatment between 2018 and 2023 [1].

Before initiating the study, approval was obtained from the local ethics committee (approval no. KB/145/2017, July 4, 2017). All procedures were performed in accordance with the ethical standards of the local ethics committee and the Declaration of Helsinki. Informed consent to participate in the study was obtained from the legal

**Table 1.** The International TSC Diagnostic Criteria [1] in our own modification. A definite clinical diagnosis of TSC can be established in a proband with two major features or one major feature with two or more minor features, or a pathogenic *TSC1* or *TSC2* variant must be detected in unaffected tissue (or blood).

Major features	Minor features
<ul style="list-style-type: none"> <li>• Hypomelanotic macules (<math>\geq 3</math>; at least 5mm diameter)</li> <li>• Angiofibroma (<math>\geq 3</math>) or fibrous cephalic plaque</li> <li>• Ungual fibromas (<math>\geq 2</math>)</li> <li>• Shagreen patch</li> <li>• Multiple retinal hamartomas</li> <li>• Multiple cortical tubers and/or radial migration lines</li> <li>• Subependymal nodule (<math>\geq 2</math>)</li> <li>• Subependymal giant cell astrocytoma</li> <li>• Cardiac rhabdomyoma</li> <li>• Lymphangiioleiomyomatosis (LAM)</li> <li>• Angiomyolipomas (<math>&gt; 2</math>)</li> </ul> <p>(LAM and AML is considered a single criterion)</p>	<ul style="list-style-type: none"> <li>• “Confetti” skin lesions</li> <li>• Dental enamel pits (<math>&gt; 3</math>)</li> <li>• Intraoral fibromas (<math>\geq 2</math>)</li> <li>• Retinal achromatic patch</li> <li>• Multiple renal cysts</li> <li>• Nonrenal hamartomas</li> <li>• Sclerotic bone lesions</li> </ul>

guardians of all patients, as well as from the participants themselves ( $\geq 16$  years of age) prior to enrolment.

The following clinical data were analysed: age (years), gender, height (cm), body weight (kg), body mass index (BMI) ( $\text{kg}/\text{m}^2$ ), hypertension (HT), and genetic findings (pathogenic variants in the *TSC1*, *TSC2*, and *TSC2/PKD1* genes). Anthropometric parameters were assessed using WHO [8] growth charts for the youngest children, OLA [9] charts for preschool children, and OLAF charts for school-aged children [10].

Renal imaging included ultrasound (US) in all children and magnetic resonance imaging (MRI) in 41 patients. Ultrasound (US) B-mode scans were taken using a Philips Epiq 5G system (Royal Philips, Amsterdam, The Netherlands), while T2, T1, and DWI-weighted MRI images were taken using the MAGNETOM Skyra 3T system (Siemens AG, Berlin, Germany), with and without intravenous Gadovist (gadobutrol) (Bayer AG, Leverkusen, Germany). The kidney size (calculated as the mean length of the right and left kidneys) and the presence and characteristics of renal lesions (angiomyolipomas, cysts, and other abnormalities) were evaluated. For angiomyolipomas and cysts, the largest diameter of the largest lesion (mm) was recorded.

Biochemical parameters were analysed: serum creatinine (mg/dL), cystatin C (mg/L), uric acid (mg/dL), total cholesterol (mg/dL), cholesterol fractions (mg/dL), and triglycerides (mg/dL). Glomerular filtration rate (GFR) was calculated using the creatinine and creatinine-cystatin Schwartz formula ( $\text{mL}/\text{min}/1.73 \text{ m}^2$ ) [11]. Elevated uric acid levels were defined as  $\geq 5.5$  mg/dL according to Feig [12]. Total cholesterol was considered elevated at  $\geq 200$  mg/dL, and triglycerides at  $\geq 100$  mg/dL in children aged 0–9 years and  $\geq 130$  mg/dL in children aged 10–18 years [13]. Increased (abnormal) albuminuria was defined as an albumin-creatinine ratio (ACR)  $\geq 30$  mg/g [14].

Statistical analysis of the obtained results was performed using TIBCO Statistica 13.3 (TIBCO Software Inc., Palo Alto, CA, USA). The results were presented as mean values, standard deviation, and range. The normality of the distribution was assessed using the Shapiro–Wilk test. Comparisons between groups with a normal distribution

were performed using the Student's *t*-test, while data with a non-normal distribution were compared using the Mann–Whitney *U* test. The strength of the relationship between two data sets was assessed using Pearson's linear correlation or Spearman's rank correlation, depending on the distribution. A *p* value  $< 0.05$  was considered statistically significant.

## Results

Clinical data for TSC patients under the care of the Clinic are presented in Table 2. The study group included comparable numbers of boys and girls, with a mean age of approximately 8 years. Genetic testing was performed in more than 80% of patients. The most frequently detected pathogenic variant was located in *TSC2*, and less commonly in *TSC1*. Four patients (7.3%) had a deletion involving the *TSC2* and *PKD1* genes (a cluster of adjacent genes). Five patients (9.1%) had negative genetic tests. Ten patients (18.2%) were overweight, and none were obese.

Biochemical findings for the study group are presented in Table 3.

The mean GFR calculated using the creatinine-based formula was approximately  $138 \text{ mL}/\text{min}/1.73 \text{ m}^2$ , with values  $< 90 \text{ mL}/\text{min}/1.73 \text{ m}^2$  observed in two children (3.6%). The creatinine-cystatin C Schwartz formula yielded a mean GFR of approximately  $111 \text{ mL}/\text{min}/1.73 \text{ m}^2$ , with values  $< 90 \text{ mL}/\text{min}/1.73 \text{ m}^2$  identified in three children (5.5%). Uric acid levels were elevated in five patients (9.1%), total cholesterol in seven patients (12.7%), and triglycerides in ten patients (18.2%). Elevated albuminuria was detected in eleven patients (20.0%). The assessment of renal lesions in patients with TSC is presented in Table 4.

Angiomyolipomas were identified in approximately three-quarters of patients, including fat-poor lesions in nine children (16.4%). The mean AML diameter was approximately 13.1 mm, with lesions measuring  $\geq 30$  mm observed in five children (9.1%). Cysts were present in more than 80% of the patients, with an average size of approximately 10 mm. The largest cysts (up to 75 mm) were found in four children with contiguous gene syndrome

**Table 2.** Clinical data of patients with TSC

Number of patients (n)	55
Boys/girls (n/n) (%/%)	28/27 (50.9/49.1%)
Age (years)	8.1 $\pm$ 4.6 (1.6–17.8)
Genetic screening (n) (%)	45 (81.8%)
Mutation in <i>TSC1</i> (n) (%)	12 (21.8%)
Mutation in <i>TSC2</i> (n) (%)	24 (43.6%)
Mutation in <i>TSC2/PKD1</i> (n) (%)	4 (7.3%)
No mutation	5 (9.1%)
Height (cm)	131.2 $\pm$ 25.5 (81–190)
Height Z-score	0.00 $\pm$ 1.00 (-1.96–2.30)
Body weight (kg)	33.1 $\pm$ 17.0 (10–76)
Body weight Z-score	0.00 $\pm$ 1.00 (-1.36–2.53)
BMI ( $\text{kg}/\text{m}^2$ )	17.8 $\pm$ 3.1 (13.5–29.3)
BMI Z-score	0.83 $\pm$ 0.17 (0.58–1.47)
n – number of patients; TSC – tuberous sclerosis complex; PKD – polycystic kidney disease; BMI – body mass index	

**Table 3.** Biochemical findings in TSC children

Parameter	Value
Creatinine (mg/dL)	0.42 ± 0.14 (0.19–0.80)
Schwartz GFR (creatinine) (ml/min/1.73 m <sup>2</sup> )	138.4 ± 31.3 (83.6–230.4)
Schwartz GFR (creatinine and cystatin C) (mL/min/1.73 m <sup>2</sup> )	111.2 ± 16.9 (72.0–156.8)
Uric acid (mg/dL)	4.1 ± 1.0 (2.4–7.6)
Total cholesterol (mg/dL)	164.7 ± 34.1 (83–294)
LDL cholesterol (mg/dL)	90.6 ± 28.5 (25.8–173.2)
HDL cholesterol (mg/dL)	57.0 ± 17.2 (10–104)
Triglycerides (mg/dL)	81.7 ± 38.0 (35–237)
ACR (mg/g)	23.12 ± 34.9 (2.7–225.7)

GFR – glomerular filtration rate; LDL – low-density lipoprotein; HDL – high-density lipoprotein; ACR – albumin/creatinine ratio

**Table 4.** Renal lesions in TSC children

Parameter	Value
Number of patients (n)	55
Kidney size (mm)	95.2 ± 17.3 (62–155)
AMLs (n/n) (%)	40/55 (72.7%)
Fat-poor AMLs (n/n) (%)	9/55 (16.4%)
AML size (mm)	13.1 ± 14.8 (1–71)
AML ≥30 mm (n/n) (%)	5/55 (9.1%)
Renal cysts	46/55 (83.6%)
Cyst size (mm)	10.3 ± 12.3 (2–75)

n – number of patients; AML - angiomyolipoma

(CGS). Figures 1 and 2 present examples of renal AMLs in children with TSC.

HT was diagnosed in seven patients (12.7%) with TSC. A comparison between normotensive and hypertensive patients is shown in Table 5. Hypertensive children exhibited higher triglycerides, larger longitudinal kidney size, and larger cysts.

A separate analysis was performed for four patients with CGS (one girl and three boys) aged 1.5 to 7.67 years, with a mean age of 4.54 ± 4.5 years (Tab. 6).

In this group, the size of the largest cyst ranged from 10 to 75 mm, with a mean of 40.3 ± 38.0 mm. GFR <90 mL/min/1.73 m<sup>2</sup> was observed in one patient (89.4 mL/min/1.73 m<sup>2</sup>). HT was found in three patients. Figure 3 presents cysts in a child with CGS.

We assessed the correlations between the severity and size of renal tumours and the remaining analysed parameters were evaluated. Positive correlations were identified only between AML size and age ( $r = 0.470$ ,  $p < 0.001$ ) and the ACR index ( $r = 0.444$ ,  $p = 0.001$ ).

## Discussion

Our cross-sectional, single-centre study aimed to characterize renal manifestations in a cohort of patients with a rare, genetic disorder known as TSC. We demonstrated that TSC renal disease is common already in children, occurring in approximately 80% of patients. Cysts and

AMLs are the most frequently observed abnormalities. No other renal lesions were detected in our cohort. Many patients presented with large renal lesions. Some patients exhibited HT and elevated urinary albumin excretion. Despite advanced renal involvement, the vast majority of patients had normal renal function, defined as GFR ≥90 mL/min/1.73 m<sup>2</sup>.

TOSCA (Tuberous Sclerosis Registry to Increase Disease Awareness) is the largest clinical case series of TSC to date. Data from 2,093 TSC patients, including 1,324 children (63.3%), were summarized in 2017. The patients enrolled in our study at the Department of Pediatrics and Nephrology, Medical University of Warsaw constitute a group similar to the TOSCA registry in terms of gender distribution and the rates of pathogenic TSC variants (TSC2 43.6% vs. 63.3%, TSC1 21.8% vs 19.8%). The mean age of patients in the TOSCA registry was 13 years, which is higher than in our cohort [7].

In the TOSCA registry, AML lesions were present in 47.2% of patients (72.7% in our cohort), AML lesions with a diameter >3 cm were found in 41.9% (9.1% in our cohort), and renal cysts were identified in 22.8% of patients (83.6% in our cohort). In our Center, renal lesions are the main cause of admission in TSC patients, which may explain the significantly higher incidence of AMLs and cysts in the study group compared with the TOSCA registry. However, it cannot be ruled out that the higher incidence of renal lesions in our cohort resulted from the use of two imaging modalities in most patients (MRI and US), as well as a uniform, precise protocol and high-



Figure 1. Small cysts in both kidneys in a child with TSC (MRI)

quality equipment (3-Tesla MRI). Similarly to the TOSCA registry, AML size correlated positively with age in our cohort [15]. AMLs, unlike CNS lesions, continue to grow throughout life in TSC patients, with a marked acceleration during adolescence. The risk of spontaneous, often massive, haemorrhage is the main risk associated with AML lesions >3 cm in diameter. Other symptoms that may result from their presence in the kidneys include pain, HT, and impaired renal function [16].

In our cohort, pathogenic *TSC2* variants predominated among genetically screened patients, which is consistent with literature reports. Defects in the *TSC2* gene are typically associated with a more severe course of the disease, particularly with more pronounced neurological symptoms [1]. The negative genetic screening in five patients (9.1%) in the study group most likely resulted from mosaicism, i.e., the presence of at least two genetic lines in a single individual: one carrying a pathogenic *TSC1* or *TSC2* variant and the other (e.g., in peripheral blood) carrying a normal variant. Mosaicism occurs in up to approximately 18% of patients with TSC [2]. In some patients, alterations in the non-coding sequences of these genes (e.g., introns) are also observed [17]. Four patients were diagnosed with *TSC2/PKD1* CGS (polycystic kidney disease with tuberous sclerosis, PKDTS), arising from the deletion of two genes (*TSC2* and *PKD1*) located in close proximity on the short arm of chromosome 16. PKDTS represents a combination of symptoms characteristic of both TSC and polycystic kidney disease (PKD). Patients with PKDTS experience rapid development of renal cysts, early renal impairment, and

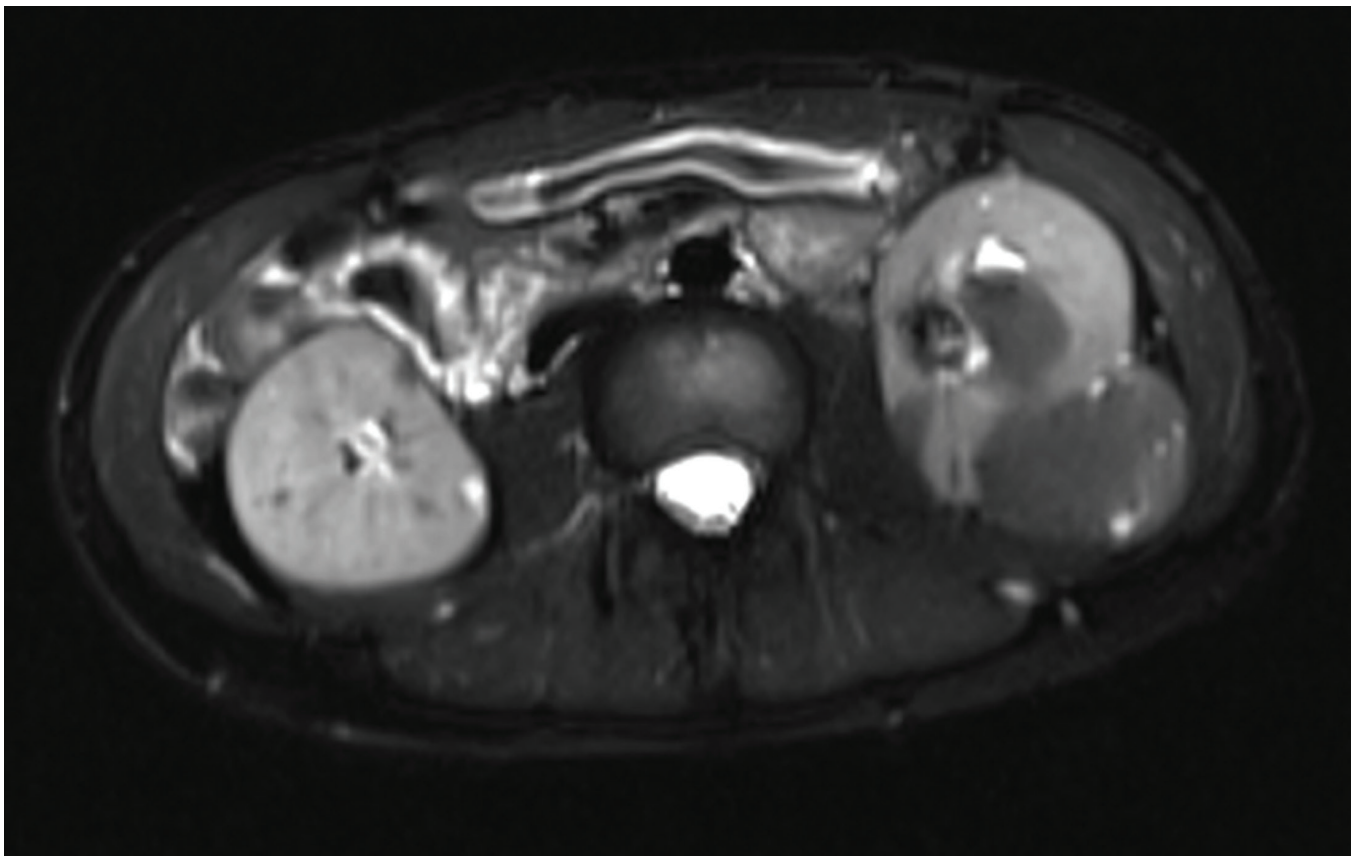


Figure 2. Exophytic fat-poor (atypical) AML in the left kidney of a TSC child (MRI)

Table 5. HT vs normotensive patients with TSC

	TSC children with HT	Non-HT TSC children	P
Number of patients (n)	7	48	-
Age (years)	8.9 ± 6.6	7.9 ± 4.3	0.588
Sex (boys/girls)	5 / 2	23 / 25	0.245
BMI (kg/m <sup>2</sup> )	17.8 ± 2.8	17.8 ± 3.2	0.979
Schwartz GFR (mL/min/1,73 m <sup>2</sup> )	110.0 ± 27.5	111.4 ± 15.4	0.844
Cholesterol (mg/dL)	163.7 ± 33.9	164.8 ± 34.9	0.939
Triglycerides (mg/dL)	111.6 ± 61.1	77.3 ± 32.5	0.026
Renal length (mm)	114.4 ± 21.8	92.4 ± 15.0	0.001
AML size (mm)	11.5 ± 7.5	13.2 ± 15.8	0.831
Cyst size (mm)	22.6 ± 27.1	6.3 ± 5.7	<0.001

TSC – tuberous sclerosis complex; HT – hypertension; n – number of patients; BMI – body mass index; GFR – glomerular filtration rate; AML – angiomyolipoma

Table 6. Summary of clinical and biochemical data in four patients with contiguous gene syndrome (TSC2/PKD1)

Patient	Age (years)	Sex (M/F)	Schwartz GFR (mL/min/1.73 m <sup>2</sup> )	HT (YES/NO)	Max cyst size (mm)
1	7.67	M	89.4	TAK	44
2	1.58	M	156.8	TAK	75
3	1.50	F	72.1	TAK	10
4	7.42	M	139.2	NIE	32

M – male; F – female; GFR – glomerular filtration rate

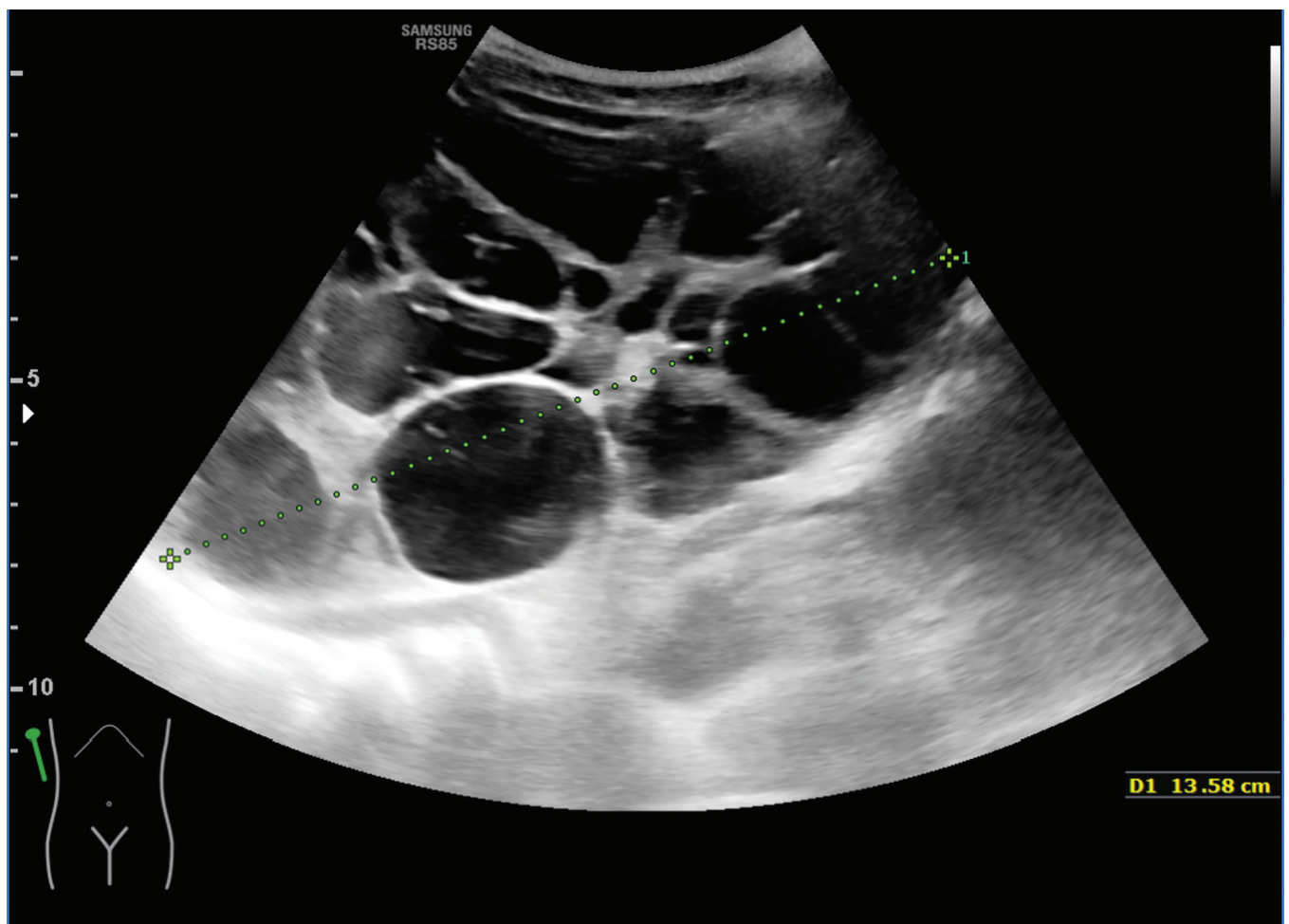


Figure 3. Cystic right kidney in a child with contiguous gene syndrome (TSC2/PKD1) (US)

possible progression to end-stage kidney disease in the second or third decade of life [18].

In our study group, HT was diagnosed in 7 of 55 patients (12.7%), including three CGS patients. The incidence of HT among TSC patients increases with age; according to the literature, it is observed in approximately 5% of children and 25% of adults [15, 16], although some data suggest that it may exceed 30% [19]. It is worth emphasizing that larger renal cyst size in our cohort was an HT risk factor, which lines with observations in children with autosomal dominant polycystic kidney disease (ADPKD) [20].

In the study group, nearly all patients had normal renal function, with the lowest GFR measured at 72 mL/min/1.73 m<sup>2</sup>. GFR was assessed in our study using both the simplified Schwartz formula and the creatinine-cystatin C equation [11]. Cystatin C is recommended in patients with neurological disorders, including those with TSC. Such individuals may experience muscle atrophy, which can reduce creatinine production and lead to a falsely elevated GFR when estimated solely from creatinine [1]. It has been postulated that patients with TSC are at risk of hyperfiltration, attributed to overactivity of the mTOR pathway in the glomeruli, which may represent the earliest stage of kidney injury, analogous to diabetic kidney disease [19]. We also observed elevated GFR values in our cohort, including one child with PKDTS.

Elevated (abnormal) urinary albumin excretion was observed in 11 patients with TSC (20.0%). Albuminuria is an early and highly sensitive marker not only of impaired glomerular integrity but also of endothelial health throughout the body [14, 21]. It is important to emphasize that we demonstrated a positive correlation between AML size and the ACR index, indicating that renal parenchymal involvement by focal lesions is associated with an increased risk of CKD progression in these children [14].

As mentioned earlier, patients with TSC are at risk for the development and progression of chronic kidney disease. About 2–7.5% of TSC patients develop end-stage kidney disease, typically in adulthood, and at a significantly younger age in the case of those with PKDTS. Risk factors for end-stage kidney disease in TSC patients include the size and growth rate of renal lesions, prior surgical interventions (nephrectomy, embolization), and the presence of a co-occurring PKD1 mutation [22].

In 2024, the European Reference Network for Rare Kidney Diseases (ERKNet) published updated recommendations for diagnosing and managing renal lesions in patients with TSC [23]. In the updated guidelines, as well as in the 2021 recommendations of the International Tuberous Sclerosis Complex Consensus Group, a growing AML >3 cm in diameter is an indication for initiating mTOR inhibitors (sirolimus or everolimus) [1, 23]. For diagnosed HT, first-line therapy consists of drugs to inhibit the renin-angiotensin-aldosterone system (RAAS) [23]. Fat-poor (atypical) AMLs pose a particular diagnostic and therapeutic challenge, as they may be mistaken for renal cancer on imaging studies. Renal

cancer is characterized by a faster growth toward the renal hilum, whereas AML typically grows exophytically, outward from the organ [1]. In selected, uncertain cases, biopsy of the lesion may be considered [23].

In summary, it should be emphasized that clinically significant renal abnormalities occur already in children with TSC. The size of AMLs increases with age and correlates with urinary albumin excretion. Patients with CGS are a group with the most severe disease course and are at risk of developing end-stage renal disease already during childhood. Children with TSC require regular blood pressure measurements, evaluation of renal abnormalities through imaging, and monitoring of biochemical parameters in line with current recommendations. The specificity and interdisciplinary nature of the disease highlight the need for care provided by an experienced clinical team with access to advanced diagnostic and therapeutic modalities.

## Conclusions

- Renal lesions are common in TSC children, with the most severe renal manifestations occurring in patients with contiguous gene syndromes.
- The size of AMLs in TSC children increases with age.
- Large AMLs are a risk factor for increased urinary albumin excretion in this patient group.
- In paediatric patients with TSC, large cyst size is a risk factor for HT.
- All paediatric patients with TSC should be followed up by a paediatric nephrologist.

## Acknowledgements

We would like to thank Prof. Małgorzata Pańczyk-Tomaszewska and Prof. Sergiusz Józwiak for their support in implementing this project.

## References

1. Northrup H, Aronow ME, Bebin EM, et al.; International Tuberous Sclerosis Complex Consensus Group. Updated International Tuberous Sclerosis Complex Diagnostic Criteria and Surveillance and Management Recommendations. *Pediatr Neurol*, 2021; 123: 50–66. doi: 10.1016/j.pediatrneurol.2021.07.011
2. Salussolia CL, Klonowska K, Kwiatkowski DJ, Sahin M. Genetic etiologies, diagnosis, and treatment of tuberous sclerosis complex. *Annu Rev Genomics Hum Genet*, 2019; 20: 217–240. doi: 10.1146/annurev-genom-083118-015354
3. Shepherd CW, Gomez MR, Lie JT, Crowson CS. Causes of death in patients with tuberous sclerosis. *Mayo Clin Proc*, 1991; 66: 792–796. doi: 10.1016/s0025-6196(12)61196-3
4. Kingswood JC, Belousova E, Benedik MP, et al. Renal angiomyolipoma in patients with tuberous sclerosis complex: findings from the Tuberous Sclerosis registry to increase disease awareness. *Nephrol Dial Transplant*, 2019; 34: 502–508. doi: 10.1093/ndt/gfy063
5. Bissler JJ, Kingswood J. Renal manifestation of tuberous sclerosis complex. *Am J Med Genet C Semin Med Genet*, 2018; 178: 338–347. doi: 10.1002/ajmg.c.31654
6. Thiravit S, Teerasamit W, Thiravit P. The different faces of renal angiomyolipomas on radiologic imaging: a pictorial review. *Br J Radiol*, 2018; 91: 20170533. doi: 10.1259/bjr.20170533

7. Kingswood JC, d'Augères GB, Belousova E, et al.; TOSCA consortium and TOSCA investigators. Tuberous Sclerosis registry to increase disease Awareness (TOSCA) – baseline data on 2093 patients. *Orphanet J Rare Dis*, 2017; 12: 2. doi: 10.1186/s13023-016-0553-5
8. de Onis M. 4.1 The WHO Child Growth Standards. *World Rev Nutr Diet*, 2015; 113: 278–294. doi: 10.1159/000360352
9. Kułaga Z, Grajda A, Gurzkowska B, et al. Polish 2012 growth references for preschool children. *Eur J Pediatr*, 2013; 172: 753–761. doi: 10.1007/s00431-013-1954-2
10. Kułaga Z, Litwin M, Tkaczyk M, et al. Polish 2010 growth references for school-aged children and adolescents. *Eur J Pediatr*, 2011; 170: 599–609. doi: 10.1007/s00431-010-1329-x
11. Schwartz GJ, Muñoz A, Schneider MF, et al. New equations to estimate GFR in children with CKD. *J Am Soc Nephrol*, 2009; 20: 629–637. doi: 10.1681/ASN.2008030287
12. Feig DI, Kang DH, Johnson RJ. Uric acid and cardiovascular risk. *N Engl J Med*, 2008; 359: 1811–1821. doi: 10.1056/NEJMra0800885. Erratum in: *N Engl J Med*, 2010; 362: 2235
13. Stewart J, McCallin T, Martinez J, et al. Hyperlipidemia. *Pediatr Rev*, 2020; 41: 393–402. doi: 10.1542/pir.2019-0053
14. Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2024 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease. *Kidney Int*, 2024; 105: S117–S314. doi: 10.1016/j.kint.2023.10.018
15. Kingswood JC, Belousova E, Benedik MP, et al. Renal manifestations of tuberous sclerosis complex: key findings from the final analysis of the TOSCA study focussing mainly on renal angiomyolipomas. *Front Neurol*, 2020; 11: 972. doi: 10.3389/fneur.2020.00972
16. Eijkemans MJ, van der Wal W, Reijnders LJ, et al. Long-term Follow-up Assessing Renal Angiomyolipoma Treatment Patterns, Morbidity, and Mortality: An Observational Study in Tuberous Sclerosis Complex Patients in the Netherlands. *Am J Kidney Dis*, 2015; 66: 638–645. doi: 10.1053/j.ajkd.2015.05.016
17. Man A, Di Scipio M, Grewal S, et al. The genetics of tuberous sclerosis complex and related mTORopathies: current understanding and future directions. *Genes (Basel)*, 2024; 15: 332. doi: 10.3390/genes15030332
18. Arredondo Montero J, Bronte Anaut M, Velayos M, et al. TSC2/PKD1 contiguous gene deletion syndrome. *Clin Pediatr (Phila)*, 2024; 63: 411–413. doi: 10.1177/00099228231173911
19. Janssens P, Van Hoeve K, De Waele L, et al. Renal progression factors in young patients with tuberous sclerosis complex: a retrospective cohort study. *Pediatr Nephrol*, 2018; 33: 2085–2093. doi: 10.1007/s00467-018-4003-6
20. Massella L, Mekahli D, Paripović D, et al. Prevalence of hypertension in children with early-stage ADPKD. *Clin J Am Soc Nephrol*, 2018; 13: 874–883. doi: 10.2215/CJN.11401017
21. Viazzi F, Leoncini G, Conti N, et al. Microalbuminuria is a predictor of chronic renal insufficiency in patients without diabetes and with hypertension: the MAGIC study. *Clin J Am Soc Nephrol*, 2010; 5: 1099–1106. doi: 10.2215/CJN.07271009
22. Vabret E, Couchoud C, Lassalle M, Vigneau C. From tuberous sclerosis complex to end stage renal disease: who are these patients? *J Nephrol*, 2021; 34: 607–615. doi: 10.1007/s40620-020-00714-3
23. Mekahli D, Müller RU, Marlais M, et al. Clinical practice recommendations for kidney involvement in tuberous sclerosis complex: a consensus statement by the ERKNet Working Group for Autosomal Dominant Structural Kidney Disorders and the ERA Genes & Kidney Working Group. *Nat Rev Nephrol*, 2024; 20: 402–420. doi: 10.1038/s41581-024-00818-0



## MEDICAL SERVICES IN THE POLISH CAMPAIGN OF 1939 – A SYNTHESIS. PART I: MEDICAL SERVICE CAPACITY

Służba zdrowia w kampanii polskiej 1939 roku – synteza. Część I: Potencjał służby zdrowia



Aleksander Rutkiewicz<sup>1,2</sup>

1. Faculty of Health Sciences, University of Bielsko-Biala, Poland
2. Department of Anesthesiology and Intensive Care, Beskid Oncology Centre, John Paul II Municipal Hospital in Bielsko-Biala, Poland

Aleksander Rutkiewicz – 0009-0000-8398-5818

### Abstract

**Introduction and objective:** This research paper was created as part of the project “Polish Campaign of 1939 – Synthesis” conducted by the War Studies University. The aim of this three-part article is to provide a comprehensive account of the role of the Polish health service during the 1939 campaign. The subsequent sections examine the initial capabilities of the health service, wartime planning and preparations, and the actual participation of medical services during the campaign. The primary research question focuses on the factors that led to the collapse of Poland’s medical services in September 1939. **Material and methods:** The author drew on historical materials collected at the Central Military Archive (Warsaw-Rembertów) and the Archives of the Polish Institute and the General Władysław Sikorski Museum (London). This synthesis also incorporates previous research by historians, published sources, and a wide range of personal recollections and testimonies. **Results:** The Polish health service suffered a defeat in 1939. The system for evacuating and treating the wounded collapsed within the first days of the war. Evacuation difficulties, rapidly depleting stocks of prophylactic serums, and delays in surgical care led to widespread complications from infected wounds, including numerous cases of tetanus. **Conclusions:** The main factors that led to the medical crisis in 1939 included the very limited initial capacity of the medical service (staff shortages, underdeveloped hospitals), low financial investment and insufficient material reserves, the highly centralized medical supply system, reliance on railways for medical evacuation, the low degree of motorization in both the Polish Army and society, poor road conditions, and the nature of the enemy’s operations – sudden, deep attacks on the rear, disruption of communication networks, and targeting of civilian areas.

### Streszczenie

**Wprowadzenie i cel:** Praca powstała w ramach projektu „Kampania polska 1939 roku – synteza”, prowadzonego przez Akademię Sztuki Wojennej. Celem trzyczęściowego artykułu jest kompleksowe przedstawienie działań polskiej służby zdrowia w trakcie kampanii polskiej 1939 r. W kolejnych częściach omówiono wyjściowy potencjał służby zdrowia, plany i przygotowania wojenne oraz udział służby zdrowia w kampanii wojennej. Podstawowe pytanie badawcze dotyczyło przyczyn załamania się systemu pomocy rannym we wrześniu 1939 r. **Materiał i metody:** Podstawowy zasób źródeł, który posłużył do opracowania artykułu, znajduje się w Centralnym Archiwum Wojskowym (Warszawa-Rembertów) oraz w Archiwum Instytutu Polskiego i Muzeum im. gen. Władysława Sikorskiego (Londyn). W syntezie uwzględniono również wcześniejsze ustalenia historyków, źródła drukowane oraz szeroki wybór wspomnień i relacji. **Wyniki:** Polska służba zdrowia poniosła w 1939 r. klęskę. System ewakuacji i pomocy rannym w ciągu kilku pierwszych dni wojny uległ załamaniu. Problemy z ewakuacją, szybko wyczerpujące się zapasy surowic profilaktycznych oraz spóźniona pomoc chirurgiczna były przyczyną masowo występujących powikłań septycznych ran, w tym licznych przypadków tężca. **Wnioski:** Do najważniejszych przyczyn, które doprowadziły do katastrofy sanitarnej w 1939 r., należały: bardzo skromny potencjał wyjściowy służby zdrowia (deficyt kadr, niski poziom szpitalnictwa), małe nakłady finansowe, brak odpowiednich rezerw materiałowych, centralizacja systemu zaopatrzenia sanitarnego, wiodąca rola kolei w planach ewakuacji sanitarnej, niski stopień motoryzacji Wojska Polskiego i społeczeństwa, zły stan dróg oraz sposób prowadzenia walki przez wroga (gwałtowne i głębokie uderzenia na tyły polskiego państwa, porażenie sieci komunikacyjnych, atakowanie celów cywilnych).

**Keywords:** medical services; medical evacuation; Polish campaign of 1939

**Słowa kluczowe:** służba zdrowia; ewakuacja medyczna; kampania polska 1939 roku

DOI 10.53301/lw/204331

Received: 25.03.2025

Accepted: 24.04.2025

Published: 30.12.2025

**Corresponding author:**

Aleksander Rutkiewicz

Faculty of Health Sciences, University of Bielsko-Biala,  
Bielsko-Biala

e-mail: olorut@o2.pl

## Introduction

The 1939 war campaign ended with the greatest defeat in the history of Polish statehood. In just over a month, the Second Polish Republic lost its territory, which was partitioned between two occupiers: Nazi Germany and the Soviet Union. The Polish Army was spectacularly defeated, and only a small fraction of the mobilized soldiers managed to reach neutral countries with the intention of continuing the fight. The Polish political authorities went into exile. As a result of the campaign, thousands of Polish citizens, both civilians and soldiers, lost their lives. For the population that remained within the territory of pre-war Poland, a period of persecution, extermination, deportation, poverty, and hunger began. In collective memory, the defeat in 1939 is associated with profound trauma. The consequences of the Nazi and Soviet invasion of Poland had far-reaching political, social, and economic effects – not only for Poland but for the whole of Europe.

Although many years have passed and numerous works have examined the Polish campaign of 1939, a comprehensive, multidimensional synthesis is still lacking. The need to undertake work on such a study was recognized by the staff of the War Studies University. An interdisciplinary research team appointed for this purpose, under the leadership of Col. Dr. Juliusz S. Tym, Professor at the War Studies University, received a targeted grant from the Ministry of Education and Science (No. MEiN/2021/DPI/319).

Among the issues requiring deeper analysis within the project was the broadly understood field of logistics, including medical services.

The following article is the result of work carried out within the aforementioned research team. The aim was to present the activities of the medical service during the Polish campaign of 1939 as coherently as possible. A comprehensive approach to the subject required consideration of the initial potential of the health service, war plans and preparations, and the course of military operations. The fundamental research question concerned the reasons for the collapse of the system providing care for the wounded in September 1939.

The state's medical and sanitary preparedness for war was a multidimensional and highly complex matter. In this sphere, the interdependence between military and civilian structures was particularly evident. The basic tasks of the military medical service, as defined in the 1929 regulation "Medical Service in the Field", were of a universal nature. They included *preventing a reduction in troop numbers by averting disease and treating those soldiers who were lost due to wounds and illness* [1]. It should be noted that while in peacetime these tasks could be carried out by the forces and resources of the military health service, wartime expansion of the structures required the mobilization of reserve personnel from among civilian doctors, dentists, pharmacists, and other medical staff. Their mobilization, by its very nature, depleted the personnel of civilian healthcare institutions. In the event of war, it was planned to utilize the resources of various organizations, primarily the Polish Red Cross (PCK) and, to some extent, civilian hospitals. Civilian material resources stored in

pharmacies were also intended for use in the war zone. The sources of pharmaceutical and dressing supplies functioned, at least in part, as a common denominator. Any shortages in this area impacted both the civilian and military sectors alike. Warfare inevitably generated losses among the civilian population. Civilian hospitals had to be prepared to accommodate them – at least in theory. Given this overlap, it is difficult to clearly separate the civilian and military medical services when discussing the preparations of the Polish health service for war and its role in the 1939 campaign.

A review of the existing literature on the subject goes beyond the scope of this article. However, the most important publications issued after 1989 should be mentioned: Czesław Marmura, *Medyczna myśl wojskowa II Rzeczypospolitej* ["Military Medical Thought of the Second Polish Republic"] [2]; Andrzej Felchner, *Pod znakiem Eskulapa i Marsa. Służba zdrowia Wojska Polskiego (od jesieni 1918 r. do mobilizacji w 1939 r.)* ["Under the Sign of Aesculapius and Mars. The Health Service of the Polish Army (from autumn 1918 to mobilization in 1939)"] [3]; and Waldemar Rezmer, *Operacyjna służba sztabów Wojska Polskiego w 1939 roku. Organizacja. Zasady funkcjonowania. Przygotowania do wojny* ["Operational Service of the Staffs of the Polish Army in 1939. Organization. Principles of Operation. Preparations for War"] [4]. Although these works made a significant contribution to our knowledge of the functioning of the Polish health service in the interwar period, none of them provided a broader discussion of the medical service activities in September 1939.

The primary set of archival documents used to prepare this three-part article is held in two institutions: Central Military Archives (Centralne Archiwum Wojskowe – CAW) in Warsaw-Rembertów and the Archives of the Polish Institute and Sikorski Museum in London (Archiwum Instytutu Polskiego i Muzeum im. gen. Władysława Sikorskiego – IPMS). Special attention should be given to the accounts of the 1939 campaign collected in the IPMS. It should be noted, though, that these were compiled in exile – in France or the United Kingdom. Some of them were submitted to a commission established in connection with the outcome of the 1939 military campaign. Therefore, the content of the accounts may have been modified to present the course of events and the role of their authors in a specific light. They should thus be approached with a degree of critical scrutiny and caution. An important historical source, especially for describing the potential of the Polish health service, is *Mały Rocznik Statystyczny 1939* ["Concise Statistical Yearbook 1939"] [5]. In preparing the synthesis, the existing findings of other historians were also taken into account.

## Personnel potential

Interwar Poland suffered from a shortage of medical personnel. In 1938, the state had a total of 12,917 physicians. In relation to the population, this amounted to a meager ratio of 3.7 doctors per 10,000 inhabitants. Thus, compared with most European countries, Poland ranked near the bottom. Among the 18 countries included in the Concise Statistical Yearbook 1939, Poland occupied the penultimate place, ahead only of Lithuania and Finland

**Table 1.** Number of physicians per 10,000 inhabitants in selected European countries. Source: Mały Rocznik Statystyczny/Concise Statistical Yearbook [5]

Country	Year	Number of physicians per 10,000 inhabitants
Hungary	1936	11.2
Switzerland	1937	10.8
Italy	1935	8.3
Latvia	1936	7.9
Denmark	1936	7.9
Norway	1936	7.7
Belgium	1934	7.4
Czechoslovakia	1936	7.4
Germany	1937	7.3
Netherlands	1936	7.0
France	1937	6.5
Soviet Union	1934	5.0
Bulgaria	1936	4.4
Sweden	1936	4.3
Poland	1938	3.7
Yugoslavia	1936	3.7
Lithuania	1937	3.4
Finland	1937	3.4

(see Tab. 1) [5]. Another unfavorable factor was the extremely uneven distribution of personnel. More than half of the doctors (53%) were concentrated in large cities with populations exceeding 100,000. Among the voivodeships, the best situation in this respect was in Krakowskie Voivodeship, while the worst was in Wołyńskie Voivodeship (see Tab. 2).

**Table 2.** Number of physicians in individual voivodeships in Poland (as of 1938). Source: Mały Rocznik Statystyczny/Concise Statistical Yearbook [5]

Voivodeship	Number	per 10,000 inhabitants
Białostockie	427	2.3
Kieleckie	634	2.0
Krakowskie	1333	5.3
Lubelskie	479	2.0
Lwowskie	1653	4.9
Łódzkie	850	4.1
Nowogródzkie	205	1.8
Poleskie	219	1.7
Pomorskie	651	3.1
Poznańskie	886	3.5
Stanisławowskie	414	2.6
Śląskie	555	4.0
Tarnopolskie	337	2.0
Warsaw (city)	2816	22.1
Warszawskie	474	2.0
Wileńskie	619	4.6
Wołyńskie	365	1.6
Total	12917	3.7

The deficit also affected dentists, of whom there were only 3,686 in the country in 1938 (1.1 per 10,000 inhabitants) [5]. Completing this picture was the dramatically small number of professional nurses, who, according to official statistics, numbered 6,674 nationwide (1.9 per 10,000 inhabitants) [5]. Some support to the medical workforce came from 1,403 feldshers [5]. The problem with this professional group lay in their severely limited competencies and varied level of expertise. Since no new feldshers were trained during the interwar period, the average age in this group must have been high. The situation was somewhat better in the case of pharmacists with higher education, of whom there were 3,787 in 1938. They were supported by a group of 1,638 pharmacy assistants [5].

A concern for the military health service leadership was that, of the total number of physicians practicing in the Second Polish Republic, a significant proportion (estimated at around 40%) belonged to national minorities. It was argued that within the medical community (...) *the Polish element is steadily diminishing. This phenomenon must be considered dangerous, for the health of the nation, the most precious treasure we possess, is thus continually entrusted to non-Polish hands* [6]. It may be assumed that there were also concerns about how medical service personnel of non-Polish nationality would behave in the event of armed conflict.

In August 1939, the military health service had 1,215 officers on active duty, including 84 reserve officers. This number comprised 917 doctors, 116 pharmacists, 59 dentists, and 123 other officers, mainly sanitary, serving in administrative and instructional roles [3]. Thanks to reserves, however, the personnel potential of the military health service was considerably greater. It should be noted, though, that mobilization of reserves simultaneously depleted the personnel of civilian health service structures. An example was the Pomorskie Voivodeship, where more than 60% of doctors were to be mobilized [7].

Due to the lengthy nature of medical education, there was no possibility of an emergency and rapid increase in the number of medical personnel in the period preceding the war. The education of physicians alone lasted at least seven years, six of which were devoted to academic study, followed by one year of postgraduate internship. It should be emphasized that during this time a medical student acquired only basic professional competencies. Training a specialist with appropriate clinical experience (particularly in surgical specialties, which were highly needed during wartime) took several additional years.

However, it is worth noting that in the interwar period Poland made significant efforts to increase the number of medical professionals. Medical faculties operated at the universities of Kraków, Lwów, Poznań, Warsaw, and Wilno. Dentistry was also taught at these faculties, with the exception of Warsaw, where an independent Academy of Dentistry functioned outside the university structure. Between 1923 and 1938, the number of physicians per capita increased by more than 50%. For dentists, the increase was even greater, reaching 175%. However, the initial staffing deficits and needs were so

large that, during 20 years of the reborn Polish state, it was not possible to even approach the levels of more developed countries.

The training of medical personnel for the Polish Army was carried out by the Sanitary Training Center in Warsaw (Fig. 1). Instruction was conducted along two tracks. Future career medical officers pursued medical studies at the Faculty of Medicine of the University of Warsaw, while the Sanitary Training Center was responsible for general military and military-medical training. Similarly, officer cadets studying pharmacy were enrolled as students of the Faculty of Pharmacy at the University of Warsaw. Future military dentists were trained at the Dental Academy.

In total, between 1922 and 1939, 601 professional officer cadets were trained at the Sanitary Training Center and its predecessors, of whom 474 graduated as medical service officers [3, 8]. In addition to preparing career personnel, the Center also trained reserve cadets as well as professional sanitary non-commissioned officers. The total number of trained reservists is difficult to determine.

Graduates of civilian medical faculties (medicine, dentistry, pharmacy) were subject to 12 months of compulsory military service. This consisted of six months of training at the Sanitary Training Center and an additional six months of practical service within a line formation or an appropriate sanitary establishment. For doctors, the

purpose of the service was to prepare reservists ready to fill positions such as junior regimental doctors, doctors of independent battalions (or squadrons), commanders of sanitary companies in infantry divisions or sanitary platoons in cavalry brigades, or chiefs of wartime hospitals. Pharmacist reservists, in turn, were designated for work in military pharmacies, bacteriological-chemical laboratories, and sanitary supply establishments. Dentists, in turn, were to staff positions in field dental laboratories.

Col. Dr. Wincenty Babecki, who in 1939 served as deputy director of the Department of Health Service at the Ministry of Social Welfare, pointed to the problem of insufficient clinical competence among military physicians. In his assessment, postgraduate education for military doctors focused mainly on issues of sanitary tactics, army organization, service structures, and similar matters, while offering very little specialized medical training. This was believed to be the result of a doctrine introduced by Gen. Dr. Felicjan Sławoj Składkowski, according to which *a military doctor should first and foremost be a good officer, and only afterwards a "sawbones"*. (...) Moreover, after completing their education and training at the Sanitary Training Center, young military doctors were sent to line units *and only very few had the opportunity for brief specialization in hospitals, which in most cases did not provide adequate conditions for their professional development* [9]. By contrast, it was not uncommon for mobilized reserve doctors to possess extensive clinical experience gained from hospital work, often with specializations and even academic titles. Their



**Figure 1.** Until 1939, the principal institution for training professional medical service officers (physicians, dentists, pharmacists) was the Sanitary Training Centre located in Warsaw's Ujazdów district. In peacetime, career officers covered most of the army's medical needs. However, the wartime expansion of medical service structures required the mobilization of hundreds of professionals who ordinarily worked in the civilian health system. This mobilization, amid the severe shortage of medical personnel in the Second Polish Republic, further depleted the already limited resources of hospitals, pharmacies, and outpatient clinics. Photograph: Ceremonial oath at the Sanitary Training Center. Source: National Digital Archives

military ranks, however, were disproportionately low compared with their professional qualifications – some held non-commissioned officer ranks such as corporal or sergeant “with census” (i.e. with educational credentials).

When discussing the personnel potential of the broadly understood medical services, it is also essential to consider the resources of the Polish Red Cross (PCK). According to the regulation issued by the President of Poland, the organization’s primary purpose was to *cooperate with military-sanitary institutions in wartime and to prepare for such cooperation in peacetime* [10]. In accordance with its statute, the tasks of the Polish Red Cross during war included providing aid and care to soldiers injured as a result of military operations (both from allied and enemy armies), supporting prisoners of war, keeping casualty records, and assisting civilians affected by armed conflict. The organization’s potential could also be used in peacetime, for example during natural disasters and epidemics [11]. Its reach and capabilities were considerable. In 1939, the number of adults affiliated with its 17 districts exceeded 300,000, in addition to nearly 450,000 young people [12, 13]. The PCK conducted training for the civilian population and for state institutions, prepared sanitary posts and medical supply depots, and organized rescue and sanitary teams. From the perspective of the military medical service, one of the organization’s most important roles was the training of nursing personnel who, in times of crisis, were expected to reinforce military hospitals. The organization operated two nursing schools: in Warsaw and Poznań. In 1939, the PCK Health Service Sisters’ Corps numbered over 700 nurses, more than half of whom were graduates of these schools [13].

### Hospital facilities

The situation of hospital infrastructure was equally unfavorable. In 1938, Poland had 677 hospitals with a total of

**Table 3.** Number of hospital beds per 10,000 inhabitants in selected countries. Source: Mały Rocznik Statystyczny/Concise Statistical Yearbook [5]

Country	Year	Number of beds per 10,000 inhabitants
Germany	1936	98.2
Canada	1936	93.7
Australia	1935	84.2
Norway	1936	84.0
Austria	1936	77.3
Sweden	1936	76.1
Denmark	1936	65.8
Latvia	1937	65.2
Finland	1937	63.7
Czechoslovakia	1936	54.0
Hungary	1936	53.2
France	1933	30.2
Soviet Union	1934	28.0
Poland	1938	21.7
Bulgaria	1936	19.8
Greece	1935	19.4
Yugoslavia	1936	18.1
Lithuania	1937	16.3

74,999 beds, which corresponded to a ratio of 21.7 beds per 10,000 inhabitants. By this measure, Poland was also at the bottom of the European ranking (see Tab. 3). At the same time, there were marked disparities between different regions of the country (see Tab. 4). In the west (Pomorskie, Poznańskie, Łódzkie, Kieleckie, Śląskie, and Krakowskie Voivodeships) which were the first to be exposed to German occupation, 46.7% of all hospitals and as many as 56.3% of beds were concentrated. When the northern voivodeships directly exposed to an attack

**Table 4.** Civilian hospitals in Poland by voivodeship (as of 1938). Source: Mały Rocznik Statystyczny/Concise Statistical Yearbook [5]

Voivodeship	Number of hospitals (% of total)	Number of beds	
		Overall (% of total)	per 10,000 inhabitants
Białostockie	34 (5,0%)	2,333 (3.1%)	12.9
Kieleckie	42 (6,2%)	3,224 (4.3%)	10.1
Krakowskie	48 (7,1%)	8,167 (10.9%)	32.7
Lubelskie	39 (5,8%)	2,812 (3.7%)	10.5
Lwowskie	31 (4,6%)	6,243 (8.3%)	18.6
Łódzkie	51 (7,5%)	5,584 (7.4%)	19.8
Nowogródzkie	18 (2,7%)	625 (0.8%)	5.4
Poleskie	16 (2,4%)	852 (1.1%)	6.8
Pomorskie	35 (5,2%)	5,541 (7.4%)	47.0
Poznańskie	85 (12,6%)	9,540 (12.7%)	42.1
Stanisławowskie	20 (3,0%)	1,359 (1.8%)	8.6
Śląskie	55 (8,1%)	10,174 (13.6%)	72.9
Tarnopolskie	14 (2,1%)	1,035 (1.4%)	6.1
Warszawa (miasto)	63 (9,3%)	8,045 (10.7%)	63.5
Warszawskie	58 (8,6%)	5,867 (7.8%)	21.4
Wileńskie	37 (5,5%)	2,506 (3.3%)	18.6
Wołyńskie	31 (4,6%)	1,092 (1.5%)	4.8
Razem	677 (100%)	74,999 (100%)	21.7

from East Prussia (i.e. Warszawskie and Białostockie) are included, the share of hospitals and beds increases to 60.3% and 67.2%, respectively. In the eastern regions (Wileńskie, Nowogródzkie, Poleskie, Wołyńskie, Tarnopolskie, Stanisławowskie Voivodeships), which in the event of conflict with the Third Reich could have served as rear-area hospital facilities, there were 136 permanent hospitals, accounting for only 9.9% of all beds [5].

The problem lay not only in the number of hospitals and the beds they contained. A large proportion of civilian medical facilities, particularly in rural areas, were poorly equipped and had very limited staff. Hospitals employing only one or two physicians were not uncommon. Some of these facilities lacked analytical laboratories and X-ray equipment. The inability to perform X-rays hindered – and in some cases completely prevented – procedures to remove foreign bodies such as bullets and shrapnel. An example can be found in the Łódzkie Voivodeship, where a review of civilian hospitals conducted in the period preceding the war revealed that hospital care in the coun-

ties was inadequate (see Tab. 5). In some cases, such as the hospital in Końskie, it was explicitly noted that it was “primitive in its arrangements”. A major drawback of the hospital building was heating by tiled stoves. Moreover, it was not the only hospital in the province that lacked central heating [14, 15].

According to the report of Col. Dr. Jan Mintowt-Czyż, head of the Technical-Medical Division of the Department of Health of the Ministry of Military Affairs, cooperation in the period preceding the war between the Ministry of Social Welfare, which oversaw civilian hospitals, and the Ministry of Military Affairs left much to be desired. In his assessment, only a small portion of civilian hospitals could serve as a base for the development of military hospitals, and the civilian health service was not prepared for war [16]. This evaluation was shared by Col. Dr. Wincenty Babecki, deputy director of the Department of Health Service of the Ministry of Social Welfare. In a report prepared after the evacuation to France, he clearly indicated that the civilian health service had not been prepared for war.

**Table 5.** Civilian hospitals in selected poviats of the Łódzkie Voivodeship. Compiled by the author based on: CAW [14, 15]

Powiat	Number of hospitals	Hospital	Beds (standard - maximum)	Personnel					Wyposażenie			Assessment of hospital care in powiat*
				Equipment	Pielęgniarki	Felczery	Akuszarki	Siostry zakon.	RTG	Laboratorium	Diatermia	
Łaski	3	Łask – Szpital Powiatowy	50–75	1	4				Yes	Yes	Yes	Generally inadequate
		Pabianice – Szpital Miejski	94–120	2	5	1	1		No	No	No	
		Pabianice – Szpital Ubezpiec. Społ.	92–120	2	6	1	3		Yes	Yes	Yes	
Wieluński	1	Wieluń – Szpital Wszystkich Świętych	90–120	2					Yes	Yes	No	Very inadequate
Skierniewicki	1	Skierniewice – Szpital Powiatowy św. Stanisława	80–85	3					Yes	Yes	No	Inadequate
Sieradzki	3	Sieradz – Szpital Powiatowy św. Józefa	75–100	3	0		1	5	Yes	Yes	Yes	Inadequate
		Zduńska Wola – Szpital Miejski	25–40	1	3				No	No	Yes	
		Warta – Szpital Psychiatryczny	450–500	4	8				No	No	No	
Łowicki	1	Łowicz – Szpital Św.	80	2					Yes	No	Yes	Inadequate
Kutnowski	1	Kutno – Szpital Powiatowy Św. Walentego	107–120	4					No	No	No	Inadequate
Konecki	1	Końskie – Szpital Powiatowy Związku Komunalnego	50–80	2					Yes	Yes	No	
Piotrkowski	3	Piotrków Trybunalski – Szpital Św. Trójcy	120–150	3					Yes	Yes	No	Inadequate
		Piotrków Trybunalski – Szpital Ubezpieczalni Społecznej	80–150	2					No	Yes	No	
		Piotrków Trybunalski – Szpital Żydowski imienia Salomei i Markusa małżonków Braun	60–80	2					Yes	Yes	No	
Brzeziński	2	Tomaszów Mazowiecki – Szpital Miejski	125–150	2					Yes	Yes	Nie	Inadequate
		Brzeziny – Szpital Komunalny	50–55	2					No	No	Nie	

\* Ocena oryginalna sporządzona przez autorów dokumentów

**Table 6.** Permanent military hospitals in 1939. Compiled on the basis of: CAW [23], IPMS [16, 22]

Hospital	Town/City	Beds	Notes
Town/City	Beds	800	
Beds	Notes	120	
Notes	Warsaw	900	New building under construction
2. Regional Hospital	Chełm	300	
Branch No. 2 of the Regional Hospital	Lublin	100	
3. Regional Hospital	Grodno	400	Under renovation
4. Regional Hospital	Łódź	500	New building
5. Regional Hospital	Kraków	700	Under renovation and expansion
6. Regional Hospital	Lwów	700	Under renovation and expansion
7. Regional Hospital	Poznań	500	Renovated and expanded
8. Regional Hospital	Toruń	400	Renovation and expansion in the design phase
Branch No. 8 of the Regional Hospital	Grudziądz	200	
9. Regional Hospital	Brześć nad Bugiem	500	Renovated and expanded
10. Regional Hospital	Przemyśl	500	
Military Hospital of the Fortified Area	Wilno	500	Renovated and expanded
Garrison Hospital	Równe	150	Renovated and expanded
Garrison Hospital	Radom	100	New building, intended to serve as a surgical center in wartime

As he noted, in the period preceding the war, military representatives were fostering the mistaken belief that the armed forces *would not rely on civilian hospitals except in a few cases of combat within defensive areas, and that the military itself would organize its own war hospitals. This position was highly inconvenient for the Ministry of Social Welfare, as it deprived the ministry of an important argument in pressing local governments and social insurance institutions for the expansion of hospitals. Such a stance was (...) confirmed even before the outbreak of the war by Col. Laski, head of the Mobilization Department of the Health Service of the Ministry of Military Affairs* [9]. If Babecki's words are true, then the attitude of the leadership of the military health service can be regarded as short-sighted, or even ignorant. Another matter is that civilian hospitals were instructed to prepare plans for a substantial increase in the number of beds in the event of war (by 40–100%). However, the lack of allocated funds for this purpose, combined with already difficult material, equipment, and staffing conditions, meant that the chances of implementing these plans were minimal [17].

The condition of military hospitals was considerably better (see Tab. 6). In 1939, the armed forces possessed a total of ten regional hospitals. These were large, generally multi-specialty centers with several hundred beds, equipped with surgical wards, their own pharmacies, laboratories, and X-ray departments. The largest of these – the First Regional Hospital in Warsaw – had 900 beds. Most of the regional hospitals had been renovated and expanded, or were undergoing such work at the time. The most modern facility, newly constructed and commissioned in 1937, was the Fourth Regional Hospital in Łódź. Equally impressive, by Polish standards, was the School Hospital of the Sanitary Training Center, which served not only clinical and educational functions but was also a leading scientific center of the military health service.

Warsaw additionally hosted a smaller, but nationally unique, clinical unit – the Institute of Traumatic Surgery. Smaller military hospitals operated in Wilno, Radom, and Równe. In addition to permanent hospitals, the army had five seasonal hospitals, several garrison infirmaries with dozens of beds each, a number of smaller infirmaries, and sanatoria. It can be estimated that on the eve of war, the military healthcare service had roughly 9,000 beds across hospitals and sanatorium facilities. These estimates do not include field hospitals, which were planned to be established as part of mobilization efforts.

#### Material and equipment capacity

In 1939, Poland had 487 establishments producing medicines and therapeutic agents [18]. These included, among others, critically important agents for treating the wounded, such as analgesics including morphine, ether for anesthesia, hexobarbital (an intravenous general anesthetic), and circulatory stimulants such as nikethamide and nicotine (see Tab. 7).

Domestic pharmaceutical production covered approximately 75% of national demand for medicines [18, 19]. This statistic, however, requires several caveats. First, access to healthcare in prewar Poland was limited, so actual demand for pharmaceuticals was relatively low. Second, these figures reflect peacetime conditions, not the dramatic surge in demand that occurs during full-scale armed conflict. Third, pharmaceutical production in Poland was largely dependent on imported substrates and semi-finished products. Notably, the main supplier of chemical and pharmaceutical preparations was, in fact, Germany [5]. Fourth, the geographic distribution of pharmaceutical plants was unfavorable. More than 53% of all enterprises were concentrated in the Łódzkie and Warszawskie Voivodeships. Around 21% were located in the western

**Table 7.** Selected medicines important for aiding the wounded in military operations, produced in Poland before the outbreak of World War II. Compiled by the author based on: Kikta [18], Wytwórczość chemiczna w Polsce [33], Łowicki i Breitman [34]

Agent	Trade name	Intended use	Manufacturer
Diethyl ether		Inhalation anesthetic	Fabryka Chemiczno-Farmaceutyczna "Elit", Warszawa
			Zakłady Chemiczne "Synthesa" Sp. z o.o., Warszawa
			Spółka Akcyjna dla Przemysłu Chemicznego w Łańcucie
Hexobarbital	Sennarcol	Intravenous anesthetic	Przemysłowo-Handlowe Zakłady Chemiczne Ludwik Spiess i Syn S.A., Warszawa
Morphine		Opioid analgesic	Warszawskie Towarzystwo „Motor” S.A.
			Polska Spółka Wytwarzania Chemikaliów „Roche” S.A., Warszawa
Pantopon	Pantopon Roche	Mixture of opium alkaloids with analgesic and antispasmodic effects	Polska Spółka Wytwarzania Chemikaliów „Roche” S.A., Warszawa
Procaine	Polocaina	Local anesthetic	Przemysłowo-Handlowe Zakłady Chemiczne Ludwik Spiess i Syn S.A., Warszawa
Nikethamide	Corpyrin	Cardiovascular stimulant	Chemiczno-Farmaceutyczne Zakłady Przemysłowe F. Karpiński S.A., Warszawa
	Stiminol		Przemysłowo-Handlowe Zakłady Chemiczne Ludwik Spiess i Syn S.A., Warszawa
Caffeine		Stimulant of the nervous and cardiovascular systems	Mokotowska Fabryka Chemiczno-Farmaceutyczna A. Gąsecki i Synowie S.A., Warszawa Fabryka Chemiczno-Farmaceutyczna „Geo” S.A., Warszawa Towarzystwo Przemysłu Chemiczno-Farmaceutycznego Magister Klawe S.A., Warszawa Fabryka Chemiczno-Farmaceutyczna AP Kowalski S.A., Warszawa Fabryka Chemiczno-Farmaceutyczna B. Krogulecki, Warszawa Fabryka Chemiczna „Pharmedia” Sp. z o.o., Warszawa Przemysłowo-Handlowe Zakłady Chemiczne Ludwik Spiess i Syn S.A., Warszawa
Acetylsalicylic acid	Motopirin	Analgesic and anti-inflammatory drug	Warszawskie Towarzystwo „Motor” S.A.
Sulfonamides	Septazin	Bacteriostatic chemotherapeutics	Przemysłowo-Handlowe Zakłady Chemiczne Ludwik Spiess i Syn S.A., Warszawa
	Antistreptin		Fabryka Chemiczno-Farmaceutyczna „Geo” S.A., Warszawa

provinces (Silesia, Greater Poland, and Pomerania), while roughly 20% were in southern voivodeships (Krakowskie and Lwowskie). In the eastern provinces, fewer than 6% of pharmaceutical enterprises were active [18]. Consequently, occupation of the industrialized western regions would have severely disrupted domestic drug production. Fifth, up to 30% of the capital of pharmaceutical enterprises came from foreign sources [19].

A major achievement, however, was Poland's independence from imported sera and vaccines, which were produced in several domestic facilities. Among the largest were the Vaccine and Serum Production Plant of the Magister Klawe Chemical-Pharmaceutical Society S.A. and the Serum and Vaccine Production Division of the National Hygiene Institute. Before the war, efficient domestic production even allowed for partial export of surpluses abroad [20]. Yet here too a caveat is necessary. The statistics refer to peacetime conditions. The problem became apparent when, in the period preceding the

war, the military requested increased production. This occurred only after an analytical-coordination conference organized in August 1939 by the Department of Health of the Ministry of Military Affairs, with the participation of staff from the National Institute of Hygiene and representatives of Magister Klawe S.A. At that time, it became clear that existing stocks of anti-tetanus and anti-gangrene sera were so low that they would likely be insufficient to meet the needs of not only the civilian population but even the armed forces. The decision was therefore made to maximize production as much as possible. The challenge was that serum preparation took approximately six months [20].

Poland also produced disinfectants. In 1938, 15 plants supplied more than 1,000 tons of these agents. Considerable capacity also existed in the production of dressings, which were manufactured by several dozen companies. Surgical sutures (both silk and catgut) were produced on a much smaller scale. For bioabsorbable (catgut) sutures,

the quality of domestic raw material – lamb intestines – was low. Consequently, domestic production covered only about half of the prewar demand for this category, with the remainder imported from abroad [18, 19]. High-quality surgical instruments were manufactured domestically (produced in three factories: A. Mann, J. Jodłowski, and Olszewski), as well as X-ray machines and related equipment (including products by Rurix, the Borkowski Brothers' manufacturing plants, and the companies operated by Feliks Walknowski and Jan Babicki).

A key issue in preparing for the treatment of casualties in a potential military conflict was the organization of a blood donation and transfusion system. Polish experts, however, did not reach a consensus on which transfusion method – direct donation or indirect transfusion using blood preserved in bottles – offered greater practical value in wartime conditions. This question periodically fueled intense debate among military physicians. Without going into technical detail, it should be noted that establishing a blood transfusion system was an enormous challenge. A system based on direct transfusion, in which blood is transferred from donor to recipient at the bedside, required a pool of potential donors located near transfusion centers and hospitals – an obvious difficulty under wartime circumstances. The alternative method, using preserved blood, required a network of donation points, laboratories, adequate supplies of bottles and preservatives, and refrigerators for storage. It also depended on the ability to transport blood under appropriate conditions, which represented a significant limitation in the Polish context. On the eve of the Second World War, centers specializing in transfusion medicine existed only in larger cities, mostly attached to hospitals (among them Warsaw, Lwów, Kraków, Poznań, and Gdynia). Notably, since 1936 the Central PCK Hospital in Warsaw had operated the Institute of Blood Transfusion and Preservation. A second PCK blood donation center functioned at the Emergency Station in Łódź [21]. In the context of the scale of the conflict that broke out on 1 September 1939, however, the potential of the above-mentioned centers was but a proverbial “drop in the ocean of needs”.

Although Poland's capacity to manufacture pharmaceuticals and other medical supplies did not appear small, the country's overall financial weakness weighed heavily on its actual material potential in this field. In the months immediately preceding the outbreak of the war, civilian hospitals were expected not only to increase the number of available beds but also to prepare several months' worth of sanitary materials and medicines. The problem was that they received no funding for this purpose, which meant that either the task could not be carried out at all, or the amount of stockpiled supplies was far from sufficient [17]. A similar problem affected the military health service. As noted by Col. Dr. Jan Mintowt-Czyż in a report written already in exile: *Since the Ministry of Military Affairs did not allocate appropriate credits for the purchase of mobilization sanitary supplies (these credits were only obtained in the last few years), they had to be arranged independently. To achieve this, part of the so-called subsistence credits was used, and savings were introduced in everyday expenditures...* [22]. Cutting current expenses was not the only way to secure funds for sanitary equipment. Another was the commercial activ-

ity of military hospitals, which offered paid medical services to civilians. According to Col. Mintowt-Czyż, *fees collected from these patients were allocated to the so-called renewal of the Department of Health credits and were directed almost exclusively toward the purchase of mobilization medical equipment. In the final years before the war, these renewed credits amounted to around one million zloty annually* [22]. The state budget was also partially relieved by a decision requiring private pharmacies and those belonging to the Social Insurance Institution to maintain specific reserves of sanitary materials. Yet here too, private pharmacies, lacking additional funds earmarked for this purpose, faced major difficulties in fulfilling the requirement [17].

The sanitary supplies of the Polish Army were stored primarily in two central depots: the Main Sanitary Depot No. 1 in Warsaw (Powązki) and the Main Sanitary Depot No. 2 in Przemyśl. Both were directly subordinate to the Sanitary Supply Directorate, headquartered in Warsaw and headed in 1939 by Lt. Col. Pharm. Tadeusz Moszczeński. The Warsaw depot had greater capacity and a more developed organizational structure. In addition to the Field Equipment and Materials Storage Division and the Current Supplies Storage Division, it also operated a pharmaceutical processing unit. The warehouses stored, among other supplies, medicines, sera and vaccines, laboratory glassware, dressings, field sanitary equipment, dental materials, as well as spare disinfecting and sterilizing instruments [23]. The depot in Przemyśl essentially functioned only as a distribution station, since it received sanitary materials from the Warsaw depot at Powązki and was entirely dependent on it.

The quantities of sanitary materials accumulated in both depots were a cause for concern, particularly with regard to selected items such as medicines, sera and field medical equipment. For example, the Warsaw depot had only 43,000 ampoules of tetanus serum and 40,000 ampoules of gas gangrene serum, while the Przemyśl depot had no serum reserves at all. The scale of these shortages becomes fully apparent only when considering that at least one ampoule of tetanus serum and two ampoules of anti-gangrene serum were required for each wounded soldier [20].

After the campaign, the head of the receiving center of the Main Sanitary Depot No. 1, Capt. Dr. Pharm. Stanisław Brzeziński, assessed the situation as follows: *The Military Sanitary Depot in Warsaw at Powązki was not adequately supplied with sanitary materials for wartime. There was too little dressing material and too few prophylactic sera (...) it may be assumed that, in the pre-war period, the pace of sanitary material procurement was not significantly increased* [24]. Maj. Pharm. Kazimierz Butler, who headed the Current Use Department of the same institution, reported: *I drew Col. Moszczyński's attention to the fact that we were not producing a larger number of personal dressings – the answer was always the same: we have no money* [25]. In another document he noted: *The reserves for mobilization were minimal. Only in August of this year [1939 – author] did the order come that a certain amount of sanitary material from current use was to be set aside, but this reserve was also very insufficient* [26]. Equally poor were the reserves accumulated in the Main Sanitary Depot No. 2 in

Przemyśl, as indicated by the deputy manager of the depot, Capt. Pharm. Tadeusz Kulig [27]. Similar conclusions, though not based on his own experience but on collected accounts, were reached by Maj. Dr. Henryk Mazanek. In his study on the activities of the medical service during the 1939 campaign, he wrote: *Despite the fact that only two sanitary depots were planned for wartime, the amount of materials stored in them was relatively small. (...) In the department of current-use materials, the depots did not hold larger quantities of sanitary supplies, because they had just completed distributing materials to units according to the allocation list (...) the purchasing office had not yet managed to procure new materials, and as a result the depots' current-use warehouses did not contain even the quantities that should have been accumulated under existing regulations, and which were intended to cover a six-month supply for the peacetime army. The quantities set aside for mobilization were also small, because it was only in 1939 that the Health Department issued orders reserving certain amounts of sanitary material for mobilization. In the Main Sanitary Depot No. 1 in Warsaw, only dressing material was stockpiled in larger quantities [20].*

A certain stock of sanitary materials was held by military pharmacies, which operated within all permanent military hospitals, selected seasonal hospitals, and some sanatoria. However, pharmacies primarily secured the current needs of hospitals and infirmaries and could not be treated as sources of supply for field units.

While the supply and equipment of permanent military hospitals in peacetime raised no objections, the quality and quantity of equipment intended for mobilized field units left much to be desired. The bodies mobilizing health service units were primarily the reserve cadres of regional hospitals. However, they did not possess the necessary reserves to equip the mobilized units adequately. Col. Mintowt-Czyż noted: *The supply of hospitals with equipment according to the mobilization plan had to come from purchases or requisitions, and this was a complete fiction – the hospitals did not possess such essential items as autoclaves and X-ray machines. Quartermaster equipment did not exist at all [22].* Equally alarming was a letter from the army inspector, Lt. Gen. Mieczysław Norwid-Neugebauer, dated 12 June 1939, concerning sanitary equipment: *During many years of inspections and observations at inter-divisional exercises, I found that the wartime equipment intended for the medical service units of large formations did not meet requirements, both in terms of quality and, in many cases, equipment design [28].* However, there were also positive examples. One noteworthy case was the high quality of domestically produced field surgical kits, which were widely praised. Some physicians even remarked that they were overly elaborate.

As mentioned earlier, civilian pharmacies were also expected to play a role in supplying military medical units during wartime operations. On 27 March 1939, the Ministry of Social Welfare issued a directive requiring pharmacies to maintain strictly defined quantities of selected medicines and medical supplies [29]. In subsequent months, minor modifications were introduced to the list, which ultimately comprised more than 60 items. These included, among others, 2 kg of ether for anesthe-

sia, 2 kg of chloroform for anesthesia, 100 ampoules of procaine for infiltration anesthesia, 5 kg of 95% alcohol, 400 ampoules of morphine, 10 vials of tetanus antitoxin, 5 vials of gas-gangrene antitoxin, 50 individual dressings, 200 bandages, 25 kg of cotton wool, and – interestingly – 40 liters of oxygen in cylinders [30]. Altogether, in 1938 Poland had 2,310 pharmacies [5]. In theory, they constituted a significant logistical resource. Unfortunately, it has not been established to what extent the directives on mandatory reserves were actually implemented. It should also be noted that the continuity of pharmacy operations under wartime conditions was adversely affected by the planned mobilization, which encompassed a considerable proportion of their personnel, including pharmacists.

The Polish Red Cross (PCK) also maintained reserves of sanitary materials. These were stored in the Main PCK Depot in Warsaw as well as in smaller district and branch depots.

#### Means of transport and medical evacuation

The problem of insufficient motorization within the Polish Army also affected the medical service. This was evident both in the inadequate number of motor vehicles and in their poor quality. For this reason, horse-drawn wagons remained the primary means of medical evacuation at the tactical level. A large portion of these consisted of old and heavily worn supply wagons, model 19. Plans also envisaged the widespread use of requisitioned peasant carts for medical evacuation. Most of these had no suspension, and their only “adaptation” for medical use consisted of lining the wagon bed with straw. Under such conditions, severely wounded soldiers were condemned to painful and exhausting journeys over rough, uneven roads. Another issue concerning some of the medical horse-drawn wagons was highlighted by Gen. Norwid-Neugebauer, who pointed out that *wheeled transport vehicles of foreign types are too heavy for our terrain and road conditions and for our draft animals, and moreover the wheel spacing, much wider than in our domestic wagons, does not match the ruts of our dirt roads [28].*

Most of the ambulances available to the Polish Army in 1939 had been purchased from the budget of the Polish Red Cross (PCK) (Fig. 2). According to estimates by Col. Dr. Babecki, the number of vehicles supplied by this organization in the years preceding the war amounted to approximately 200 [9]. The PCK ambulances were grouped into medical motor columns, which were placed under the administrative and technical authority of individual armored battalions. According to mobilization plans, these battalions were to form a total of 17 medical motor columns, including 14 PCK columns [31]. Such a number of sanitary car columns allowed their use primarily at the operational level, with individual field armies able to count on the allocation of at most one or two of them. The number of ambulances was so small that neither of the two motorized brigades of the Polish Army received its own sanitary column or even a motorized sanitary platoon. It is enough to mention that the entire 10th Motorized Cavalry Brigade, with a total strength of about 5,000 personnel and more than 1,100 vehicles, possessed only 20 ambulances.



**Figure 2.** Although the photograph might suggest otherwise, the degree of motorization in the Polish Army was lamentably low. This was especially true for motor ambulances, whose shortage became particularly evident in September 1939. Most ambulances had been purchased with funds from the Polish Red Cross (PCK). However, these vehicles were subordinated to military structures (primarily armored battalions) responsible for their maintenance and operation. Photograph: Ceremony of handing over new ambulances by the Polish Red Cross. Source: National Digital Archives

However, the medical service struggled not only with the low number of motor vehicles. The Zaolzie operation, carried out in the autumn of 1938 as a kind of test and training ground for the Polish Army, revealed that the technical condition of the sanitary vehicles involved left much to be desired. Although no direct clash with the Czech side occurred and the sanitary column assigned to the “Silesia” Operational Group essentially remained in reserve, the operation exposed the structural shortcomings of the ambulances. One report noted: *The assigned sanitary vehicles frequently broke down, struggling to cope with greater demands. The main cause seems to be their construction. Heavy bodies were mounted on light passenger-car chassis with heavy axles and a weak, delicate engine, making it impossible to expect the performance of a truck. The most common defects concerned the gear transmission* [32].

Given the generally low level of motorization in the country, the possibilities of acquiring improvised evacuation means by requisitioning civilian vehicles were very limited. It was assumed that in larger cities it would be possible to take over and adapt buses for this purpose. However, this solution was feasible only in urban centers with an adequate fleet, such as Lwów, Gdynia, and Katowice.

Given the above circumstances, as well as the experience gained during the Polish–Bolshevik War, rail transport held a special place in Polish medical doctrine and the medical evacuation system. Hospital trains were organizationally divided into permanent (kept in readiness), semi-permanent (with reduced staffing), and improvised

units. The “American-type” trains, dating back to the previous war, consisted of 16 carriages with a total capacity of 360 lying patients. The “Polish-type” trains comprised 30 carriages and could transport 150 bedridden and 100 seated patients. Mobilization plans envisaged the use of 36 permanent and semi-permanent trains [31]. Although the nominal number of trains and their patient-transport capacity appeared impressive, preparing them to effectively fulfill their tasks proved highly challenging. The Ministry of Communications was responsible for assembling the train sets, while reserve staff from regional hospitals were expected to supply sanitary and quartermaster materials. The previously described problems with medical supply also affected the trains [20]. It is worth noting that medical trains were inextricably linked to railway lines. The railway network in the Second Polish Republic, particularly in areas of the former Russian partition, was inadequately developed. Thus, evacuation routes for the wounded were determined by railway lines, which created considerable logistical and organizational difficulties for the medical service.

Against the backdrop of the above-mentioned capacities and limitations of Polish healthcare, the potential of domestic air ambulance services was, in practice, negligible. The fleet of around 30 medical aircraft, including the Lublin R-XVIIb and RWD-13S, performed very well during peacetime in transporting critically ill patients – though only individually – from remote regions of the country to specialist centers in larger cities. However, in the event of a full-scale conflict, they could in no way influence



**Figure 3.** Every ceremony for the handover of a new medical aircraft was carried out with great pomp and widely publicized in the media. This, however, did not change the fact that a fleet of approximately 30 RWD-13S and Lublin R.XVIIb medical planes had very limited potential in the event of a full-scale armed conflict. The RWD-13S could carry only one patient at a time, while the R.XVIIb could carry two. Photograph: Ceremony for the handover of a new RWD medical aircraft at the Kraków Błonia. Source: National Digital Archives

the overall situation (Fig. 3). A Lublin R-XVIIb could carry two wounded patients on stretchers at a time, while an RWD-13S could carry only one. Theoretically, several Fokker F-VII transport planes and aircraft belonging to the "Lot" airline could be adapted for evacuation purposes.

## References

1. Służba zdrowia w polu. Warszawa: Ministerstwo Spraw Wojskowych, 1929
2. Marmura C. Medyczna myśl wojskowa II Rzeczypospolitej. Pruszków: Agencja Wydawnicza ULAK, 1998
3. Felchner A. Pod znakiem Eskulapa i Marsa. Służba zdrowia Wojska Polskiego (od jesieni 1918 r. do mobilizacji w 1939 r.). Oświęcim: Wydawnictwo Napoleon V, 2016
4. Rezmer W. Operacyjna służba sztabów Wojska Polskiego w 1939 roku. Organizacja. Zasady funkcjonowania. Przygotowania do wojny. Warszawa: Wydawnictwo Tetragon, 2010
5. Mały Rocznik Statystyczny 1939. Warszawa: Nakładem Głównego Urzędu Statystycznego, 1939
6. Centralne Archiwum Wojskowe (CAW). Departament Zdrowia Ministerstwa Spraw Wojskowych, sygn. I.300.62.39. Pismo Departamentu Zdrowia Ministerstwa Spraw Wojskowych do Ministra Wyznań Religijnych i Oświecenia Publicznego w sprawie nostryfikacji dyplomów lekarskich. kwiecień 1937 r.
7. Centralne Archiwum Wojskowe (CAW). Oddział IV Sztabu Generalnego, sygn. I.303.7.600. Materiały dotyczące zasobów służby sanitarnej na terenie DOK VIII (Toruń), (bez daty).
8. Markowski B, red. Podchorążowie z Ujazdowa. Wspomnienia Szkoły Podchorążych Sanitarnych 1922–1939. Londyn: Nakładem Klubu Wychowanków Szkoły Podchorążych Sanitarnych, 1972
9. Instytut Polski i Muzeum gen. Sikorskiego (IPMS). Relacje z kampanii 1939 roku – służba sanitarna. Sygn. B.I.118. Raport płk. lek. dr. W. J. Babeckiego w sprawie przygotowania Polski do wojny i współpracy administracji wojskowej i cywilnej w zakresie służby zdrowia, 18.03.1940
10. Rozporządzenie Prezydenta Rzeczypospolitej z dnia 1 września 1927 r. o Stowarzyszeniu „Polski Czerwony Krzyż”. Dz.U. 1927 nr 79 poz. 688
11. Statut Stowarzyszenia „Polski Czerwony Krzyż”. Warszawa: Nakładem Zarządu Głównego Polskiego Czerwonego Krzyża, 1939
12. Archiwum Akt Nowych. Powstanie i historia Polskiego Czerwonego Krzyża. Działalność PCK głównie w okresie okupacji 1939–1945. Wspomnienia i materiały Józefa Stemlera. Sygn. 2/762/0/2/8. Stemler J. Dzieło samopomocy i miłosierdzia – Polski Czerwony Krzyż w latach wojny 1939–1945. Rys ogólny. Warszawa: Wydawnictwo Zarządu Głównego Polskiego Czerwonego Krzyża, (bez daty)
13. Uhma S., Bliźniewski R. Polski Czerwony Krzyż 1919–1959. Warszawa: Państwowy Zakład Wydawnictw Lekarskich, 1959
14. Centralne Archiwum Wojskowe (CAW). Biuro Inspekcji Głównego Inspektoratu Sił Zbrojnych, sygn. I.302.4.2157. Ewidencja szpitali, aptek, składów aptecznych, lekarzy i innego personelu niepodlegającego mobilizacji
15. Centralne Archiwum Wojskowe (CAW). Oddział IV Sztabu Generalnego, sygn. I.303.7.596. Ewidencja i wykazy aptek oraz składów aptecznych, zasobów leków w aptekach w powiatach województwa Łódzkiego. (bez daty)
16. Instytut Polski i Muzeum gen. Sikorskiego, IPMS, Ministerstwo Spraw Wojskowych – służba zdrowia. Sygn. B.I.12E, Załącznik do zeszytu ewidencyjnego płk. dr. Jana Mintowta-Czyża, L.863/39, odpis, dokument bez daty

17. Instytut Polski i Muzeum gen. Sikorskiego (IPMS). Relacje z kampanii 1939 roku – służba sanitarna. sygn. B.I.118. Protokół przesłuchania płk. dr. Wincentego Babeckiego przed komisją powołaną w związku z wynikiem kampanii wojennej 1939 r., (bez daty)
18. Kikta T. Przemysł farmaceutyczny w Polsce (1823–1939). Warszawa: Polska Izba Przemysłu Farmaceutycznego i Wyrobów Medycznych, 2007
19. Kurkowska-Bondarecka K. Historia polskiego przemysłu farmaceutycznego. Warszawa: Stowarzyszenie Inżynierów i Techników Przemysłu Chemicznego, 1995
20. Instytut Polski i Muzeum gen. Sikorskiego (IPMS). Relacje z kampanii 1939 roku – służba sanitarna. Sygn. B.I.118. Mazanek H, Studium Służby Zdrowia z okresu wojny polsko-niemieckiej we wrześniu 1939 r., (bez daty)
21. Paliga R. Krwiolecznictwo i krwiodawstwo w medycynie polskiej XIX i XX wieku (1830–1951) od powstania listopadowego do utworzenia Instytutu Hematologii. Poznań: Uniwersytet Medyczny w Poznaniu, 2012: 164–167
22. Instytut Polski i Muzeum gen. Sikorskiego (IPMS). Ministerstwo Spraw Wojskowych – służba zdrowia, sygn. B.I.12E. Kwestionariusz dla Służby Zdrowia w sprawie Zaopatrzenia Sanitarnego, płk dr Jan Mintowt-Czyż, odpis (bez daty)
23. Centralne Archiwum Wojskowe (CAW). Departament Zdrowia Ministerstwa Spraw Wojskowych, sygn. I.300.62.54. Obsada służby zdrowia. 1939
24. Instytut Polski i Muzeum gen. Sikorskiego (IPMS). Relacje z kampanii 1939 roku – służba sanitarna. Sygn. B.I.118, Załącznik do zeszytu ewidencyjnego kpt. dr. farm. Stanisława Brzezińskiego, 03.12.1939
25. Instytut Polski i Muzeum gen. Sikorskiego (IPMS). Relacje z kampanii 1939 roku – służba sanitarna. Sygn. B.I.118, Załącznik do zeszytu ewidencyjnego mjr. mgr. farm. Kazimierza Butlera
26. Instytut Polski i Muzeum gen. Sikorskiego (IPMS). Relacje z kampanii 1939 roku – służba sanitarna. Sygn. B.I.118. Kazimierz Butler – odpowiedź na kwestionariusz
27. Instytut Polski i Muzeum gen. Sikorskiego (IPMS). Relacje z kampanii 1939 roku – służba sanitarna. Sygn. B.I.118. T. Kulig – Odpowiedź na kwestionariusz w sprawie zaopatrzenia sanitarnego przed i podczas wojny pol-niem 2 1939 r., 17.01.1940 r.
28. Centralne Archiwum Wojskowe (CAW). Główny Inspektorat Sił Zbrojnych. Sygn. I.302.4.2158. Pismo inspektora armii gen. dyw. M. Norwid-Neugebauera L.dz.3323/tj.39 z 12.06.1939 w sprawie wyposażenia sanitarnego
29. Centralne Archiwum Wojskowe (CAW). Główny Inspektorat Sił Zbrojnych. Sygn. I.302.4.2158. Pismo mgr. P. Piłarskiego Kierownika Samodzielnego Referatu Wojskowego Ministerstwa Opieki Społecznej Nr W.1/132-9 w sprawie materiału leczniczego i opatrunkowego, który posiadać mają apteki, dokument z 26.06.1939
30. Centralne Archiwum Wojskowe (CAW). Główny Inspektorat Sił Zbrojnych. Sygn. I.302.4.2158. Załącznik do pisma M.O.S. z 27.03.1939 nr Zf.5/6-9 poprawiony pismem z 28.06.1939 nr W.1/132-9
31. Rybka R., Stepan K. Najlepsza broń. Plan mobilizacyjny „W” i jego ewolucja. Warszawa: Oficyna Wydawnicza „Adiutor”, 2010
32. Korbal J. Zaolzie – klęska tyłów? Część II: krytyka i wnioski. Technika Wojskowa Historia, 2023; 1: 18–30
33. Wytwórczość chemiczna w Polsce. Nakładem Związku Przemysłu Chemicznego Rzeczypospolitej Polskiej, Warszawa 1937
34. Łowicki JA, Brejtman MJ. Farmakoterapia kliniczna. Nakładem czasopisma Współczesne Lecznictwo Farmaceutyczne i Fizykalne, Warszawa, 1937



# EXPANDING .308 WINCHESTER CALIBRE AMMUNITION AND SOFT TISSUE INJURY

Amunicja ekspandująca kalibru .308 Winchester  
a obrażenia w tkance miękkiej



Grzegorz Motrycz

University of Lomza, Poland

Grzegorz Motrycz -  0000-0003-0203-7993

## Abstract

**Introduction and objective:** The aim of the study was to analyse injuries inflicted by Scenar bullets, which resemble dum-dum (expanding) projectiles in their design. Particular attention was paid to the impact of bullet velocity on the shape of the temporary cavity in soft tissue and the possibility of predicting wound profile parameters at comparable kinetic energies of the bullets. **Materials and methods:** An experiment was conducted using a block of ballistic gelatin cooled to 6°C. The block was fired at from a distance of 25 m using an Oberland Arms OA10 rifle, calibre .308 Winchester. The velocity of the bullet and its movement in the gelatin were recorded using a high-speed Phantom Miro 310 camera at 20,000 frames per second. The expansion and fragmentation of the bullet, as well as the effect of kinetic energy on the formation of the temporary cavity were assessed. **Results:** A description of the phenomena was presented, the process of permanent and temporary cavity formation created by the Scenar bullet was discussed, and photographic documentation was presented. **Conclusions:** The velocity of the Scenar bullet affects the shape of the temporary cavity within the soft tissue. A lighter bullet (167 gr) with lower kinetic energy produced a larger temporary cavity compared to a heavier bullet with higher energy (185 gr) due to loss of stability.

## Streszczenie

**Wprowadzenie i cel:** Celem badania była analiza obrażeń powodowanych przez pocisk Scenar, który swoją konstrukcją przypomina pociski ekspandujące typu dum-dum. Szczególnie skoncentrowano się na wpływie prędkości pocisku na kształt jamy chwilowej w tkance miękkiej oraz na możliwości przewidywania parametrów profilu rany przy porównywalnej energii kinetycznej pocisków. **Materiał i metody:** Przeprowadzono eksperyment, wykorzystując blok żelatyny balistycznej schłodzonej do 6°C. Ostrzelano go z odległości 25 m, używając karabinu Oberland Arms OA10 kaliber .308 Winchester. Rejestrowano prędkość pocisku i jego ruch w żelatynie za pomocą szybkiej kamery Phantom Miro 310 z prędkością 20 000 klatek na sekundę. Analizowano sposób ekspansji oraz fragmentacji pocisku, a także wpływ energii kinetycznej na tworzenie się jamy chwilowej. **Wyniki:** Przedstawiono opis zjawisk, omówiono proces tworzenia się kanału trwałego i jamy chwilowej wywołany przez pocisk Scenar oraz zaprezentowano dokumentację fotograficzną. **Wnioski:** Prędkość pocisku Scenar wpływa na kształt kanału chwilowego w tkance miękkiej. Lżejszy pocisk (167 gr) o mniejszej energii kinetycznej, dzięki utracie stabilności, wytworzył większą jamę chwilową w porównaniu z pociskiem cięższym o wyższej energii (185 gr).

**Keywords:** international humanitarian law; dum-dum bullet; Scenar bullet

**Słowa kluczowe:** międzynarodowe prawo humanitarne; pocisk dum-dum; pocisk Scenar

DOI 10.53301/lw/204714

Received: 16.12.2024

Accepted: 06.05.2025

Published: 30.12.2025

**Corresponding author:**

Grzegorz Motrycz  
Akademia Łomżyńska,  
ul. Akademicka 14, 18-400 Łomża  
e-mail: gmotrycz@al.edu.pl

## Introduction

Expanding bullets, commonly referred to as dum-dums, are projectiles designed to increase the impact on soft tissue. As they expand within the body, they tend to produce more extensive damage compared with full metal-jacketed (FMJ) projectiles [1]. During penetration, these projectiles transfer energy to the surrounding tissues, resulting in injury, the severity of which depends on factors such as loss of stability and the degree of deformation. This process may also lead to projectile fragmentation, thereby increasing the risk of internal injuries [2]. Consequently, injuries inflicted by expanding projectiles present a significant challenge for surgeons [3].

The ban on the use of expanding bullets was introduced in 1899 under the Hague Declaration concerning Expanding Bullets that expand or flatten easily in the human body. The authors of this document were inspired by the 1868 St. Petersburg Declaration, which sought to prohibit excessively cruel weapons in response to the development of the dum-dum projectiles [4]. The wording of Article 8(2)(b) and Article 8(2)(e) was derived from the 1899 Hague Declaration and referred to bullets with a hard envelope (jacket), bullets in which the core was not fully covered, and bullets with scoring.

In the current geopolitical context, some countries oppose further expansion of the ban on the use of expanding projectiles. Public arguments have emerged suggesting that the use of such ammunition is necessary and particularly useful in counterterrorism operations. This argument is often supported by the notion that operations conducted in urban environments (dynamic operations) using semi-jacketed or hollow-point ammunition during efforts to restore public order may offer certain advantages [5]. The primary advantage of such projectiles, compared with standard FMJ bullets, is their tendency to remain within the assailant's body. This reduces the risk of injury to bystanders. It is also worth noting that, due to their design, expanding bullets exhibit substantial 'disabling power,' defined as the ability to immediately incapacitate an attacker after a single hit, thereby preventing them from firing a shot [6]. Despite ongoing controversy, defence companies are developing controlled-expansion ammunition. Efforts are focused on identifying solutions that will maintain the advantages of this type of ammunition while increasing its predictability and limiting injuries.

From the point of view of international humanitarian law and ethical principles, the use of expanding projectiles in

military operations remains controversial. The distinction between evaluating their use in counterterrorism (restoring public order) vs military operations arises from two separate branches of law. According to Melzer, one possible, though imperfect, explanation is that there is greater tolerance for 'collateral damage' in warfare than in counterterrorism operations [7]. The situation looks different in the United States, where such ammunition, when used for private purposes, such as hunting, personal protection, or law enforcement, is not subject to international conventions. An example is the 9 mm RIP™ radically invasive bullet, the use of which would theoretically fall under the scope of international restrictions [8], yet the U.S. does not fully recognize these limitations [9]. The bullet in question consists of eight segments, referred to by the manufacturer as 'trocars' (a term originating from a surgical instrument). These segments are designed to fragment upon entry and penetrate soft tissue, thereby maximizing the severity of damage [10].

The group of bullets referred to as deforming or expanding includes lead-core bullets, jacketed soft-point (JSP) bullets, and semi-jacketed hollow-point (SJHP) bullets. From a physical standpoint, the mechanism of incapacitation can be described as controlled expansion, which involves fragmentation. Manufacturers achieve controlled expansion by creating a hollow point in the bullet's tip.

Upon impact, the expansion process begins at the projectile's tip, leading to an increase in its cross-sectional diameter and the amount of energy dissipated in the soft tissue (Fig. 1). These projectiles exhibit minimal change in trajectory following soft tissue penetration [11], because the tip deforms upon striking the target, taking on a mushroom-like shape [12]. As a result of this deformation, the projectile's centre of mass shifts closer to the point at which hydrodynamic drag forces act, thereby increasing its stability. The magnitude and pattern of expansion depend on the size and shape of the hollow point (air void), as well as on the projectile's material and construction.

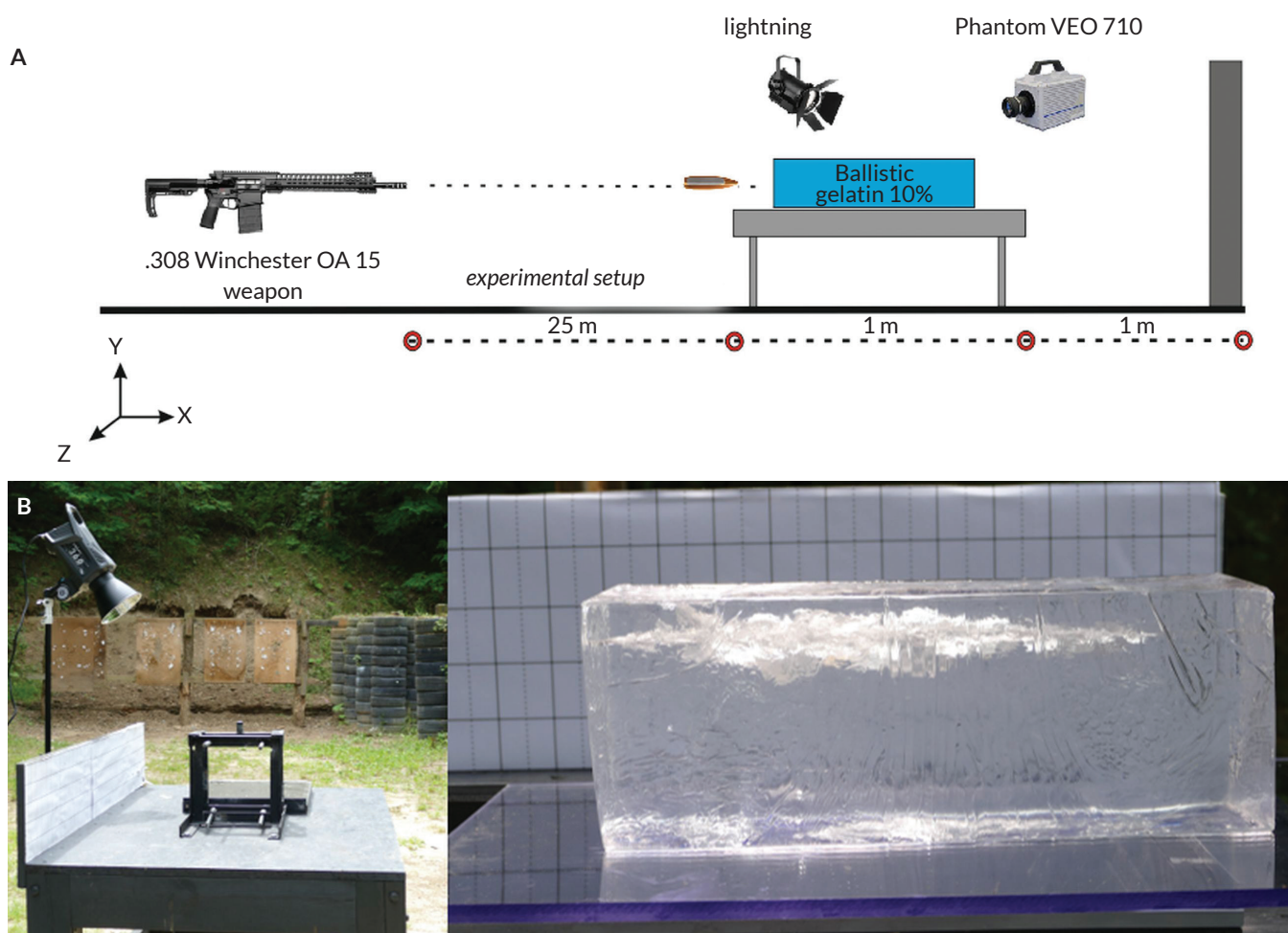
## Aim

The aim of the experiment was to investigate the damage inflicted by the Scenar projectile, which is similar in design to dum-dum projectiles. The following research questions were formulated:

- Does bullet velocity affect the shape of the temporary cavity in soft tissue?
- Will bullets with comparable kinetic energy produce identical parameters and an identical shape of the temporary cavity in soft tissue?



Figure 1. A schematic image of a projectile deforming in a controlled manner (by G. Motrycz)



**Figure 2.** A. Schematic diagram of the experimental setup (prepared by G. Motrycz). B. Ballistic gelatin block on the experimental setup. Image taken by G. Motrycz / K.J. Helnarska

## Materials and methods

The experimental setup is shown in Figure 2, located at the shooting range in Dąbrówka. The atmospheric conditions during the experiment were as follows: temperature 23–26°C, no wind, and atmospheric pressure of 1,015 hPa. The projectiles were fired at a block of ballistic gelatin from a distance of 25 meters, aimed at a point approximately 7 cm from the edge of the block, in its mid-part.

During the experiment, the projectile's velocity was measured, and its travel through the gelatin was recorded using a Phantom Miro 310 ultra-high-speed camera, which captured images at 20,000 frames per second at a resolution of 1,280 × 800 pixels. The camera and its lens were positioned to provide a field of view of 40 cm × 60 cm. A board with a printed grid of markers spanning 100 cm was placed behind the ballistic gelatin block to enable calibration of horizontal and vertical distance measurements and precise determination of the projectile's position. The resulting video footage was analysed with an accuracy of 0.1 ms. Before the experiment, the ballistic gelatin was cooled to 6°C.

The experiment used Scenar bullets manufactured by the Finnish company Nammo Lapua Oy, designated GB422 and GB432. These are full-jacket, hollow-point boat-tail

bullets featuring a hollow point at the tip and a tapered base. Their design incorporates a hollow point which, when combined with the shape of its surface, directs the pressure wave outward upon impact. This causes the bullet to expand at the front and increase its diameter. The core is made of a lead alloy with an antimony additive, which increases hardness and strength, thereby promoting extensive fragmentation upon impact with soft tissue. As a result, the bullet splits into two or three pieces, and the jacket separates from the core. A cross-section of the .264-caliber Scenar projectile, illustrating its design, is shown in Figure 3. Technical specifications are presented in Table 1. During the experiment, two shots were fired using Scenar bullets weighing 10.85 g (167 gr) and 12.00 g (185 gr), achieving muzzle velocities of 836.5 m/s and 766.3 m/s, respectively. This corresponds to energies of 3,796 J and 3,523 J, respectively, a difference of 273 J.

The experiment was conducted using a German Oberland Arms OA10 sniper rifle chambered in .308 Winchester (7.62 × 51 mm), equipped with a 0.64 m long four-groove barrel, as shown in Figure 4.

Based on individual images captured at 0.1 ms intervals, it was possible to track the bullet's expansion and fragmentation, which is crucial for assessing ammunition effectiveness and characterizing injuries in the clinical context. The process of temporary cavity formation was



**Figure 3.** A cross-sectional image of .264, 123 gr. Hollow Point Boat Tail, Lapua Scenar. Source: <https://reloaders.eu/lapua-scenar-a-good-hunting-bullet/> [13]

also analysed. This phenomenon is important for the pathophysiology of wound formation and has a direct impact on the extent of soft tissue damage. Furthermore, the analysis focused on the bullet's stability during tissue penetration, its trajectory and rotation, all of which affect the accuracy and effectiveness of the ammunition.

**Results**

Recording the projectile's travel through ballistic gelatin using a high-speed camera delivered important data on terminal ballistics, which may be relevant in both military and medical contexts. Individual frames captured by the high-speed camera are shown in Table 2.

The 167 gr Scenar bullets, striking soft tissue at 836.5 m/s, begin to tilt after traveling approximately 170 mm (0.0002 s). Simultaneously, pressure acting on the hollow point initiates controlled expansion, resulting in the separation of jacket and fragmentation of the projectile. In contrast, a 185-gr bullet striking soft tissue at 766.3 m/s with an energy of 3523 J penetrates the tissue in a stable manner. Differences in bullet behaviour within

**Table 1.** Technical parameters of the projectiles used in the experiment [14, 15]

	10.85 g / 167 gr Scenar (GB422)	12.0 g / 185 gr Scenar (GB432)
Muzzle velocity	820 m/s	755 m/s
Muzzle energy	3648 J	3420 J
Mean pressure	<415 MPa	<415 MPa
Maximum one-time pressure	<477 MPa	<477 MPa

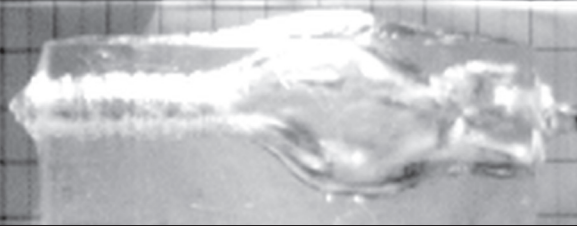

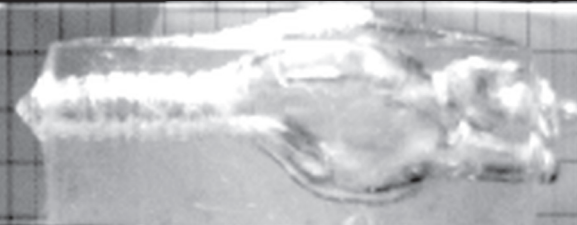

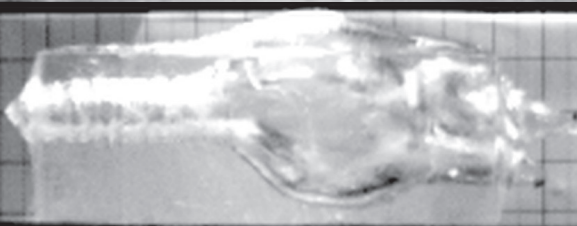
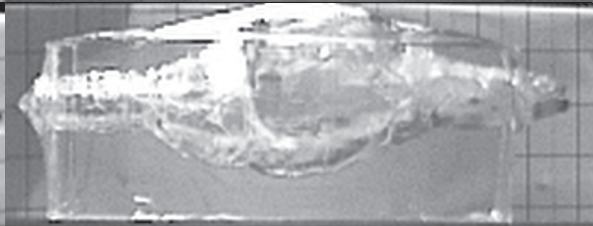


**Figure 3.** .308 Winchester OA-10 sniper rifle. Image taken by G. Motrycz

Table 2. Stages of soft tissue penetration by a Scenar projectile

Time (s)	Scenar 10.85 g /167 gr	Scenar 12.00 g /185 gr
0.0000		
0.0001		
0.0002		
0.0003		
0.0004		
0.0005		
0.0006		
0.0007		

**Table 2 (cont.).** Stages of soft tissue penetration by a Scenar projectile

Time (s)	Scenar 10.85 g /167 gr	Scenar 12.00 g /185 gr
0.0008		
0.0009		
0.0010		

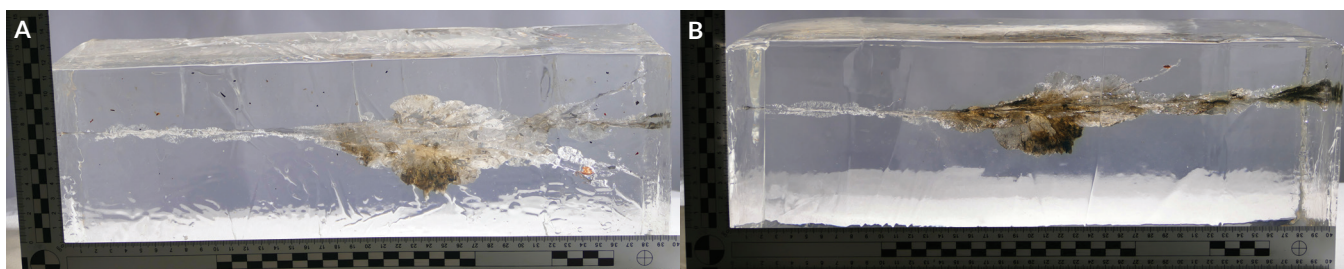
soft tissue result from the rotational motion imparted by the grooved barrel around the projectile’s longitudinal axis of symmetry, known as rotational stabilization. Proper rotational velocity is crucial: if it is too low, the bullet may tumble, whereas excessively high rotational speed causes the projectile’s longitudinal axis to maintain the same spatial orientation and undergo precession, leading to a loss of stability. The rotational stabilization of the projectile is influenced by factors such as its shape, mass distribution, and density of the penetrated medium, as well as translational and rotational velocities.

As a result of the loss of rotational stabilization of the 167-gr bullet and the initiation of the expansion process at 0.0003 seconds, a hydrodynamic wave develops, leading to fragmentation. Formation of a large temporary cavity is a secondary effect. Despite the tumbling effect, the 185-gr bullet maintains sufficient angular velocity to allow for stable exit from the ballistic gelatin block. Controlled expansion occurs only in the final phase of penetration, approximately 35 cm from the entry wound, which may result in a less severe injury.

Figure 5 shows a permanent cavity formed after Scenar projectiles pass through ballistic gelatin. Once the 167-gr Scenar projectile (Fig. 5A) impacts the gelatin, it travels steadily across approximately 170 mm, creating a narrow permanent cavity. Then the projectile starts to tumble, as a result of loss of stability, producing an approximately 90 mm-wide elliptical channel. The cavity diameter reaches its maximum value when the projectile has rotated 90°, resulting in the greatest drag force exerted by the ballistic gelatin on the projectile.

The fragmenting bullet rotates nearly 180° in the vertical plane before exiting the gelatin. At a depth of approximately 340 mm, it leaves behind pieces of jacket, with small fragments of the lead-antimony alloy core seen in this area. These fragments contaminate the wound and cause additional damage by acting as secondary projectiles.

The Scenar 185-gr projectile (Fig. 5B) strikes ballistic gelatin and travels steadily for approximately 160 mm, creating a narrow permanent cavity. Subsequent loss of



**Figure 5.** Ballistic gelatin blocks penetrated by the projectile: **A.** Scenar 10.85 g (167 gr); **B.** Scenar 12.00 g (185 gr). Image taken by G. Motrycz / K.J. Helnarska

stability causes it to tumble, producing an oval-shaped channel approximately 45 mm wide while maintaining its rotational velocity. As it tumbles, a portion of the jacket separates at a depth of approximately 300 mm. In this case, the core remains intact, indicating an absence of fragmentation.

## Conclusions

Fragmentation of the Scenar projectile and the accompanying formation of a temporary cavity is the primary mechanism leading to tissue injury. If the projectile further loses its rotational speed and begins to tumble, the extent of the injury increases. Based on the conducted experiment, it can be concluded that projectile velocity influences the shape of the temporary cavity in soft tissue. It is important, however, to consider not only the projectile's forward velocity but also its rotational speed and degree of stabilization. As the projectile penetrates soft tissue, the rotational velocity imparted by the barrel's rifling decreases, and once it falls below the threshold required for gyroscopic stability, the projectile begins to tumble. In this case, the soft tissue acting on the projectile's tip (hollow point) causes its expansion, partial jacket separation, and progressive deformation of the core, ultimately leading to fragmentation. The combined effect of these processes has a significant impact on the shape and extent of the temporary cavity.

The next research question addressed whether bullets with comparable kinetic energy can yield identical parameters and wound channel morphology within the soft tissue. The experiment used Scenar bullets of identical shape but differing mass and muzzle velocity. Although the kinetic energy differed by only approximately 7.7% (273 J), it was initially hypothesized that the bullet with higher energy (185 gr) would generate more extensive tissue damage. However, due to the loss of rotational velocity and the resulting loss of stability, the lighter 167 gr bullet, despite having lower kinetic energy, produced a larger temporary cavity, indicating potentially greater severity of tissue damage.

In contrast, the 185 gr bullet (3,523 J) penetrated the entire 40-cm gelatin block and initiated controlled expansion only at a depth of approximately 35 cm, just before exiting the block.

The results of the experiment may serve as a reference point for further optimization of ammunition and the development of new projectile designs aimed at minimizing

unnecessary tissue damage and better aligning with the requirements of international humanitarian law.

## References

1. Maiden N. Ballistics reviews: mechanisms of bullet wound trauma. *Forensic Sci Med Pathol*, 2009; 5: 204–209. doi: 10.1007/s12024-009-9096-6
2. Oura P, Niinimäki J, Brix M, et al. Observing the fragmentation of two expanding bullet types and a full metal-jacketed bullet with computed tomography – a forensic ballistics case study. *Int J Legal Med*, 2024; 138: 671–676. doi: 10.1007/s00414-023-03062-6
3. Anatoliyovych IL, Yuriyovych OU, Valentynovych OH. Surgical treatment features of liver gunshot wound with a dum dum bullet (expanding bullet). *Int J Emerg Med*, 2022; 15: 57. doi: 10.1186/s12245-022-00460-2
4. Bruns PV. Über die Wirkung der Bleispitzengeschosse (Dum-Dum-Geschosse). *Beiträge zur klinischen Chirurgie*, 1898; 21: 825–848
5. Hampson F. Study on human rights protection during situations of armed conflict, internal disturbances and tension. Submitted to the Council of Europe Steering Committee for Human Rights (CDDH), DH-DEV, 2002. 1
6. Gumeniuk K, Lurin IA, Tsema I, et al. Gunshot injury to the colon by expanding bullets in combat patients wounded in hybrid period of the Russian-Ukrainian war during 2014–2020. *BMC Surg*, 2023; 23: 23. doi: 10.1186/s12893-023-01919-6
7. Melzer N. *Targeted Killing in International Law*. Oxford: Oxford University Press, 2008
8. Hague Convention Declaration III. On the use of bullets which expand or flatten easily in the human body. 22. 1899 July 29
9. International Committee of the Red Cross. Rule 77. Expanding Bullets. <https://ihl-databases.icrc.org/en/customary-ihl/v1/rule77> (access: 16.11.2018)
10. New bullet dubbed 'last round you'll ever need' hits market, Access: August 30, 2025 <https://www.youtube.com/watch?v=-caj7il3bME>
11. Kneubuehl BP. General wound ballistics. In: Kneubuehl BP, Coupland RM, Rothschild MA, Thali MJ, eds. *Wound ballistics: basics and applications* (Translation of the revised 3<sup>rd</sup> German edition). Berlin: Springer, 2011
12. Hollerman JJ, Fackler ML, Coldwell DM, Ben-Menachem Y. Gunshot wounds: 1. Bullets, ballistics, and mechanisms of injury. *AJR Am J Roentgenol*, 1990; 155: 685–690
13. Lapua Scenar – a good hunting bullet? <https://reloaders.eu/lapua-scenar-a-good-hunting-bullet/> (access: 30.08.2025)
14. Cartridge Specification Nammo Lapua Oy TD000734 Version 8
15. Cartridge Specification Nammo Lapua Oy TD000606 Version 7



## METASTASIS OF RENAL CELL CARCINOMA TO THE CHEEK IN A 73-YEAR-OLD MAN

Przerzut raka jasnokomórkowego nerki do skóry policzka u 73-letniego mężczyzny



Krzysztof Stanisław Winiarz

Department of Oncology, Independent Public Provincial Specialist Hospital in Chełm, Poland

Krzysztof Stanisław Winiarz –  0009-0009-6588-1738

### Abstract

Renal carcinoma accounts for 2 to 3% of all adult malignancies worldwide. Five-year survival rates in Poland are approximately 58% for both sexes. More than 70% of cases are diagnosed at an early stage. However, the remaining patients develop metastases to the lungs, liver, bones, adrenal glands or the other kidney. Cutaneous location is rare. Skin metastases account for approximately 6% of cases and have a poor prognosis. Invasive cutaneous renal cell carcinoma involving the scalp, neck, trunk, limbs and genitals has been reported in the literature. This paper presents a case of a 73-year-old man with renal carcinoma invading the skin of the cheek. The post-nephrectomy follow up includes, depending on the risk group, thoracic and abdominal computed tomography, as well as abdominal ultrasound. In this case, the tumour was found to be a metastasis, among others, to the lungs, chest lymph nodes, and the other kidney. There was no regression of the cheek metastasis after one cycle of palliative immunotherapy with ipilimumab in combination with nivolumab. The patient did not survive until the next cycle due to progression of lung metastases. According to the literature and the case described above, metastases of renal carcinoma may appear both shortly after the diagnosis and at a distant time. Typically, they occur as a single, rapidly growing tumour in any cutaneous location, which, however, is accompanied by cancer spread (single or multiple) to other organs. Therefore, given the available therapeutic options, such as the use of tyrosine kinase inhibitors, regular patient monitoring is essential. This should include not only imaging and laboratory tests, but also a thorough history focused on unusual symptoms, careful skin examination, and a decisive, prompt response to any suspicious abnormalities.

### Streszczenie

Rak nerki stanowi od 2 do 3% wszystkich nowotworów złośliwych na świecie. W Polsce wskaźniki 5-letniego przeżycia wynoszą około 58% dla obu płci. Ponad 70% nowotworów nerki rozpoznaje się w stadium ograniczonym regionalnie. W pozostałych przypadkach występują przerzuty do płuc, wątroby, kości, nadnerczy lub drugiej nerki. Umiejscowienie przerzutów w skórze jest rzadkością – stanowią one około 6% przypadków i wiążą się złym rokowaniem. W literaturze opisywano przerzuty raka nerkowokomórkowego w obrębie skóry głowy, szyi, tułowia, kończyn oraz narządów płciowych. W niniejszej pracy przedstawiono przypadek 73-letniego mężczyzny z przerzutem raka nerki do skóry policzka. Guz towarzyszył chorobie rozsianej do płuc, węzłów chłonnych klatki piersiowej oraz przerzutowi do drugiej nerki. Zgodnie z aktualnymi zaleceniami pacjent po nefrektomii z powodu raka nerkowokomórkowego powinien pozostawać pod kontrolą, obejmującą – w zależności od grupy ryzyka – tomografię komputerową klatki piersiowej i jamy brzusznej oraz ultrasonografię jamy brzusznej. Jak się okazało, w opisywanym przypadku guz towarzyszył chorobie w stadium rozsiewu, m.in. do płuc. Po jednym cyklu paliatywnej immunoterapii ipilimumabem w skojarzeniu z nivolumabem nie stwierdzono regresji zmiany na policzku, a pacjent zmarł przed podaniem kolejnego cyklu z powodu progresji przerzutów do płuc. Jak wynika z piśmiennictwa oraz przedstawionego przypadku, przerzuty tego nowotworu mogą wystąpić zarówno w niedługim czasie po rozpoznaniu nowotworu, jak i wiele lat później. Zazwyczaj mają postać pojedynczego, szybko rosnącego guza w dowolnej lokalizacji skóry, który jednak towarzyszy przerzutom (pojedynczym lub mnogim) w innych narządach. Mając na uwadze dostępność terapii, jak choćby inhibitorów kinazy tyrozynowej, tak ważna jest okresowa kontrola chorego, obejmująca nie tylko badania obrazowe i laboratoryjne, ale również wywiad dotyczący nietypowych dolegliwości oraz badanie skóry, a także zdecydowane, szybkie reagowanie na wszelkie podejrzane zmiany.

**Keywords:** renal cell carcinoma; clear cell carcinoma; skin metastases; unusual sites of metastasis; cutaneous metastases of renal carcinoma

**Słowa kluczowe:** rak nerki; rak jasnokomórkowy; przerzuty do skóry; przerzut raka o nietypowym umiejscowieniu; przerzut raka nerki do skóry

DOI 10.53301/lw/203674

Received: 28.01.2025

Accepted: 03.04.2025

Published: 30.12.2025

### Corresponding author:

Krzysztof Stanisław Winiarz

Department of Oncology, Independent Public Provincial Specialist Hospital in Chełm

e-mail: lek.k.winiarz@gmail.com

## Introduction

Renal cancer accounts for approximately 2–3% of all adult malignancies worldwide. Its incidence peaks in the seventh decade of life and, similar to mortality, increases linearly with age [1, 2]. In Poland, renal cancer ranks ninth in men and tenth in women, with a slightly higher prevalence among men. The five-year survival rate is approximately 58% for both sexes [2]. Currently, the vast majority of renal cell carcinomas (over 70%) are diagnosed at a regional stage [1]. In the remaining patients, distant metastases are detected, most commonly in the lungs, liver, bones, adrenal glands, or the contralateral kidney approximately 6% of all cases and associated with a poor prognosis. Cases of renal cell carcinoma (RCC) involving the skin of the head and neck, trunk, limbs, and genitals have also been described [3].

The aim of this paper was to present a case of a man with a distant metastasis of clear cell renal carcinoma to the skin of the cheek.

## Case report

A 73-year-old man presented to the Department of Oncology for his initial visit in early 2025 due to a rapidly growing exophytic tumour on the right cheek. The lesion is shown in Figurew. 1.

According to the patient's history and medical records, he underwent left-sided nephrectomy in 2018 for a 4.5-cm tumour located in the lower part of the renal hilum, which was diagnosed as clear cell renal carcinoma (ccRCC).

During the visit, the patient reported an unintended weight loss of approximately 15 kg over the preceding six months.

He denied any prior mole or trauma in the cheek region.

The bright red exophytic, friable and easily bleeding lesion with a bluish base was located slightly posterior to the right oral commissure. Its appearance was inconsistent with that of a primary cutaneous neoplasm, typical granulation tissue, or a purulent/inflammatory lesion.



**Fig. 1.** Renal cancer metastasis to the cheek in the described patient. Image taken by K. Winiarz

The buccal mucosa was not involved, and there was normal salivary flow.

The patient exhibited no trismus, and palpation of the regional head and neck lymph nodes revealed no lymphadenopathy.

Computed tomography (CT) performed several months after nephrectomy revealed multiple small pulmonary nodules of up to 7 mm, whose appearance remained stable compared with the previous scan. Additionally, a new 4 mm nodule was identified in the left lung, along with two 3-mm and 4-mm nodules in the right lung. No lymph nodes showed features suggestive of malignant involvement.

Another CT scan, performed four years later (in June 2023), demonstrated nodular lesions within the lung parenchyma consistent with metastatic disease, including a 19-mm and a 33-mm nodule in the right and the left lung, respectively. Enlarged, suspicious lymph nodes were also identified: a 12-mm right axillary lymph node and a 19-mm mediastinal lymph node.

During the initial visit in January 2025, a biopsy of the cheek tumour was obtained, and the routinely scheduled CT of the chest, abdomen, and pelvis was expedited and performed in an urgent mode.

At the subsequent visit, the histopathological report confirmed a tumour partially composed of cells with clear cytoplasm and demonstrating the PAX8(+) and RCC(-) immunophenotype. Along with clinical findings, this supported the diagnosis of metastatic dissemination of RCC.

The subsequent contrast-enhanced CT scan (performed despite the patient having a solitary kidney, due to clinical necessity) revealed multiple nodular metastatic lesions in both lungs: a 65-mm, 53-mm, and 48-mm tumour in the middle, right lower, and left lower lobe, respectively. Multiple pathological lymph nodes were also identified in the mediastinum, including right paratracheal nodes measuring up to 29 mm, subcarinal nodes of up to 24 mm, and hilar nodes of up to 22 mm). The axillary lymph nodes were not enlarged. No pleural effusion was observed. A 20-mm hypervascular nodule was identified in the upper pole cortex of the right kidney, raising suspicion of either a primary renal cell carcinoma or a metastatic RCC. The right kidney was of normal size, with no additional suspicious foci or signs of urinary obstruction. No abnormalities were detected in the left renal bed. The liver was slightly enlarged, while the gallbladder, pancreas, and adrenal glands exhibited no focal abnormalities. Several nonspecific small hypodense lesions of up to 10 mm were found in the spleen. No abdominal lymphadenopathy was detected; however, a trace amount of fluid was present in the pelvis. No suspicious osseous lesions were identified. Urinalysis was unremarkable, and complete blood count revealed mild anaemia.

It was decided during multidisciplinary consultation that the patient be referred for palliative systemic therapy. Given its size and the overall extent of the disease, the cheek metastasis was not excised, with the expectation that systemic treatment might induce at least partial regression.

The patient received one cycle of immunotherapy with nivolumab at 3 mg/kg in combination with ipilimumab at 1 mg/kg. Unfortunately, there was marked progression of pulmonary lesions during this period, and the patient passed in early March 2025. No partial regression of the cheek metastasis was observed.

## Discussion

The aim of this study was to present a case of a man with a distant ccRCC metastasis to the cheek, a rare dissemination site for this particular malignancy. The lesion was identified in the setting of advanced systemic spread to the lungs and lymph nodes. Many literature reports describe the most common sites for RCC metastasis. Dudani et al. assessed 10,105 cases of metastatic kidney cancer. Clear cell renal cell carcinoma is most likely to give metastases to the lungs (70%), lymph nodes (45%), bones (32%), liver (18%), and adrenal glands (10%). However, the distribution of metastatic sites differed among histologic subtypes. Pulmonary, adrenal, cerebral, and pancreatic involvement was more common in ccRCC than in other subtypes, whereas nodal involvement was more common in papillary RCC (pRCC). Liver metastases were more likely to occur in the chromophobe subtype (chrRCC) [5].

Hamid et al. described a case of a 54-year-old man who developed an early subcutaneous RCC metastasis, identified three months after the initial diagnosis. The lesion progressed without pain or skin discolouration. Excisional biopsy confirmed metastatic disease, and the patient was put on pazopanib (tyrosine kinase inhibitor). After one month of therapy, ulceration developed at the tumour site, which subsequently healed. Treatment with tyrosine kinase inhibitor resulted in a partial, durable response in this case, despite the absence of continuous therapy [6].

Anzalone et al. assessed Mohs micrographic surgery (offering precise microscopic control of the entire tumour margin) as an excision technique for cutaneous metastases arising from various malignancies. The authors concluded that this rarely used approach proved effective in their patient presenting with a solitary cutaneous RCC metastasis involving the occipital region. There was no recurrence of the lesion during the two-year follow-up period; however, the patient ultimately passed as a result of progressive systemic disease. The authors proposed that, in carefully selected cases, surgical excision of isolated cutaneous metastases could be considered as an additional indication for Mohs surgery [4].

Kassam et al. reported a case of a 68-year-old woman with a pulsatile, centrally elevated, hard reddish-purple lesion approximately 4 cm in diameter, located on the skin of the left parietal region. The lesion was enlarging but otherwise asymptomatic. The patient had a prior diagnosis of RCC. The differential diagnosis included haemangioma, basal cell carcinoma, and a cutaneous horn. Head CT showed no bone involvement, while laboratory tests showed hypercalcaemia (2.95 mmol/L) and anaemia (7.2 g/dL).

These findings strongly suggested that the scalp lesion represented a distant RCC metastasis. The tumour was surgically excised, with histopathology confirming metastatic RCC [3].

In their recommendations on post-treatment surveillance for solid malignancies, Jassem et al. note that there is no evidence that any follow-up strategy improves outcomes in RCC patients who have undergone radical surgery. Post-radical treatment surveillance should be tailored to the patient's risk of recurrence, as determined by validated nomograms incorporating the TNM staging system, symptoms at diagnosis, and tumour advancement. It should also be emphasized that the lungs are the most common site of RCC metastasis; therefore, chest imaging should be performed alongside abdominal assessment [7].

## Conclusions

The aim of this study was to describe a case of a 73-year-old man with a distant RCC metastasis to the cheek. Cutaneous RCC metastases are rare (approximately 6% of cases) and are associated with a poor prognosis [3, 4]. As demonstrated by both literature data and the present case, such metastases may develop shortly after diagnosis or many years later. These lesions typically present as solitary, rapidly growing tumours at any cutaneous site and are often accompanied by single or multiple metastases to other organs. Given the available therapeutic options, such as tyrosine kinase inhibitors, regular patient follow-up is essential. Surveillance should include not only imaging and laboratory work-up, but also careful evaluation of any new or unusual symptoms and thorough skin examination, with prompt and decisive action in response to any suspicious abnormalities.

## References

1. Krzakowski M, Warzocha K, Potemski P, Wysocki P. *Onkologia kliniczna*. Tom 2. Gdańsk: Via Medica, 2023
2. Jezierski A, Rutkowski P, Wysocki W. *Chirurgia onkologiczna*. Tom 1. Warszawa: Wydawnictwo Lekarskie PZWL, 2018
3. Kassam K, Tiong E, Nigar E, Kumar M. Exophytic parietal skin metastases of renal cell carcinoma. *Case Rep Dermatol Med*, 2013; 2013: 196016. doi: 10.1155/2013/196016
4. Anzalone CL, Cohen PR, Migden MR, Tannir NM. Mohs surgery in metastatic cancer: renal cell carcinoma solitary cutaneous metastasis and visceral tumor metastases to skin treated with microscopically controlled surgical excision. *Int J Dermatol*, 2013; 52: 856–861. doi: 10.1111/ijd.12021
5. Dudani S, de Velasco G, Wells JC, et al. Evaluation of clear cell, papillary, and chromophobe renal cell carcinoma metastasis sites and association with survival. *JAMA Netw Open*, 2021; 4: e2021869. doi: 10.1001/jamanetworkopen.2020.21869
6. Hamid ARAH, Rustandi R, Matondang S, et al. Renal cell carcinoma with early skin metastasis and partial response on tyrosine kinase inhibitor: A case report. *Int J Surg Case Rep*, 2022; 94: 107020. doi: 10.1016/j.ijscr.2022.107020
7. Jassem J, Kowalczyk A, Biesiada A, et al. Post-treatment follow-up in common solid malignancies: expert panel recommendations. *Nowotwory J Oncol* 2022; 72: 384–407. doi: 10.5603/NJO.a2022.0058



## PERSONALIZED TEMPOROMANDIBULAR JOINT ENDOPROSTHESES – OWN EXPERIENCE

Spersonalizowane endoprotezy stawu skroniowo-  
-żuchwowego – własne doświadczenia



Iwona Niedzielska<sup>1</sup>, Julia Maślanka<sup>2</sup>, Jakub Fiegler-Rudol<sup>2</sup>, Daria Wziątek-Kuczmik<sup>1</sup>

1. Department and Clinic of Cranio-Maxillofacial Surgery, Medical University of Silesia in Katowice, Poland
2. Student Scientific Club at the Department and Clinic of Cranio-Maxillofacial Surgery, Medical University of Silesia in Katowice, Poland

Iwona Niedzielska –  0000-0003-1256-9408

Julia Maślanka –  0009-0009-8049-0831

Jakub Fiegler-Rudol –  0009-0009-3173-9389

Daria Wziątek-Kuczmik –  0000-0002-5720-6419

### Abstract

**Background:** Temporomandibular joint disorders can severely impair mandibular function, aesthetics, and quality of life. When conservative management fails, temporomandibular joint replacement with patient-specific, custom-made prostheses provides a reliable surgical solution. However, the success of such interventions depends not only on surgical precision but also on comprehensive prehabilitation and rehabilitation. **Objective:** This study presents a case series highlighting the critical role of individualized rehabilitation in optimizing outcomes after temporomandibular joint replacement. **Materials and methods:** Three patients with advanced temporomandibular joint pathology, a comminuted condylar fracture, bilateral temporomandibular joint ankylosis, and mandibular ameloblastoma, underwent reconstruction with custom implants. Each patient participated in a structured prehabilitation program, including physiotherapy, laser therapy, and myofascial release, followed by an individualized postoperative rehabilitation protocol. **Results:** All patients achieved significant functional recovery, including improved mandibular mobility, mastication, swallowing, and speech, as well as complete pain resolution and restoration of facial symmetry. The multidisciplinary rehabilitation approach was instrumental in accelerating recovery and enhancing quality of life. **Conclusion:** Temporomandibular joint replacement with custom-made prostheses, combined with a protocol-driven prehabilitation and rehabilitation program, ensures optimal functional and aesthetic outcomes. This case series emphasizes that rehabilitation is not an adjunct but an essential, integral component of successful temporomandibular joint reconstruction.

### Streszczenie

**Wprowadzenie:** Zaburzenia stawu skroniowo-żuchwowego mogą poważnie upośledzać funkcję żuchwy, estetykę oraz jakość życia. W przypadkach, gdy leczenie zachowawcze nie przynosi efektów, wymiana stawu na spersonalizowaną, indywidualnie wykonaną endoprotezę stanowi wiarygodne rozwiązanie chirurgiczne. Skuteczność takich interwencji zależy jednak nie tylko od precyzji operacyjnej, lecz także od kompleksowej strategii prehabilitacji i rehabilitacji. **Cel:** Celem pracy jest przedstawienie serii przypadków, które podkreślają kluczową rolę indywidualnej rehabilitacji w optymalizacji wyników leczenia po wymianie stawu skroniowo-żuchwowego. **Materiał i metody:** Trzech pacjentów z zaawansowaną patologią stawu skroniowo-żuchwowego, roztrzaskanym złamaniem wyrostka kłykciowego, obustronną ankylozą stawu oraz ameloblastomą żuchwy, poddano rekonstrukcji stawu przy użyciu indywidualnie zaprojektowanych implantów. Każdy z pacjentów uczestniczył w ustrukturyzowanym programie prehabilitacji, obejmującym fizjoterapię, laseroterapię oraz uwalnianie mięśniowo-powięziowe, a następnie realizował spersonalizowany protokół rehabilitacji pooperacyjnej. **Wyniki:** U wszystkich pacjentów odnotowano istotną poprawę funkcjonalną, w tym zwiększenie ruchomości żuchwy, poprawę żucia, połykania i mowy, całkowite ustąpienie bólu oraz przywrócenie symetrii twarzy. Wielospecjalistyczne podejście rehabilitacyjne odegrało kluczową rolę w przyspieszeniu procesu powrotu do zdrowia i poprawie jakości życia. **Wniosek:** Wymiana stawu skroniowo-żuchwowego przy użyciu indywidualnych endoprotez, połączona z protokolowym programem prehabilitacji i rehabilitacji, zapewnia optymalne efekty funkcjonalne i estetyczne. Przedstawione przypadki podkreślają, że rehabilitacja nie jest dodatkiem, lecz nieodzownym i integralnym elementem skutecznej rekonstrukcji stawu skroniowo-żuchwowego.

**Keywords:** prehabilitation; physiotherapy; postoperative rehabilitation; temporomandibular joint disorders

**Słowa kluczowe:** prehabilitacja; fizjoterapia; rehabilitacja pooperacyjna; zaburzenia stawu skroniowo-żuchwowego

DOI 10.53301/lw/209432

Received: 28.07.2025

Accepted: 12.08.2025

Published: 30.12.2025

## Introduction

Temporomandibular joint (TMJ) disorders include a broad spectrum of conditions affecting the jaw joint and surrounding muscles, frequently resulting in notable disruption of both function and facial harmony [1–3]. These conditions may lead to persistent discomfort, restricted jaw mobility, and difficulties with basic actions such as chewing, speaking, or swallowing, all of which can significantly degrade a patient's overall well-being [4]. In many cases, the chronic nature of these symptoms contributes to anxiety, sleep disturbances, and reduced productivity, amplifying their social and economic impact. Beyond the physical manifestations, the psychological burden, driven by facial imbalance, ongoing pain, and reduced social confidence, can be equally profound [5]. TMJ dysfunction arises from multiple causes such as physical injury, developmental anomalies, autoimmune or infectious diseases, systemic conditions such as rheumatoid arthritis, or age-related degeneration [6]. Emerging research also suggests a possible link between TMJ disorders and neurogenic inflammation, pointing to novel pathways for future therapeutic intervention. In advanced or treatment-resistant cases, where noninvasive therapies fail, surgical reconstruction becomes a necessary path forward [6]. A cutting-edge solution involves total joint replacement using custom-engineered, patient-specific implants [7]. These precision-designed prostheses closely replicate the anatomical structure and biomechanical behavior of the natural joint, offering enhanced outcomes in terms of joint stability, mobility, and aesthetic restoration [8]. Recent advances in computer-aided design (CAD) and 3D printing have revolutionized the production of these implants, allowing for greater customization and faster surgical planning. Nevertheless, surgical replacement represents only one component of comprehensive care. Long-term success depends on a robust rehabilitation strategy that begins preoperatively (prehabilitation) and extends well beyond surgery [9]. This integrative approach is vital for enhancing procedural outcomes, reducing postoperative complications, and facilitating complete functional recovery [10]. Additionally, incorporating tele-rehabilitation and digital monitoring tools has shown promise in improving patient adherence and allowing real-time feedback during recovery. At the Department of Craniofacial and Maxillofacial Surgery in Katowice, TMJ disorders are managed through a patient-centered, holistic care model. A dedicated rehabilitation team collaborates closely with surgeons, physiotherapists, and specialists to support the patient throughout all stages of recovery. From accurate diagnosis to full reintegration into daily life, this coordinated approach helps patients not only regain physical functionality but also rebuild confidence and psychosocial well-being. The integration of mental health support and patient education further empowers individuals to actively partici-

## Corresponding author:

Jakub Fiegler-Rudol  
Student Scientific Club at the Department  
and Clinic of Cranio-Maxillofacial Surgery,  
Medical University of Silesia in Katowice, Poland  
e-mail: jakub.fieglerrudol@gmail.com

pate in their recovery journey, making the process more sustainable and effective. The aim of this case series is to showcase an integrative pathway to TMJ replacement, emphasizing the transformative impact of personalized rehabilitation. By presenting detailed clinical cases, we highlight the depth of multidisciplinary coordination necessary for successful outcomes in TMJ reconstruction. Each case underscores the importance of tailoring rehabilitation not only to anatomical needs but also to the patient's lifestyle, goals, and psychological resilience. This report adheres to the recommendations outlined in "Guidelines To Writing A Clinical Case Report" published in *Heart Views: The Official Journal of the Gulf Heart Association* [10], which stress the importance of structured narrative, rich clinical detail, and analytical commentary to maximize educational and clinical value. This article introduces an innovative, patient-centered framework for TMJ replacement that integrates customized 3D-printed implants, prehabilitation, and digital rehabilitation tools, highlighting the transformative impact of multidisciplinary care on both functional recovery and psychosocial outcomes.

## Materials and methods

This case series, conducted at the Department of Craniofacial and Maxillofacial Surgery, Medical University of Silesia in Katowice, Poland, included three patients with advanced mandibular pathology requiring reconstruction using custom-made endoprostheses. All patients underwent comprehensive diagnostics, including CT and panoramic radiographs, to assess joint damage and guide implant design. Inclusion criteria encompassed TMJ pathologies unsuitable for standard surgery, such as multifragmentary condylar fractures, bilateral ankylosis, or extensive neoplastic lesions requiring joint replacement. Before surgery, patients completed a structured prehabilitation program, which included physiotherapy, myofascial release, stretching, education, and low-level laser therapy. Surgical planning was performed using digital modeling in collaboration with engineers, followed by surgery under general anesthesia. Each patient followed an individualized postoperative rehabilitation protocol with Bioptron and laser therapy, TheraBite®-assisted mobilization, electrostimulation, and kinesiotaping. Outcomes were assessed based on improvements in mobility, pain, symmetry, and overall function, demonstrating the effectiveness of this multimodal approach to TMJ replacement.

## Cases

### Case 1. Multifragmentary fracture of the condylar process of the mandible on the left side

A 32-year-old woman presented to our unit with a multifragmentary fracture of the left condylar process of the

mandible following facial trauma sustained during an assault under unknown circumstances. Initially managed conservatively at another facility, she continued to experience severe pain, significant restriction of mandibular movement, malocclusion, and visible facial asymmetry. Clinical examination revealed tenderness and swelling over the left TMJ with markedly limited mouth opening. CT imaging confirmed a comminuted fracture of the left condylar head with displacement and shortening.

Due to the extent of fragmentation and prior unsatisfactory outcomes with conservative treatment, surgical fixation was not feasible. In 2018, she underwent condylectomy of the left mandibular condylar process with stable osteosynthesis of the mandibular ramus fragments. Postoperatively, she was followed at our outpatient clinic, where persistent issues were noted, including significantly restricted mouth opening and an anterior open bite. Intensive rehabilitation led to partial improvement in occlusion and mandibular abduction; however, the patient continued to report chronic pain localized to the left TMJ area, radiating across the cheek, and aggravated by mastication of hard foods. Given the functional impairment and ongoing symptoms, the decision was made to proceed with delayed TMJ reconstruction using a custom-made endoprosthesis. After necessary preoperative preparations, in 2023, the patient underwent endoprosthetic replacement of the left TMJ under general anesthesia via combined Al-Kayat–Bramley and submandibular approaches. A custom-designed ChM implant was used, achieving the planned mandibular position and a postoperative mouth opening of 32 mm. The perioperative and postoperative courses were uneventful, and the patient was discharged home with appropriate postoperative care instructions. Following surgery and structured rehabilitation, she experienced significant functional improvement, pain relief, and restoration of facial symmetry.

Figure 1 shows the preoperative documentation and planning for TMJ reconstruction. The figure illustrates

the diagnostic and planning stages for temporomandibular joint (TMJ) replacement in a patient with advanced mandibular pathology. The left column (Patient) shows clinical photographs of the patient's profile and restricted mouth opening, indicative of impaired TMJ function. The middle column (CT) presents a coronal CT slice and a 3D CT reconstruction, revealing bilateral condylar damage and anatomical distortion. The right column (Treatment plan) shows digital planning models for the design of patient-specific, custom-made alloplastic TMJ prostheses. The virtual reconstruction includes fixation plates and prosthetic components tailored to the patient's unique anatomy (Fig. 1).

## Case 2. Bilateral ankylosis of the temporomandibular joints

A 45-year-old woman presented with a complex, long-standing clinical history beginning in 1989, when she developed mandibular osteitis secondary to a gangrenous deciduous tooth. Initial management included systemic antibiotic therapy and multiple surgical debridement sessions aimed at controlling the infection and preserving mandibular structure. Despite these interventions, the patient experienced ongoing complications, leading to progressive mandibular dysfunction over the years.

In 2006, due to persistent chronic inflammation and bone sclerosis, she underwent surgical decortication of the right mandibular angle. However, disease progression continued, culminating in the development of bilateral TMJ ankylosis. In 2011, a major surgical procedure was performed to release the ankylosis, involving bilateral excision of ankylosed bone blocks affecting both the mandibular condyles and the adjacent temporal bones. At the time of referral, physical examination demonstrated severely restricted maximal incisal opening (approximately 5–10 mm), significant facial asymmetry, and extensive post-surgical scarring along the lower face. Palpation revealed rigid, immobile TMJs, with substan-

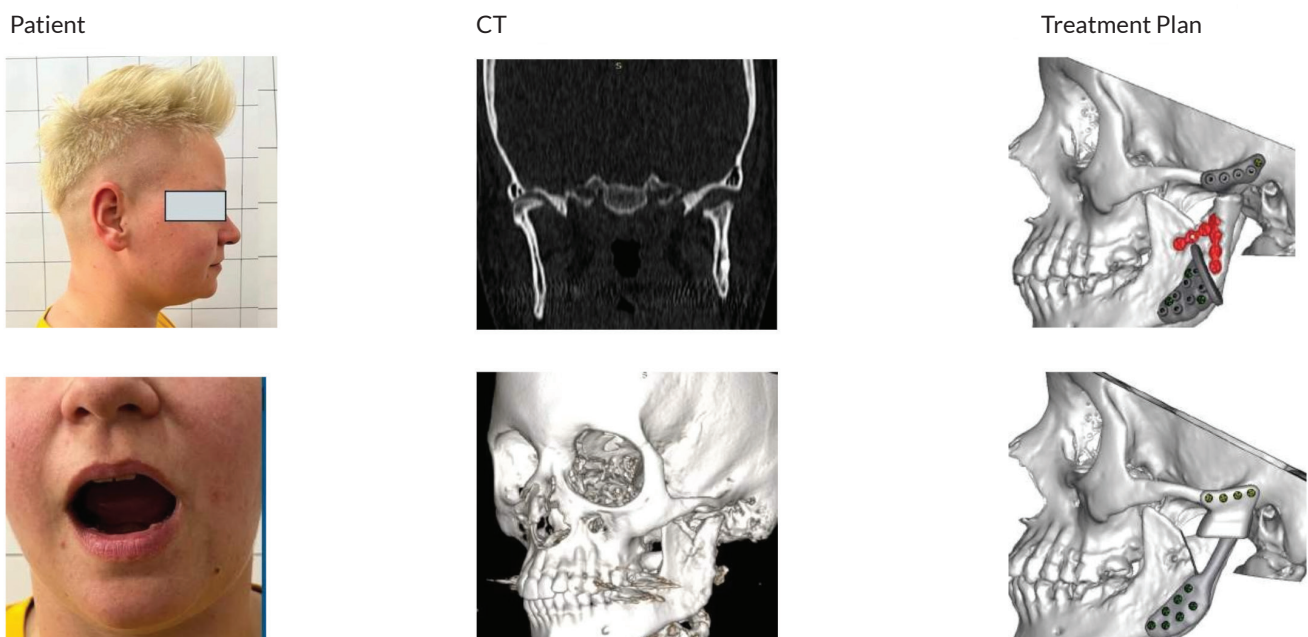


Figure 1. Case 1. Fracture of the condylar process of the mandible

tial compromise of masticatory function. Radiographic and cross-sectional imaging, including panoramic radiographs and CT scans, confirmed bilateral TMJ ankylosis with extensive joint surface destruction and remodeling. Given the severity of joint damage and the patient's functional impairment, a decision was made to proceed with bilateral TMJ replacement using custom-designed, patient-specific endoprostheses. The surgical plan was supported by a structured, multidisciplinary rehabilitation program focusing on postoperative physiotherapy, range-of-motion exercises, and long-term monitoring to prevent recurrence of ankylosis. The anticipated outcomes of the intervention included restoration of functional jaw movement, improved mastication and speech, partial correction of facial asymmetry, and enhancement of overall quality of life. Postoperatively, the patient exhibited substantial improvement: she achieved a maximal incisal opening of 30 mm, experienced marked reduction in pain, and reported significant gains in daily activities and psychosocial well-being, supported by an effective and sustained rehabilitation program.

Figure 2 shows the preoperative assessment and virtual surgical planning for TMJ prosthetic reconstruction. This figure presents the clinical, radiological, and digital planning workflow for TMJ replacement. In the left column (Patient), frontal and intraoral photographs show facial asymmetry and significant mandibular deviation with restricted opening, reflecting severe joint dysfunction. The middle column (CT) presents coronal CT and 3D volume renderings, which reveal extensive bony destruction and asymmetry of the mandibular condyles, confirming the need for joint replacement. The right column (Treatment plan) shows computer-assisted surgical planning, illustrating the design of a patient-specific TMJ prosthesis. The red-highlighted component marks the resected joint area, while the surrounding structures show custom fixation hardware tailored for anatomical precision and biomechanical stability (Fig. 2).

**Case 3. Ameloblastoma of the mandibular body**

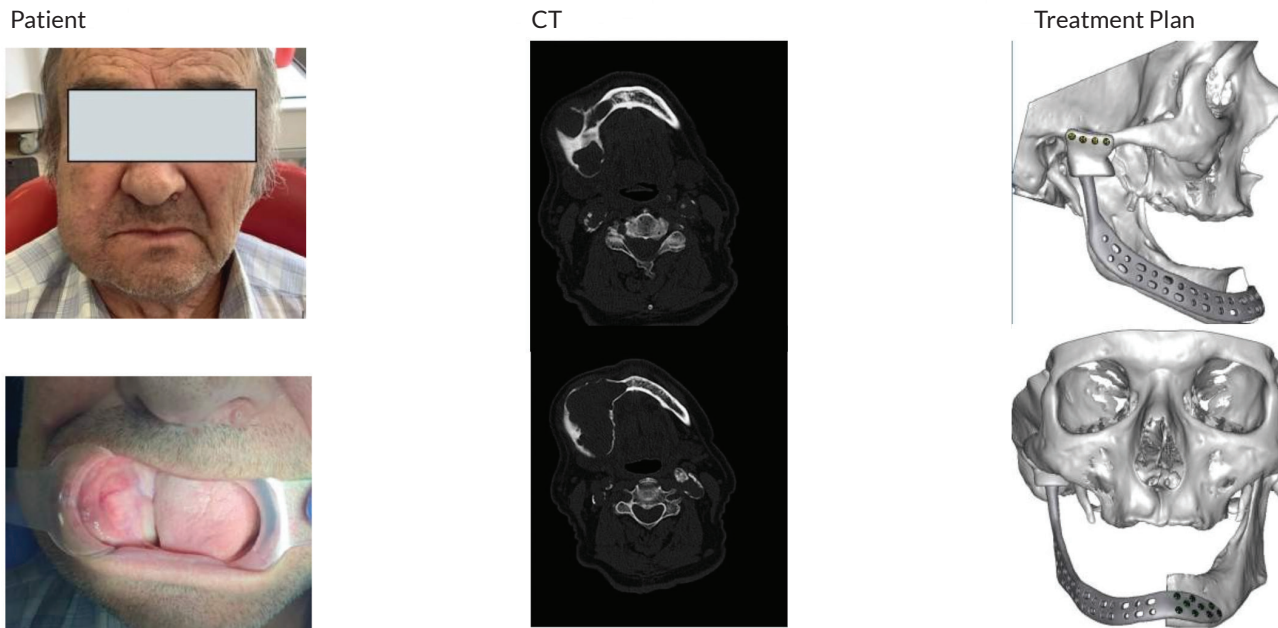
A 67-year-old male presented with a long-standing history of progressive mandibular swelling, marked facial asymmetry, and intermittent purulent discharge from the oral cavity persisting for over a year. The patient reported pain, difficulty in mastication, and reduced oral intake. Physical examination revealed gross lower jaw deformity with notable displacement of the chin and malocclusion, as well as restricted mandibular movements, and intraoral fistulae with chronic mucosal infection. Contrast-enhanced CT imaging demonstrated an extensive, multilocular radiolucent lesion involving the mandibular body and bilateral rami, with significant cortical bone destruction and soft tissue extension. Histopathological analysis of the biopsy confirmed a solid/multicystic ameloblastoma, a benign but locally aggressive odontogenic tumor.

The management plan included wide surgical resection of the affected mandibular segments with tumor-free margins, followed by immediate reconstruction using a patient-specific TMJ endoprosthesis designed to restore mandibular contour and joint function. Postoperatively, the patient underwent a structured rehabilitation program encompassing physiotherapy for jaw mobilization, nutritional support, and regular clinical monitoring. The treatment goals were complete tumor eradication, restoration of mandibular continuity and function, and improvement of facial aesthetics. The outcome was highly favorable: the infection fully resolved, jaw opening and masticatory function improved substantially, and facial symmetry was effectively restored. These results were achieved through meticulous surgical technique and coordinated multidisciplinary rehabilitation.

Figure 3 shows the clinical presentation, imaging, and surgical planning for extensive mandibular reconstruction with TMJ prosthesis. This figure documents the case



**Figure 2.** Case 2. Bilateral ankylosis of the temporomandibular joints



**Figure 3.** Case 3. Ameloblastoma of the mandibular body and rami, presenting with facial asymmetry and persistent intraoral purulent discharge for over one year

of a patient with severe mandibular pathology requiring full joint and mandibular body reconstruction using a custom alloplastic prosthesis. The left column (Patient) shows clinical images with facial asymmetry and intraoral evidence of significant mandibular loss, likely due to tumor resection or trauma, resulting in compromised occlusion and oral function. The middle column (CT) presents axial CT slices demonstrating extensive bony defects involving the mandibular ramus and body, highlighting the need for a large-scale reconstructive approach. The right column (Treatment plan) shows virtual surgical planning of a custom-designed mandibular prosthesis spanning from the TMJ region to the contralateral body, secured with fixation plates. The design accommodates complex anatomical deficits and aims to restore mandibular continuity, articulation, and symmetry.

### Prehabilitation, surgical planning, and rehabilitation

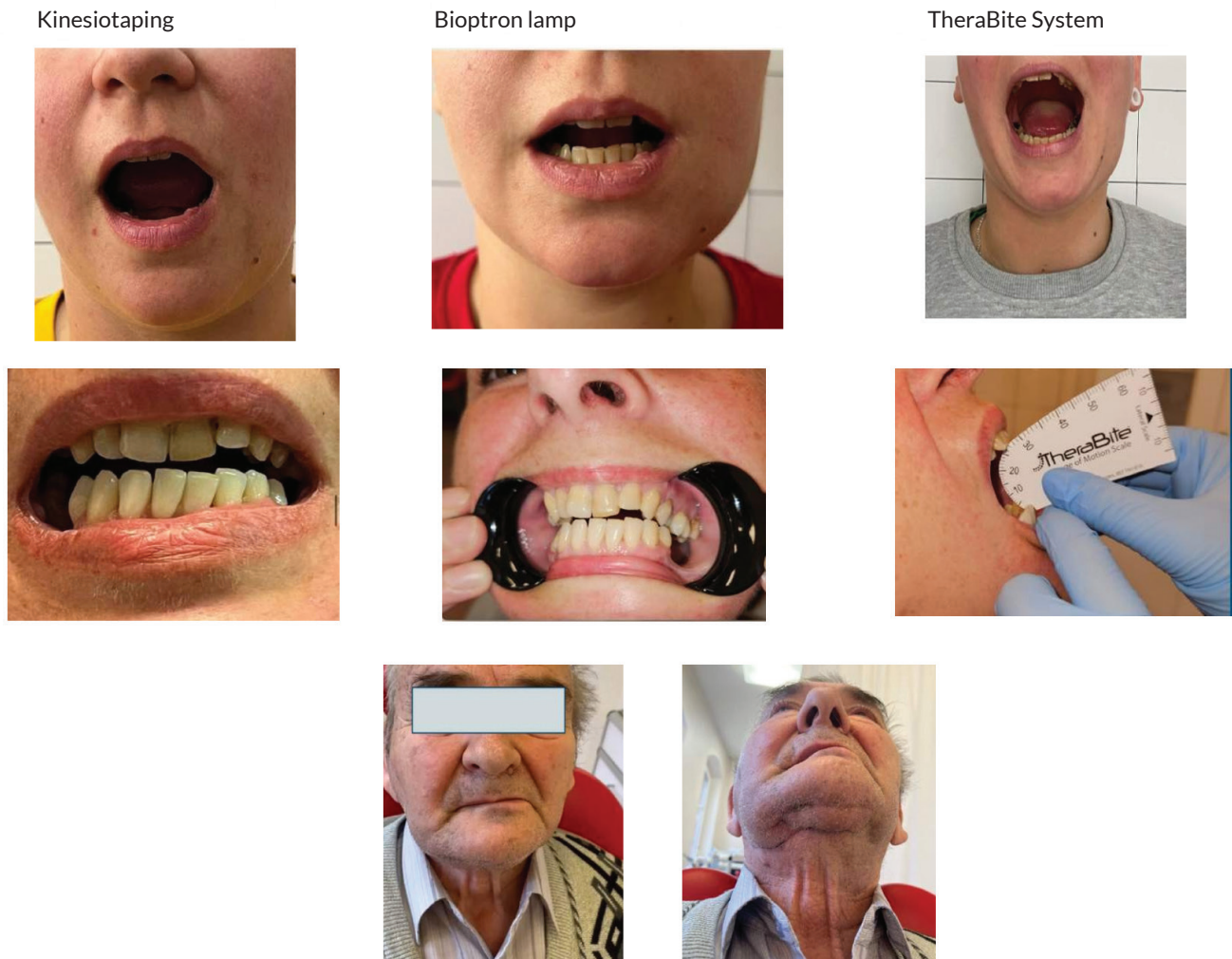
Each patient undergoing temporomandibular joint (TMJ) replacement at the Department of Craniofacial and Maxillofacial Surgery in Katowice follows a comprehensive treatment pathway that includes detailed diagnostic imaging, individualized surgical planning, operative intervention, and both pre- and post-operative rehabilitation. Prior to surgery, thorough clinical and radiological evaluations, including CT scans, are performed to assist in designing custom-made TMJ endoprostheses tailored to patients' anatomical needs. This preparatory phase ensures a precise surgical approach and contributes to optimal outcomes.

Prehabilitation, the rehabilitation process initiated before surgery, is a critical component of care. It focuses on improving muscle function, educating the patient, and preparing soft tissues for the procedure. Following surgery, rehabilitation becomes central to restoring jaw mobility, speech, and facial symmetry. Postoperative therapy includes techniques aimed at reestablishing normal

sensory perception in the facial region and stimulating lymphatic drainage to minimize swelling and inflammation. At our department in Katowice, the rehabilitation program employs a range of modern physiotherapeutic modalities. These include Biopteron lamp therapy, which uses polarized light to stimulate healing; laser therapy, for its anti-inflammatory and regenerative effects; and the TheraBite® system, a jaw motion rehabilitation modality that assists in improving mandibular range of motion. Electrostimulation is used to activate and strengthen masticatory muscles, while kinesiotaping (used in step 02 of therapy) supports soft tissues and aids lymphatic drainage. This multimodal approach ensures holistic recovery, maximizing functional restoration and patient comfort.

Figure 4 shows the postoperative rehabilitation modalities following TMJ replacement surgery. This figure showcases three key components of the individualized rehabilitation protocols used to optimize recovery after TMJ replacement. In the top row (1), the left panel (Kinesiotaping) shows the application of kinesiotape to the lower face to support lymphatic drainage, reduce swelling, and aid in soft tissue healing. The center panel (Biopteron lamp) illustrates the use of Biopteron light therapy to promote cellular regeneration, reduce inflammation, and accelerate tissue repair. The right panel (TheraBite System) shows the use of the TheraBite device to increase mandibular range of motion through passive stretching. The middle row (2) includes close-up views of dental alignment and occlusion during functional recovery, assisted mouth opening, and jaw mobility measurements using the TheraBite scale. The bottom row (3) shows frontal and submental views of an elderly patient post-rehabilitation, demonstrating restored symmetry, improved range of motion, and enhanced mandibular contour.

The results of therapy following reconstruction surgery using diagnostic templates and previously excised



**Figure 4.** Postoperative outcomes following rehabilitative therapy

bone blocks were highly favorable. Patients experienced a marked return of normal stomatognathic system functions, including improved mandibular movement, clearer articulation, effective chewing, proper swallowing, and unimpeded respiration. In addition to restoring these vital functions, the rehabilitation process significantly enhanced overall comfort and quality of life. Pain was effectively abolished, postoperative swelling was eliminated, and patients reported a noticeable improvement in their general well-being.

### Discussion

Temporomandibular joint (TMJ) disorders pose a unique challenge in maxillofacial surgery due to their multifactorial etiology, functional importance, and impact on a patients' quality of life [11, 12]. This case report highlights the critical role of not only surgical intervention but also extensive rehabilitation in restoring complete stomatognathic function and improving overall well-being. While TMJ replacement using custom-made endoprostheses is a highly advanced surgical option, it is the integration of individualized physiotherapy and prehabilitation that ultimately determines the long-term success of these procedures [13]. In this context, prehabilitation, comprising targeted physiotherapy, myofascial release, stretching exercises, neuromuscular coordination training, patient

education, and low-level laser therapy, played a pivotal role in optimizing muscular tone, improving joint mobility, reducing inflammation, and enhancing soft tissue resilience. By conditioning the stomatognathic system prior to surgery, this multimodal approach helped minimize perioperative complications, facilitated smoother surgical access, and laid the groundwork for more effective postoperative recovery [14, 15]. Structured application of these therapies, initiated weeks before surgery and tailored to each patient's specific limitations, allowed clinicians to establish baseline function and monitor improvements over time.

The three presented cases, ranging from trauma-induced fractures to extensive neoplasms and long-standing ankylosis, demonstrate the breadth of clinical scenarios in which TMJ reconstruction is indicated. Each case illustrates the importance of coordinated multidisciplinary care in overcoming severe anatomical and functional impairments. A review of current literature underscores the growing use of custom alloplastic TMJ replacements in patients with complex joint pathologies [16–20].

Yadav et al. reported that alloplastic total TMJ replacement is now considered a standard of care for adult patients with end-stage TMJ disease. They highlighted that advances in implant design, materials, and surgical tech-

niques have led to improved outcomes, including restoration of function and form, pain reduction, enhanced quality of life, and maintenance of ramal height. In cases of TMJ ankylosis, the procedure also decreases the risk of re-ankylosis and enables correction of facial asymmetry. However, the authors noted that current evidence is insufficient to support the use of this approach in skeletally immature patients [21].

Furthermore, research emphasizes the importance of functional rehabilitation in achieving maximum post-surgical benefit. Techniques such as laser therapy, electrostimulation, and mechanical jaw movement aids (e.g., the TheraBite system) have been validated in various clinical studies for their role in reducing inflammation, improving muscle tone, and expediting the return of normal mandibular function [22–25]. Despite these advances, gaps remain in the standardization of rehabilitation protocols, particularly in integrating modalities such as Biopton light therapy and kinesiotaping into post-TMJ replacement care [26]. This case series contributes to filling that gap by offering practical insight into how such techniques can be applied in routine clinical practice.

The presented cases align with the literature in supporting the view that rehabilitation is not merely a supportive add-on but rather an essential component of TMJ reconstruction [4]. In all three patients, outcomes such as restoration of articulation, mastication, swallowing, and respiration, as well as complete resolution of pain and swelling, were directly correlated with the intensity and duration of the rehabilitation process. Importantly, this report highlights the value of prehabilitation, a relatively underreported strategy that prepares soft tissues and neuromuscular pathways for surgical trauma, potentially reducing complications and accelerating recovery.

By outlining these comprehensive care pathways, this report not only reinforces current understanding but also expands best practices, advocating for the integration of individualized, multimodal rehabilitation as a clinical standard in TMJ joint replacement surgery.

In conclusion, this case report supports the growing consensus that successful outcomes in TMJ replacement depend as much on high-quality rehabilitation as on surgical precision. The evidence presented here both corroborates and extends existing knowledge regarding post-reconstructive care. It further emphasizes the need for interdisciplinary collaboration and protocol-driven rehabilitation strategies to optimize patient outcomes and redefine standards in oral and maxillofacial surgery.

## Conclusion

Temporomandibular joint replacement is an effective surgical intervention for severe joint conditions, but its success depends equally on personalized, multimodal rehabilitation. This report highlights three cases in which custom-made endoprostheses, combined with therapies such as laser treatment, electrostimulation, and kinesiotaping, led to faster recovery and improved outcomes. These cases underscore the importance of interdisciplin-

ary care and structured rehabilitation as essential components of successful TMJ surgery.

## Acknowledgements

The authors would like to thank Professor Iwona Niedzielska for providing the conceptual framework and sharing essential research material, and Doctor Daria Wziątek-Kuczmik for her assistance in manuscript preparation and approval of the final version.

## References

1. Maini K, Dua A. Temporomandibular Syndrome. [Updated 2023 Jan 30]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK551612/>
2. Kapos FP, Exposto FG, Oyarzo JF, Durham J. Temporomandibular disorders: a review of current concepts in aetiology, diagnosis and management. *Oral Surg*, 2020; 13: 321–334. doi: 10.1111/ors.12473
3. Hoffmann RG, Kotchen JM, Kotchen TA, et al. Temporomandibular disorders and associated clinical comorbidities. *Clin J Pain*, 2011; 27: 268–274. doi: 10.1097/AJP.0b013e31820215f5
4. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Board on Health Care Services; Board on Health Sciences Policy; Committee on Temporomandibular Disorders (TMDs): From Research Discoveries to Clinical Treatment; Temporomandibular Disorders: Priorities for Research and Care. Yost O, Liverman CT, English R, Mackey S, Bond EC, editors. Washington (DC): National Academies Press (US); 2020 Mar 12. PMID: 32200600. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK557986/>
5. Shackelford TK, Larsen RJ. Facial asymmetry as an indicator of psychological, emotional, and physiological distress. *J Pers Soc Psychol*, 1997; 72: 456–466
6. Vishwakarma A, Sharpe P, Shi S, Ramalingam M, eds. Stem cell biology and tissue engineering in dental sciences. 1st ed. Boston: Elsevier; 2014
7. Pruszyńska P, Kozakiewicz M, Szymor P, Wach T. Personalized temporomandibular joint total alloplastic replacement as a solution to help patients with non-osteosynthesizable comminuted mandibular head fractures. *J Clin Med*, 2024; 13: 5257. doi: 10.3390/jcm13175257
8. Wu Y, Liu J, Kang L, et al. An overview of 3D printed metal implants in orthopedic applications: Present and future perspectives. *Heliyon*, 2023; 9: e17718. doi: 10.1016/j.heliyon.2023.e17718
9. Guarda-Nardini L, Manfredini D, Berrone S, Ferronato G. Total temporomandibular joint prosthesis as a surgical option for severe mouth opening restriction. A case report of a bilateral intervention. *Reumatismo*, 2007; 59: 322–327. doi: 10.4081/reumatismo.2007.322
10. Lifková M, Czako L, Hirjak D, et al. Optimizing dental implant survival in microvascular jaw reconstruction: a comprehensive review of risk factors, clinical outcomes, and future directions. *Bratisl Med J*, 2025; 126: 600–608. doi: 10.1007/s44411-025-00076-x
11. Guidelines to writing a clinical case report. *Heart Views*, 2017; 18: 104–105. doi: 10.4103/1995-705X.217857

12. Warzocha J, Gadomska-Krasny J, Mrowiec J. Etiologic Factors of Temporomandibular Disorders: A Systematic Review of Literature Containing Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) and Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) from 2018 to 2022. *Healthcare*, 2024; 12: 575. doi: 10.3390/healthcare12050575
13. Mani B, Balasubramaniam S, Balasubramanian S, et al. Role of custom-made prosthesis for temporomandibular joint replacement in unilateral ankylosis – an evaluative study. *Ann Maxillofac Surg* 2020; 10: 344–352. doi: 10.4103/ams.ams\_132\_20
14. Jeske P, Wojtera B, Banasiewicz T: Prehabilitation – current role in surgery. *Pol Przegl Chir*, 2022; 94: 64–72. doi: 10.5604/01.3001.0015.7340
15. Wilson CM, Ronan SL. Rehabilitation postfacial reanimation surgery after removal of acoustic neuroma: a case study. *J Neurol Phys Ther*, 2010; 34: 41–9. doi: 10.1097/NPT.0b013e3181cfc324
16. Liu H, Huang L, Liu S, et al. Evolution of temporomandibular joint reconstruction: from autologous tissue transplantation to alloplastic joint replacement. *Int J Oral Sci* 2025; 17: 17. <https://doi.org/10.1038/s41368-024-00339-3>
17. Mercuri LG. Alloplastic temporomandibular joint replacement: rationale for the use of custom devices. *Int J Oral Maxillofac Surg* 2012; 41: 1033–1040. doi: 10.1016/j.ijom.2012.05.032
18. Alali YS, Al Habeeb K, Al Malhook K, et al. Utilization of alloplastic prostheses in the extended reconstruction of the temporomandibular joint: a review of the literature. *J Clin Med*, 2024; 13: 6748. doi: 10.3390/jcm13226748
19. Khattak YR, Ghaffar N, Gulzar MA, et al. Can growing patients with end-stage TMJ pathology be successfully treated with alloplastic temporomandibular joint reconstruction? – A systematic review. *Oral Maxillofac Surg*, 2024; 28: 529–537. doi: 10.1007/s10006-023-01180-4
20. Correia Lima B, Grillo R, Alvarez Quinta Reis B, et al. Use of alloplastic total joint replacement of the temporomandibular joint of growing patients: a scoping review. *Eur J Ther*, 2024; 30: 531–536. doi: 10.58600/eurjther2152
21. Yadav P, Roychoudhury A, Kumar RD, et al. Total alloplastic temporomandibular joint replacement. *J Maxillofac Oral Surg*, 2021; 20: 515–526. doi: 10.1007/s12663-021-01628-8
22. Pinto-Borges H, Carvalho O, Henriques B, et al. A preliminary analysis of the wear pathways of sliding contacts on temporomandibular joint total joint replacement prostheses. *Metals*, 2021; 11: 685. doi: 10.3390/met11050685
23. Steen JP, Jaiswal KS, Kumbhare D. Myofascial pain syndrome: an update on clinical characteristics, etiopathogenesis, diagnosis, and treatment. *Muscle Nerve*, 2025; 71: 889–910. doi: 10.1002/mus.28377
24. Hamid S, Hayek R. Role of electrical stimulation for rehabilitation and regeneration after spinal cord injury: an overview. *Eur Spine J*, 2008; 17: 1256–1269. doi: 10.1007/s00586-008-0729-3
25. Rashiq S, Galer BS. Proximal myofascial dysfunction in complex regional pain syndrome: a retrospective prevalence study. *Clin J Pain*, 1999; 15: 151–153. doi: 10.1097/00002508-199906000-00013
26. Alowaimer HA, Al Shutwi SS, Alsaegh MK, et al. Comparative efficacy of non-invasive therapies in temporomandibular joint dysfunction: a systematic review. *Cureus*, 2024; 16: e56713. doi: 10.7759/cureus.56713



## REPORT FROM THE 4TH SCIENTIFIC AND TRAINING CONFERENCE “TRAVEL MEDICINE IN MEDICAL PRACTICE”

Sprawozdanie z IV Konferencji Naukowo-Szkoleniowej  
„Medycyna podróży w praktyce lekarskiej”



Krzysztof Korzeniewski

Military Institute of Medicine – National Research Institute, Department of Epidemiology and Tropical Medicine, Poland

Krzysztof Korzeniewski –  0000-0002-0505-6279

### Abstract

Report from the 4th Scientific and Training Conference “Travel Medicine in Medical Practice” in Gdynia, 25–27<sup>th</sup> April, 2025.

### Streszczenie

Sprawozdanie z IV Konferencji Naukowo-Szkoleniowej „Medycyna podróży w praktyce lekarskiej”, która odbyła się w Gdyni w dniach 25–27 kwietnia 2025 roku.

**Keywords:** scientific and training conference

**Słowa kluczowe:** konferencja naukowo-szkoleniowa

DOI 10.53301/lw/207215

Received: 06.06.2025

Accepted: 16.06.2025

Published: 30.12.2025

### Corresponding author:

Krzysztof Korzeniewski  
Military Institute of Medicine – National Research  
Institute, Department of Epidemiology  
and Tropical Medicine  
128 Szaserów, 04-141 Warsaw  
e-mail: kkorzeniewski@wim.mil.pl

On April 25–27, 2025, the 4th Interdisciplinary Scientific and Training Conference *Travel Medicine in Medical Practice* was held in Gdynia, bringing together nearly 400 participants, including more than 20 renowned lecturers from across Poland, as well as distinguished guests such as the Chief Sanitary Inspector Paweł Grzesiowski, MD, and the President of the National Chamber of Laboratory Diagnosticians Monika Pintał-Ślimak, MD. The event, organized by the Polish Society of Maritime, Tropical and Travel Medicine (PTMMTiP), whose president since 2019 has been the head of the Department of Epidemiology and Tropical Medicine at the Military Institute of Medicine–National Research Institute, Prof. Krzysztof Korzeniewski, PhD, DSc, MD, was highly successful and generated considerable interest within the medical community.

The conference was held under the patronage of the Military Institute of Medicine – National Research Institute, the Medical University of Gdańsk, the Chief Sanitary Inspectorate, the National Chamber of Laboratory Diagnosticians, the Polish Society of Vaccinology, the Polish Society of Family Medicine, the Institute of Maritime and Tropical Medicine, and the University Centre of Maritime and Tropical Medicine.

The Polish Society of Maritime, Tropical and Travel Medicine was the first medical society in Poland to be entered into the register of scientific societies and state research institutes authorized to certify the professional skills of physicians and dentists. It was also the first in the country to conduct two editions of the certification examination in 2024–2025, awarding, based on specific requirements and successful examination results, Professional Development Certificates in Travel Medicine to 119 physicians representing 14 regional medical chambers. Certification examinations are held annually prior to the Travel Medicine Conference in Gdynia. The next edition is scheduled for April 24, 2026, preceding the 5th Interdisciplinary Scientific and Training Conference *Travel Medicine in Medical Practice*. Detailed information regarding certification and examination is available on the Society’s website ([www.ptmmtp.pl](http://www.ptmmtp.pl)). The regulations for organizing and conducting certification in professional development specify in detail the knowledge required for the examination, consistent with the standards of the International Society of Travel Medicine examination leading to the Certificate in Travel Health. Examination questions are prepared based on publications recommended by PTMMTiP (<https://ptmmtp.pl/rekomendacje>), in particular the



Figure 1. Speech by the Chief Sanitary Inspector, Dr. Paweł Grzesiowski

CDC Yellow Book 2026: Health Information for International Travel (Oxford University Press, 2025) and Travel Medicine (2025 edition, Gdynia 2025). Regardless of the professional development certification in travel medicine, PTMMTiP continues the initiative of the National Network of Travel Medicine Centers (KSOMP) (<https://ptmmtpl.pl/krajowa-siec-certyfikowanych-osrodkow-medycyny-podrozy-morskiej-i-tropikalnej>) and awards

certificates to Certified Centers for Travel Medicine after the fulfillment of specific requirements. These include medical reporting, submitting annual activity reports (<https://ptmmtpl.pl/assets/pdf/za%C5%82acznik-nr-2-sprawozdanie-roczny-COMP.pdf>), and passing a knowledge test by applicants or KSOMP members during the April conferences held in Gdynia).



Figure 2. Conference room



## REPORT FROM THE 15TH CONGRESS OF THE POLISH SOCIETY OF NEPHROLOGY

Sprawozdanie z XV Zjazdu Polskiego Towarzystwa  
Nefrologicznego



Katarzyna Romejko, Elżbieta Głuch, Anna Grzywacz, Magdalena Markowska, Mateusz Nowak,  
Dorota Górńska-Michałek, Magdalena Wiśniewska

*Military Institute of Medicine - National Research Institute, Department of Internal Medicine, Nephrology and Dialysis, Poland*

Katarzyna Romejko - ID 0000-0003-1447-2917  
 Elżbieta Głuch - ID 0009-0003-5229-256X  
 Anna Grzywacz - ID 0000-0001-6348-4215  
 Magdalena Markowska - ID 0009-0007-8015-872X  
 Mateusz Nowak - ID 0009-0003-4190-7928  
 Dorota Górńska-Michałek - ID 0009-0001-5647-3937  
 Magdalena Wiśniewska - ID 0000-0002-1686-1142

### Abstract

This year's Congress of the Polish Society of Nephrology was held in Katowice on June 12–14. During the Congress, the current recommendations of the Polish Society of Nephrology on modern diagnostic and therapeutic modalities for kidney diseases were presented. New possibilities of pharmacological nephroprotection in chronic kidney disease were discussed. Several lectures focused on the innovative treatment of hyperkalaemia. Also, the guidelines on the use of intravenous contrast agents and therapeutic strategies for reducing cardiovascular risk in patients with chronic kidney disease were presented. An important part of the Congress consisted of lectures on hereditary kidney diseases and modern treatment approaches in IgA nephropathy. Finally, the organized workshops provided an opportunity to review interesting clinical cases and update knowledge on the benefits of a low-protein diet in patients with chronic kidney disease.

### Streszczenie

Tegoroczny Zjazd Polskiego Towarzystwa Nefrologicznego odbył się w Katowicach w dniach 12–14 czerwca. Podczas wydarzenia przedstawiono aktualne stanowisko Towarzystwa dotyczące diagnostyki oraz nowoczesnego leczenia chorób nerek. Omówiono możliwości farmakologicznej nefroprotekcji w przewlekłej chorobie nerek. Kilka wykładów poświęcono nowoczesnym metodom leczenia hiperkaliemii. Zaprezentowano także zalecenia dotyczące stosowania dożylnych środków kontrastowych w grupie pacjentów z upośledzoną funkcją nerek. Ponadto omówiono możliwości terapeutyczne pozwalające zmniejszyć ryzyko chorób układu sercowo-naczyniowego w przewlekłej chorobie nerek. Istotną część Zjazdu stanowiły wykłady dotyczące chorób nerek uwarunkowanych genetycznie oraz nowoczesnych metod leczenia nefropatii IgA. Warsztaty umożliwiły zapoznanie się z ciekawymi przypadkami klinicznymi oraz zaktualizowanie wiedzy na temat korzyści płynących ze stosowania diety ubogobiałkowej u pacjentów z przewlekłą chorobą nerek.

**Keywords:** chronic kidney disease; Congress of the Polish Society of Nephrology

**Słowa kluczowe:** przewlekła choroba nerek; Zjazd Polskiego Towarzystwa Nefrologicznego

DOI 10.53301/lw/210418

Received: 24.08.2025

Accepted: 08.09.2025

Published: 30.12.2025

### Corresponding author:

Katarzyna Romejko  
 Military Institute of Medicine - National Research  
 Institute, Department of Internal Medicine,  
 Nephrology and Dialysis  
 128 Szaserów, 04-141 Warsaw, Poland  
 e-mail: kromejko@wim.mil.pl

The 15th Congress of the Polish Society of Nephrology was held at the International Congress Center in Katowice in June 12–14, 2025. Honorary patronage was provided by His Magnificence, the Rector of the Medical University of Silesia. During the Congress, the current position of the Polish Society of Nephrology on the diagnosis and modern therapeutic modalities for patients with kidney disease was presented. Therapeutic options for managing complications of chronic kidney disease (CKD), including electrolyte and acid–base disturbances, as well as cardiovascular (CV) complications, which represent the leading cause of mortality in this patient population, were discussed. Methods for preventing cardiovascular disease (CVD) in CKD and the potential for pharmacological nephroprotection were presented. The safety of intravenous contrast agents in patients with impaired renal function was also addressed. The challenges associated with renal replacement therapy and the difficulties encountered in outpatient care for kidney transplant recipients were discussed. A session devoted to hereditary kidney diseases, as well as a session addressing the diagnosis and current treatment guidelines for atypical haemolytic uremic syndrome (aHUS) was an important part of the lectures. Another important part of the Congress were workshops during which noteworthy cases of patients with kidney diseases were presented, peritoneal dialysis (PD) was discussed, and dietary recommendations in CKD were outlined, which are currently regarded as an essential component of nephroprotection.

During the Congress, participants had also the opportunity to take part in the 2.5 km or 5 km DAVITA RUN, as well as in a dinner get-together. These events allowed for exchanging experiences and observations and fostered the development of new friendships among nephrology enthusiasts.

This Report presents the key issues addressed during the Congress.

### Workshops

The 15th Congress of the Polish Society of Nephrology began with workshops that enabled active participant engagement. The workshop entitled “*Nephrological Declinations: How to Unravel Complex Cases in a Simple Way in the Department of Nephrology*” addressed seemingly well-known and commonly encountered clinical entities, which may nevertheless raise questions regarding appropriate treatment.

Professor Tomasz Hryszko, MD, PhD (Second Department of Nephrology, Hypertension, and Internal Medicine with Dialysis Unit, Medical University of Białystok) presented the topic of fluid therapy and diuretic treatment in specific clinical scenarios. In cases of hypernatraemia of unclear aetiology, defined as sodium levels  $> 145$  mmol/L, urine osmolality  $\leq 600$  mOsm/kg  $H_2O$  indicates renal water loss, that is, a deficiency of or resistance to antidiuretic hormone (ADH). In cases of a high urine osmolality, defined as  $> 1000$  mOsm/24 hrs, hypernatraemia results from osmotic diuresis. When urine osmolality is  $> 600$  mOsm/kg

$H_2O$ , volaemic status should be assessed. Hypovolemia may result from gastrointestinal (e.g., diarrhoea) or cutaneous (increased sweating) fluid loss, whereas hypervolemia may be associated with excessive salt intake, including iatrogenic sodium load arising from intravenous hypertonic saline administration. It should be remembered that 5% glucose is used for rehydration in hypernatraemic patients. If hyponatraemia is suspected, defined as a serum sodium  $< 135$  mmol/L, serum osmolality should be evaluated, with values below 275 mOsm/kg  $H_2O$  indicating hypotonic hyponatraemia. Such disorders are often triggered by exacerbation of heart failure (HF), the treatment of which requires the use of diuretics that increase water excretion, which may in turn cause a drop in serum sodium. Renal failure with decreased urine output is another condition that can cause hypotonic hyponatraemia. Urine osmolality should also be assessed. For values below 100 mOsm/kg  $H_2O$ , the drop in serum sodium may be due to polydipsia, whereas osmolality  $> 100$  mOsm/kg  $H_2O$  indicates that hyponatraemia is associated with inappropriate antidiuretic hormone secretion, for example in hypothyroidism, adrenal insufficiency, or the syndrome of inappropriate antidiuretic hormone secretion (SIADH). It may also develop as a consequence of liver cirrhosis or nephrotic syndrome. The dose of diuretics should be adjusted based on urinary sodium and urine output. Urine sodium of 70 mmol/L and urine output of 100 mL/h within 2 hours after therapy onset indicate effective diuretic response. Otherwise, the diuretic dose should be doubled. When switching from intravenous to oral diuretics, it should be remembered that the oral furosemide dose should be twice the intravenous (IV) dose (e.g., 20 mg of IV furosemide corresponds to 40 mg oral dose), whereas torasemide maintains a 1:1 ratio (10 mg IV dose corresponds to 10 mg oral dose). Isotonic or hypertonic hyponatraemia is most commonly caused by severe hyperglycaemia. Pseudohyponatraemia is also clinically important, as it arises from markedly elevated lipid levels, leading to falsely low serum sodium despite normal plasma osmolality.

Alicja Rydzewska-Rosołowska, MD, PhD (Second Department of Nephrology, Hypertension, and Internal Medicine with Dialysis Unit, Medical University of Białystok) presented guidelines for the treatment of urinary tract infections (UTIs) during the workshop, taking into account the associated diagnostic challenges. According to the latest recommendations, first-line antibiotic therapy for UTIs should consist of a single oral dose of fosfomicin, a five-day course of Furazidin, or a three-day course of pivmecillinam or trimethoprim/sulfamethoxazole. It is important to note that longer-duration antimicrobial treatment does not improve therapeutic efficacy. Recurrent UTI is diagnosed when symptoms reappear within two weeks. However, if symptoms occur later, with a negative urine culture obtained between the two episodes, or if the infection is caused by a different pathogen, a reinfection is diagnosed. There are no clear recommendations for the prevention of recurrent UTIs. Pharmacotherapy may be considered (although it is not strictly recommended) in women with recurrent

infections. In such cases, continuous trimethoprim-sulfamethoxazole prophylaxis may be used at a dose of 40 mg/200 mg once daily or three times weekly, or furazidin at 50 mg or 100 mg daily. Postcoital pharmacotherapy is also used to prevent recurrent UTIs in women and may include trimethoprim/sulfamethoxazole at 40 mg/200 mg or 80 mg/400 mg, or furazidin 50 mg or 100 mg administered once after intercourse. In addition to pharmacological prophylaxis, increased water intake, methenamine, cranberry products containing proanthocyanidins, and vaginal oestrogens in postmenopausal women have demonstrated beneficial effects. The diagnosis of UTI itself is often uncertain. Current guidelines emphasize that diagnosis should be based on clinical symptoms rather than solely on laboratory findings or urinalysis. One of the studies discussed demonstrated that unpleasant urine odour does not always correlate with an ongoing infection. Urine colour and clarity may be influenced by multiple factors, including medications (e.g., green urine after the use of propofol or orange urine following the administration of rifampicin); therefore, these characteristics should not be interpreted as definitive indicators of UTIs.

A session entitled “Nephroprotection and Diet – From Guidelines to Practice” was a particularly valuable part of the workshop. In addition to weight loss, increased physical activity, smoking cessation, and reduced sodium intake, restricting dietary protein intake is one of the non-pharmacological methods of nephroprotection. During the lecture, Professor Michał Nowicki, MD, PhD (Department of Nephrology, Hypertension, Transplantation, and Internal Medicine, Medical University of Łódź) discussed the important role of protein restriction in nephroprotection. The kidneys are involved in the catabolism and excretion of protein metabolites. A high-protein diet leads to the accumulation of toxic protein metabolites, thereby promoting kidney damage. The average protein requirement for an adult is 0.66 g/kg of body weight per day, while the safe intake is considered at 0.83 g/kg/day, according to the dietary recommendations of most nutritional associations. Unfortunately, the current average protein intake in developed countries reaches 1.35 g/kg/day, which significantly exceeds the recommended values. The 2024 KDIGO dietary guidelines for non-dialysis patients with stage G3–G5 CKD suggest a protein intake of 0.8 g/kg/day. A very low-protein diet (0.3–0.4 g/kg/day) may be considered in patients at risk of end-stage renal disease; this should be supplemented with amino acids or amino acid ketoanalogues, which are nitrogen-free amino acid precursors that are converted into amino acids in the body, thereby preventing essential amino acid deficiency. This approach allows protein requirements to be met at a level of 0.55–0.6 g/kg/day. A low-protein diet has been shown to exert multiple beneficial effects: it slows the decline in estimated glomerular filtration rate (eGFR) and reduces nephron overload, improves insulin resistance, lowers oxidative stress, corrects metabolic acidosis, decreases the production of uremic toxins, reduces proteinuria, limits the severity of secondary hyperparathyroidism, improves the lipid profile, enhances the nephroprotective effects of the

renin–angiotensin–aldosterone system (RAAS), and delays dialysis therapy. Reducing protein intake also leads to improved digestion, decreased postprandial discomfort, and reduced constipation. A low-protein diet additionally results in lower salt consumption, which in turn contributes to improved blood pressure control. Reduced serum phosphorus levels associated with a low-protein diet allow for a decrease in the use of GI phosphate-binding agents and, in the case of supplementation with keto-analogue amino acids, reduced dosage of calcium-containing medications. These benefits of a low-protein diet contribute to an improved quality of life in CKD patients. Delaying the initiation of dialysis therapy provides time for the formation and full maturation of an arteriovenous fistula, as well as for preparation for kidney transplantation or preemptive transplantation. To enable patients to initiate and adhere to a low-protein diet, it is essential to educate them about the benefits of dietary modification and to provide ongoing dietary education and monitoring, which often require consultation with and supervision by a dietitian experienced in the management of patients with kidney disease.

#### **Diagnostic imaging with intravenous contrast agents in CKD patients. Position statement of the Polish Society of Nephrology and the Polish Society of Radiology**

The first session, featuring lectures by Prof. Zbigniew Serafin, MD, PhD (Department of Radiology and Diagnostic Imaging, Faculty of Medicine, Collegium Medicum of Nicolaus Copernicus University in Toruń), Prof. Przemysław Rutkowski, MD, PhD (Medical University of Gdańsk), Prof. Dorota Kamińska, MD, PhD, and Prof. Magdalena Krajewska, MD, PhD (4th Military Clinical Hospital with Polyclinic SPZOZ in Wrocław, Faculty of Medicine, Wrocław University of Science and Technology), focused on the safety of IV contrast agents in patients with CKD. This is a crucial issue, as patients with kidney disease often experience difficulties related to contrast-enhanced imaging due to elevated renal parameters. During the session, new guidelines for the use of IV contrast media, developed in collaboration with the Polish Society of Radiology, were presented. Both scientific societies recommend assessing renal function using the CKD-EPI formula prior to the administration of iodinated contrast media (ICM). If this formula cannot be used, the MDRD equation should be used instead. The timeframe for assessing renal function is 3 months in patients without a history of CKD or with stable CKD, and 7 days prior to ICM in patients with rapidly declining renal function. Patients at risk of acute kidney injury following ICM administration were defined as those with creatinine levels >1.5 mg/dL and/or eGFR <30 mL/min/1.73 m<sup>2</sup>, with this risk considered to be low. The decision to administer hydration prior to ICM should be made on an individual basis following a thorough assessment of the patient’s hydration status. Furthermore, routine pharmacological prophylaxis before ICM administration is not recommended. There is no need to discontinue RAASis, nonsteroidal anti-inflammatory drugs (NSAIDs), diuretics, or sodium–glucose cotransporter-2 inhibitors (SGLT2i) prior to contrast adminis-

tration. Metformin should be discontinued only in patients with eGFR  $<30$  mL/min/1.73 m<sup>2</sup>, in accordance with the summary of product characteristics. Monitoring of renal function 48–72 hrs after ICM administration is recommended in all hospitalized patients with eGFR  $\leq 30$  mL/min/1.73 m<sup>2</sup>. Outpatients should have their eGFR monitored if their clinical condition deteriorates.

The approach of determining the time interval between successive ICM doses has also changed. A 48-hour interval between administrations should be maintained in patients with eGFR  $<30$  mL/min/1.73 m<sup>2</sup>, whereas individuals with normal renal function and patients with eGFR  $>30$  mL/min/1.73 m<sup>2</sup> may receive ICMs at 4-hour intervals. It is important to note that gadolinium-based contrast agents (GBCAs) used in magnetic resonance imaging (MRI) attenuate X-ray radiation after excretion into the urinary tract and may lead to interpretative errors in computed tomography (CT) of the urinary tract. Therefore, CT should precede MRI for abdominal examinations. For thoracic and CNS scans, the CT/MRI sequence is not critical. Concerns were raised in the past regarding the use of GBCAs in MRI due to an increased risk of nephrogenic systemic fibrosis (NSF) reported following their administration. In terms of the risk of NSF, GBCAs are classified as high-risk (gadodiamide, gadopentetate, gadoversetamide), intermediate-risk (gadobenate dimeglumine, gadoxetate disodium), and low-risk agents (gadobutrol, gadoterate meglumine, gadoteridol). For low-risk agents, the risk of NSF is estimated to be  $<0.07\%$ . High-risk GBCAs have now been withdrawn in Europe. Consequently, routine assessment of renal function is not recommended prior to the administration of low-risk gadolinium agents, also in individuals with renal impairment. Renal function should be assessed when intermediate-risk agents are planned, which are approved only for biliary and liver imaging in individuals with renal impairment. Intra-arterial administration of ICMs (e.g., during coronary angiography, intravascular procedures involving the abdominal aorta, or interventional radiology) differs from intravenous administration in that it requires greater contrast agent volumes due to repeated injections during the procedure, and ICMs reach the renal arteries at higher concentrations. Consequently, the risk of acute kidney injury in these patients is higher than that associated with intravenous administration. It is recommended to consider intravenous hydration, temporarily discontinue metformin, and monitor renal function for 48–72 hrs after contrast exposure in patients with eGFR  $<45$  mL/min/1.73 m<sup>2</sup> undergoing coronary angiography or intravascular abdominal aortic surgery. Similar precautions are recommended for patients with eGFR  $<30$  mL/min/1.73 m<sup>2</sup> undergoing interventional radiology procedures.

Individuals with a solitary kidney have their eGFR assessed in the same manner as the general population, and subsequent management depends on the eGFR value and the type of planned procedure, as outlined above. ICMs may be administered to patients undergoing peritoneal dialysis or haemodialysis regardless of residual urine output, and additional haemodialysis is not required unless the patient develops overhydration.

The current guidelines facilitate diagnostic and therapeutic procedures for all patients, particularly those with renal impairment. However, their practical implementation requires formal modifications to National Health Fund (NFZ) regulations, especially with regard to the financing of contrast-enhanced imaging, as previously the reporting of plasma creatinine levels and eGFR values to the NFZ was a prerequisite for reimbursement.

### Therapeutic approach to aHUS depending on the clinical profile and TMA trigger

Professor Katarzyna Krzanowska, MD, PhD (Department of Nephrology, Dialysis, Transplantation, and Internal Medicine, University Hospital in Krakow) discussed the diagnostic and therapeutic management of atypical haemolytic uremic syndrome (aHUS). This rare condition should be suspected in the presence of haemolysis, thrombocytopenia, and acute kidney injury. Dysregulation of the alternative complement pathway, triggered by environmental stimuli in genetically predisposed individuals, leads to endothelial and platelet activation, ultimately resulting in thrombotic microangiopathy. Several regulatory proteins, including factor H, membrane cofactor protein (MCP), and factor I, play a crucial role in the dissociation of the alternative pathway C3 convertase and the proteolytic degradation of C3b. Mutations in the genes encoding these proteins, which are identified in patients with aHUS, lead to uncontrolled complement activation. A comprehensive differential diagnosis is essential, as the diagnosis of aHUS is established after excluding other causes. The stages of the differential diagnostic process and the disease entities associated with the clinical presentation of aHUS are shown in Figure 1.

Laboratory and genetic workup may be supplemented with kidney biopsy, although this is not strictly required. Treatment should be initiated as early as possible, as delayed therapy is a poor prognostic factor for the recovery of renal function. In Poland, targeted therapy is available through the B.95 drug programme and incorporates eculizumab or ravulizumab. Additionally, plasmapheresis and procedures required for symptomatic management should be performed, such as blood transfusion for severe anaemia or haemodialysis in cases of severe renal failure.

### Treatment of hyperkalaemia

During the Congress, considerable attention was devoted to the management of hyperkalaemia in CKD patients. On the first day, Prof. Marcin Adamczak, MD, PhD (Silesian Medical University in Katowice), delivered a lecture entitled “*Current treatment of hyperkalaemia, including the use of calcium patiromer*”. On the second day, the entire session was dedicated to this topic and was entitled “*A new therapeutic approach to hyperkalaemia—from pathophysiology to personalized therapy*”. The session consisted of four lectures delivered by Prof. Tomasz Stompór, MD, PhD (Department of Nephrology, Hypertension and Internal Medicine, University of Warmia and Mazury in Olsztyn), Prof. Ilona Kurnatowska, MD, PhD (Clinical Department

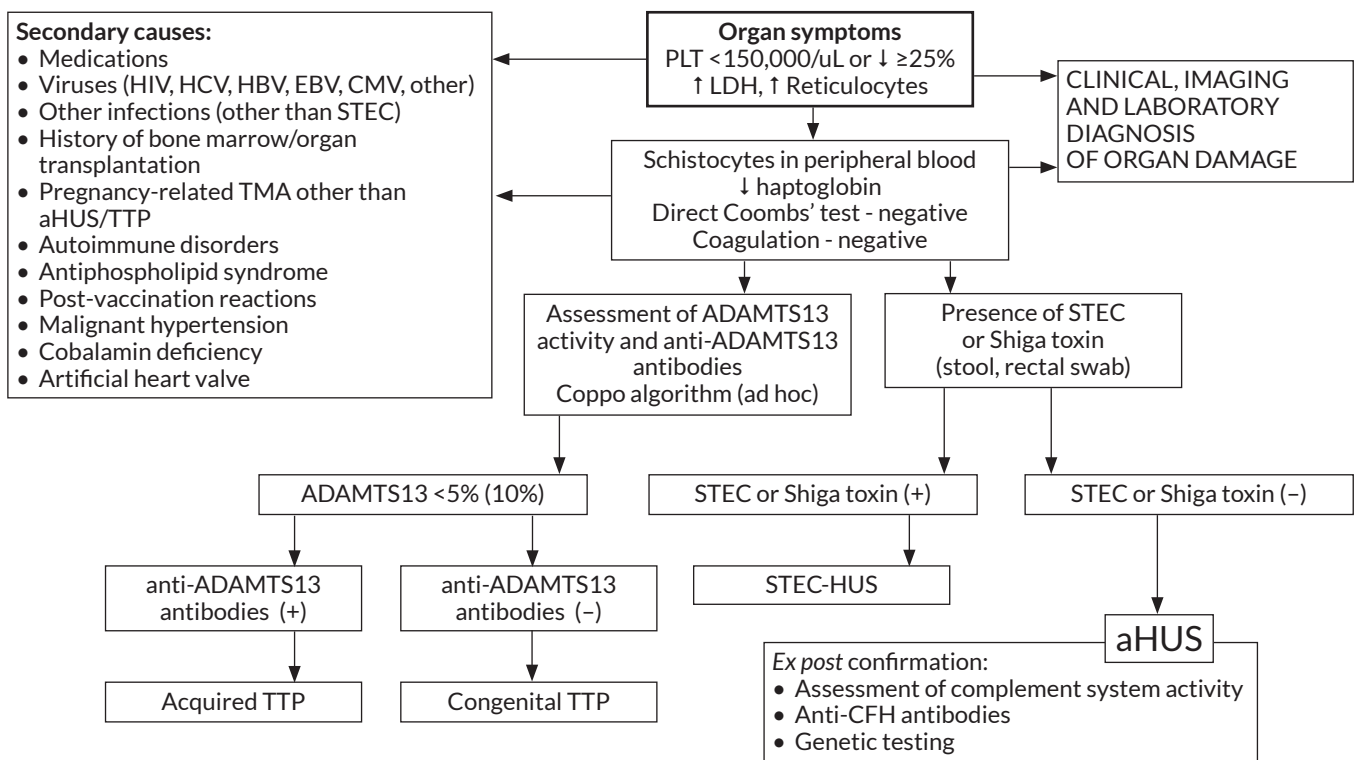


Figure 1. Suggested algorithm of TMA diagnosis

of Nephrology and Internal Medicine), N. Barlicki University Clinical Hospital in Łódź), Prof. Marcin Adamczak, MD, PhD (Medical University of Silesia in Katowice), and Prof. Beata Naumnik, MD, PhD (First Department of Nephrology, Transplantation and Internal Medicine with Dialysis Unit, Medical University of Białystok). On the final day of the Congress, Prof. Kazimierz Ciechanowski, MD, PhD (Department of Nephrology, Transplantation and Internal Medicine, Pomeranian Medical University), delivered a lecture entitled "Hyperkalaemia in kidney diseases—*aetiology, preventive methods, and current treatment options.*" The therapeutic recommendations for hyperkalaemia discussed during the Congress are presented below.

Hyperkalaemia is defined as serum ionized potassium  $>5.0$  mmol/L; however, in clinical practice, reference ranges recommended by individual laboratories should be considered. Hyperkalaemia is classified as mild (potassium  $>5.0$ – $5.5$  mmol/L), moderate (potassium  $5.6$ – $6.4$  mmol/L), and severe (potassium  $\geq 6.5$  mmol/L). It may also be classified as acute or chronic. Pseudohyperkalaemia should be excluded, as it is common and occurs in up to 35% of patients with laboratory findings of elevated serum potassium. It most often results from improper blood sampling or haemolysis of red blood cells.

In cases of acute hyperkalaemia, treatment should be initiated immediately. Calcium preparations (calcium chloride or calcium gluconate; 1–2 ampoules administered intravenously) are used to stabilize the myocardial cell membrane in the management of acute hyperkalaemia. Additional measures include salbutamol (20 mg in 4 mL of 0.9% NaCl administered via nebulization, which reduces serum potassium by approximately

0.6 mmol/L), 8.4% sodium bicarbonate (40–60 mL administered intravenously, particularly in the presence of acidosis, reducing serum potassium by approximately 0.5 mmol/L), 10% glucose with insulin (1 unit of insulin per 4–5 g of glucose; for example, 250 mL of 10% glucose with 5–6 units of insulin administered intravenously, reducing serum potassium by approximately 0.5 mmol/L), intravenous infusion of 0.9% NaCl with furosemide (40–60 mg administered intravenously) and haemodialysis, which most effectively lowers serum potassium and is considered first-line therapy in patients receiving chronic haemodialysis or those with oliguria. In addition, polystyrene sulfonate (Resonium A; 30 g in 150 mL of water or a 10% glucose solution administered orally, and less frequently rectally) is commonly used in combination with agents that promote bowel movements (e.g., lactulose 30 mL orally), resulting in a reduction in serum potassium levels of approximately 0.5–1.0 mmol/L. The onset of action of polystyrene sulfonate is variable, ranging from several hours to several days. This agent acts in the large intestine and nonspecifically binds potassium ions in exchange for sodium ions. Common adverse effects of polystyrene sulfonate include gastrointestinal disturbances, hypernatraemia, hypokalaemia, and nonrespiratory alkalosis. Intestinal necrosis also represents a serious potential complication. For this reason, the drug is not recommended for chronic treatment.

Low-potassium diet, including the avoidance of potassium-containing salt substitutes, along with the use of diuretics that increase urinary potassium excretion (loop diuretics at  $eGFR < 30$  mL/min/ $1.73$  m<sup>2</sup>) is recommended in the management of chronic hyperkalaemia in CKD patients. Sodium bicarbonate is advised (a decrease in pH by 0.1 increases serum potassium by ap-

proximately 0.4 mmol/L, and the target bicarbonate levels in CKD is 24–28 mmol/L) in patients with metabolic acidosis. Additionally, discontinuation of medications that promote hyperkalaemia, such as potassium supplements, NSAIDs, beta-blockers, and RAASi, or a reduction in their doses, should be considered. However, the approach to discontinuing RAASi in the context of hyperkalaemia has changed. Current recommendations emphasize maintaining RAASi therapy at the maximum tolerated dose whenever possible, given its long-term benefits in reducing cardiovascular risk.

The availability of two novel agents, calcium patiromer and sodium zirconium cyclosilicate, in Poland is a significant advancement in the management of chronic hyperkalaemia. Both are currently reimbursed for the treatment of hyperkalaemia in adult patients with G3b–G5 CKD who are receiving RAASi. As a result, these agents allow for continuing RAASi therapy, for example in the management of HF or HT. This is particularly important since CV complications represent the leading cause of mortality in CKD patients; therefore, the use of RAASi should not be limited in this patient population. Calcium patiromer is a nonabsorbable polymer that nonspecifically binds potassium ions in exchange for calcium ions in the distal large intestine, with an onset of action within 7 hrs after oral administration. Although this agent may cause gastrointestinal disturbances, hypokalaemia, and hypomagnesaemia, no serious adverse reactions have been reported. The recommended starting dose in adults is 8.4 g once daily. The dose may be adjusted as required within the range of 8.4–25.2 g daily to achieve target serum potassium levels. A minimum interval of 3 hrs should be maintained between patiromer and other oral medications. Sodium zirconium cyclosilicate, which selectively binds potassium ions in exchange for sodium ions, is another novel agent available for the chronic management of hyperkalaemia in adults. This agent has a rapid onset of action, occurring already 1 hour after ingestion, and binds potassium throughout the GI tract. It may also cause GI disturbances, hypokalaemia, and oedema; however, no serious adverse effects have been reported. Treatment consists of a correction phase (10 g three times daily), followed by maintenance therapy after reaching normokalaemia, which typically occurs within 24–48 hrs. Maintenance therapy is usually initiated at 5 g once daily, with the option to gradually increase the dose to 10 g once daily or reduce it to 5 g every other day, as needed; the lowest effective dose should be determined. Since it may transiently increase gastric pH, a minimum interval of 2 hrs should be maintained between the drug and orally administered medications with pH-dependent bioavailability. It is important to emphasize that, whenever possible, the inclusion of sodium-glucose cotransporter-2 (SGLT2) inhibitors should be considered in cases of hyperkalaemia. These agents are currently a cornerstone of nephroprotective therapy, as studies have demonstrated their beneficial effect in lowering serum potassium levels.

### **Hereditary kidney diseases – pathogenesis, diagnosis and treatment**

During the session on hereditary kidney diseases, lectures were delivered by Magdalena Jankowska

MD, PhD (Department of Nephrology, Transplantation and Internal Medicine, University Clinical Centre, Gdańsk); Prof. Michał Nowicki MD, PhD (Department of Nephrology, Hypertension, Transplantation and Internal Medicine, Medical University of Łódź); and Jakub Ruszkowski MD, PhD (Department of Nephrology, Transplantation and Internal Medicine, University Clinical Centre, Gdańsk), Prof. Krzysztof Pawlaczyk, MD, PhD (Department of Nephrology, Transplantation and Internal Medicine, Poznań University of Medical Sciences) and Prof. Ryszard Gellert, MD, PhD (Department of Nephrology and Internal Medicine, Medical Center for Postgraduate Education, Warsaw). Two clinical conditions were discussed during the session: autosomal dominant polycystic kidney disease (ADPKD) and Fabry disease.

ADPKD is the most common genetic cause of end-stage renal disease. It is caused by mutations in one of two genes encoding membrane proteins: *PKD1* (located on chromosome 16p13.13), which encodes polycystin-1 and accounts for 85–90% of cases, and *PKD2* (chromosome 4q21), which encodes polycystin-2 and accounts for 10–15% of cases. The absence of apparent *PKD1/PKD2* changes in several ADPKD-affected families may suggest a third locus. End-stage renal disease develops in approximately 70% of ADPKD patients at a mean age of 56 years, while average life expectancy ranges from 53 to 70 years, depending on the subtype, with shorter survival observed in *PKD1* compared to *PKD2* mutation. Patients with ADPKD experience a reduced quality of life, with depression, increased anxiety, low physical fitness, and increased pain sensitivity observed in approximately 60% of cases. Early diagnosis and timely intervention are critical for improving ADPKD prognosis. Lifestyle modifications are recommended as the first-line approach. Key measures include maintaining adequate hydration (at least 2–3 litres of fluids daily in patients with eGFR >30 mL/min/1.73 m<sup>2</sup> who are not treated with tolvaptan), adhering to a low-sodium diet, maintaining a healthy body weight, smoking cessation, engaging in regular physical activity, and limiting coffee consumption. Angiotensin-converting enzyme inhibitors (ACEi) are the first-line pharmacotherapy for HT. In cases of ACEi intolerance, angiotensin II receptor blockers (ARBs) may be used. Second-line agents include dihydropyridine calcium channel blockers and diuretics. Chronic administration of vasopressin V2 receptor antagonist tolvaptan, which slows cyst formation and CKD progression, is the only currently recommended treatment for ADPKD with proven efficacy. Tolvaptan is available in Poland through a dedicated drug programme. Serine-threonine kinase inhibitors (mTOR), metformin (in patients with diabetes), statins (for slowing disease progression), somatostatin analogues, SGLT2 inhibitors, ketogenic diet, complementary medicines, or dietary supplements are not recommended.

Fabry disease (FD), a lysosomal storage disorder caused by mutations in the gene encoding alpha-galactosidase A (GLA), resulting in a marked deficiency or inactivity of this enzyme, was another discussed genetic disorder. Despite being X-linked, symptoms can also manifest in women, with their severity depending on the pattern of

random X-chromosome inactivation. More than 1,170 variants of the GLA gene have been described. Enzyme deficiency results in the accumulation of glycolipids, including globotriaosylceramide (GL-3) and its deacylated form, globotriaosylsphingosine, in plasma and in multiple cell types throughout the body, particularly in the kidneys, myocardium, and nervous system, leading to organ damage and dysfunction. The accumulation of globotriaosylceramide is correlated with oxidative stress, complement activation, and inflammation, ultimately leading to progressive fibrosis and irreversible organ damage. In the kidneys, damage primarily involves vascular endothelial cells, mesangial cells, podocytes, and tubular epithelial cells. Renal dysfunction manifests as albuminuria, proteinuria, and impaired renal function, which can progress to end-stage renal disease. Typical extrarenal manifestations include acroparesthesia, hypohidrosis, reduced tolerance to extreme temperatures and physical exertion, sudden-onset asymmetric sensorineural hearing loss, gastrointestinal symptoms, and fatigue. Enzyme replacement therapy (ERT) with agalsidase alfa, the timely initiation of which improves cardiovascular and renal function, is the optimal treatment for FD. Its prompt use improves cardiovascular and renal function. Orally administered chaperone migalastat is another treatment option. By stabilizing mutant alpha-galactosidase A, it restores enzymatic activity and significantly slows the progression of renal failure. Clinical experience with migalastat is more limited than that with ERT, and its use is restricted to patients with eGFR >30 mL/min/1.73 m<sup>2</sup>.

The aetiology of kidney failure remains unidentified in approximately 23% of patients receiving dialysis. Genetic testing in this population yields a definitive diagnosis in 10–40% of cases. To date, more than 300 genetic defects have been implicated in CKD. Advances in modern technologies allow for precise detection of mutations responsible for kidney disease. Given the expanding range of therapeutic options, early diagnosis is essential to enable timely initiation of appropriate treatment and to slow disease progression.

### The 2025 pillars for pharmacological nephroprotection – position of the Polish Society of Nephrology

The issue of pharmacological nephroprotection in CKD patients was raised during many lectures. Nephroprotective agents have been categorized into several groups that constitute the pillars of treatment, with their use varying depending on the underlying aetiology of renal failure.

In cases of kidney disease developing secondary to diabetes mellitus (DM), five therapeutic components are considered essential:

- The first pillar involves metabolic control of DM, aiming to achieve a glycated haemoglobin level < 7%. Preferred agents include SGLT2is and glucagon-like peptide-1 (GLP-1) receptor agonists, such as semaglutide, liraglutide, and exenatide.
- Nephroprotection with SGLT2i or GLP1 receptor agonists, regardless of metabolic control, is the second pillar.

- The third pillar involves adequate blood pressure control with RAASis. Target blood pressure values are 130–139/70–79 mmHg, or 120–129/70–79 mmHg if well tolerated by the patient.
- RAASis as nephroprotective treatment at the highest tolerated dose (losartan and irbesartan are preferred) and finerenone are considered the fourth pillar.
- The fifth pillar involves correcting metabolic acidosis. For this purpose, sodium bicarbonate is administered, aiming to achieve a target HCO<sub>3</sub><sup>-</sup> levels of 24–28 mmol/L.

The aim of these interventions is to achieve glycaemic control, target blood pressure, and correction of metabolic acidosis within a three-month period.

In non-diabetic CKD, pharmacotherapy is largely analogous and focuses on antihypertensive agents. RAASis are preferred, with the aim of achieving a target blood pressure of ≤139/79 mmHg, or ≤129/79 mmHg if well tolerated (first pillar). These agents are administered at the highest tolerated doses, with benazepril, ramipril, and lisinopril being the preferred options (second pillar). SGLT2is, constituting the third pillar of therapy, are also used. Empagliflozin should not be initiated in patients with eGFR <20 mL/min/1.73 m<sup>2</sup>, and dapagliflozin should not be used in those with eGFR <25 mL/min/1.73 m<sup>2</sup>. Once initiated, treatment should be continued until the commencement of renal replacement therapy. Sodium bicarbonate should also be administered to achieve HCO<sub>3</sub><sup>-</sup> level of 24–28 mmol/L (fourth pillar). In this patient population, the therapeutic goals additionally include achieving target blood pressure and correcting metabolic acidosis within a three-month period.

### Reducing CV risk in CKD patients

The issue of CV complications in patients with CKD was discussed by Prof. Andrzej Więcek, MD, PhD (Department of Nephrology, Transplantation and Internal Medicine, Silesian Medical University in Katowice); Prof. Piotr Jankowski, MD, PhD (First Department of Cardiology and Interventional Electrophysiology and Arterial Hypertension, Jagiellonian University); Daniel Śliż, MD, PhD (Third Department of Internal Medicine and Cardiology, Medical University of Warsaw); and Prof. Jolanta Małyszko, MD, PhD (Department of Nephrology, Dialysis, and Internal Medicine, Medical University of Warsaw). CV complications, including HT, atherosclerosis, left ventricular hypertrophy, HF, and chronic coronary syndrome (CCS), develop in the early stages of renal failure and progress with declining eGFR, with their greatest severity seen in patients on renal replacement therapy. These complications represent the leading cause of mortality in CKD patients. According to the 2021 European Society of Cardiology Guidelines on Cardiovascular Disease Prevention in Clinical Practice, cardiovascular risk stratification in CKD patients is based on eGFR and the albumin-to-creatinine ratio (ACR). Consequently, the severity of albuminuria is regarded as the primary marker of CV risk in this population. According to these guidelines, CKD patients are classified as having

either high or very high CV risk. In addition to classical risk factors present in the general population, such as obesity, HT, dyslipidaemia, metabolic syndrome, lack of physical activity, smoking, chronic inflammation, and intestinal dysbiosis, CKD patients exhibit a range of non-classical risk factors that contribute to the progression of cardiovascular pathology. These factors include disturbances in calcium and phosphate metabolism, such as secondary hyperparathyroidism, elevated fibroblast growth factor 23 (FGF23) levels, and Klotho protein deficiency, as well as anaemia, fluid overload, metabolic acidosis, and nutritional disorders, including protein-energy wasting and malnutrition, which are associated with an intensified inflammatory response and accelerated atherosclerosis (malnutrition-inflammation-atherosclerosis, MIA). Additional contributors include sarcopenia, vitamin D and K deficiency, and increased levels of uremic toxins. Elevated fibroblast growth factor 23 (FGF23) levels in CKD patients have been shown to contribute to the development of HF by promoting myocardial fibrosis and left ventricular hypertrophy. Furthermore, FGF23 has been identified as an independent risk factor for mortality in patients with CKD stages G2–G4.

Metabolic disorders, CKD, and CVD are components of the cardiovascular-kidney-metabolic (CKM) syndrome. Although each represents a distinct clinical entity, the presence of one can exacerbate the course of the other two. It is now recognized that hyperglycaemia and insulin resistance, increased inflammation and oxidative stress, activation of the renin-angiotensin-aldosterone system, and neurohormonal dysregulation contribute to cardiac and renal dysfunction, and that impairment of one organ adversely affects the other. Obesity represents a key contributor to CKM syndrome. Increased adipose tissue leads to enhanced synthesis of inflammatory cytokines, such as tumour necrosis factor alpha and interleukin-6, as well as free fatty acids. These factors exacerbate insulin receptor dysfunction and result in elevated plasma glucose. Elevated levels of free fatty acids also lead to increased hepatic synthesis of triglycerides and very low-density lipoprotein cholesterol (VLDL-C), as well as an increase in low-density lipoprotein cholesterol (LDL-C), which is more atherogenic. Obesity is also linked to lower adiponectin levels. Additionally, activation of the sympathetic nervous system and RAAS in obesity leads to endothelial dysfunction, decreased nitric oxide synthesis, HT, and left ventricular hypertrophy, thereby promoting atherosclerosis and HF. Multiple pathophysiological processes observed in obesity and diabetes, including hyperfiltration, oxidative stress, increased inflammation, and profibrotic mechanisms, impair renal function and contribute to the development of CKD. HF exacerbates renal dysfunction, while renal impairment promotes CV complications. CKM syndrome is classified into four distinct stages. Stage 1 is characterized by excess body fat. Stage 2 includes impaired renal function and/or hypertriglyceridemia, type 2 DM, metabolic syndrome, and HT. Stage 3 is additionally characterized by subclinical atherosclerotic cardiovascular disease or subclinical HF. Stage 4 CKM is defined as clinical CV complications, including chronic coronary syndrome, HF, stroke, peripheral ar-

terial disease, and atrial fibrillation. The risk of mortality increases with each stage of the syndrome, rising from 5.5% in stage 1 to 15.2% in stage 4.

Patients with CVD receive multifaceted pharmacotherapy for CVD. SGLT2 inhibitors are used for both HF (with class IA recommendations from the European Society of Cardiology) and CKD. Blood pressure control is essential in this population, with RAASis serving as the primary agents. Sacubitril/valsartan has been shown to slow the progression of CKD, reduce albuminuria, decrease the risk of CV complications, and improve prognosis in patients with renal failure. Lipid-lowering therapy in CKD is primarily based on statins and, when indicated, ezetimibe, both of which reduce CV risk.

It is also possible to reduce CV risk in patients undergoing renal replacement therapy, who exhibit the most advanced CV complications and the highest mortality rates. In this population, selection of the optimal modality of renal replacement therapy, such as standard haemodialysis, haemodiafiltration, peritoneal dialysis, home dialysis, or daily dialysis, as well as extension of dialysis duration, are of critical importance. Blood pressure control is of critical importance and should be achieved using an appropriately determined so-called “dry weight,” defined as the weight at which there are no signs of overhydration and blood pressure is within the normal range, whereas further reduction in dietary sodium intake or body water content may result in hypotension. Preservation of residual diuresis reduces the risk of fluid overload and electrolyte disturbances. The choice of vascular access for dialysis is of critical importance, as the use of intravascular catheters is associated with a higher risk of infectious and thromboembolic complications compared with arteriovenous fistulas (AVFs). In patients with severe HF, however, it should be carefully considered whether an AVF is truly the optimal option, as upper-extremity fistulas in particular may increase cardiac output. If an AVF is considered appropriate in such patients, a low-flow fistula or graft is preferred. The lowest left ventricular ejection fraction (EF) at which vascular access can be established is 10%. Kidney transplantation, which significantly reduces CV mortality remains the most effective treatment option for patients with end-stage renal disease.

### **IgA nephropathy – morphology, clinical picture and limits of interpretation**

Prof. Agnieszka Perkowska-Ptasińska, MD, PhD (Department of Pathomorphology, Medical University of Warsaw), presented histopathological images of IgA nephropathy (IgAN). The pathogenesis of this disease involves abnormal glycosylation of immunoglobulin A1, leading to increased production of under-galactosylated IgA1, formation of IgA and IgG autoantibodies against Gd-IgA1 forming complexes with Gd-IgA1, and subsequent deposition of these complexes in the mesangium. This gives rise to mesangial cell activation followed by complement activation. Stimulation of the immune system results in overproduction of cytokines and growth factors, recruitment of inflammatory cells,

matrix expansion, and mesangial cell proliferation, all of which ultimately impair renal function. Mesangial proliferation and focal segmental glomerulosclerosis (FSGS) are the most common light microscopic findings in IgA nephropathy. Segmental loop necrosis and segmental crescent formation have also been described. Immunofluorescence microscopy demonstrates IgA deposits, as well as complement component C3, IgG, and IgM. Electron microscopy reveals mesangial deposits, alterations in podocyte structure, segmental thinning of the glomerular basement membrane, and, in some cases, splitting of the glomerular basement membrane. These histopathological findings allow for predicting the patient's future prognosis. Changes such as increased capillary cellularity or podocyte hypertrophy within sclerotic areas are associated with a poorer prognosis and should be taken into account during patient assessment, alongside established clinical predictors of progression to end-stage renal disease, including proteinuria exceeding >1 g/day, HT, and reduced eGFR at diagnosis.

Differentiating IgA nephropathy from type IV collagen disease (Alport syndrome) poses particular challenge due to the presence of glomerular basement membrane thinning in both conditions and the fact that they may coexist in the same patient, especially when the GBM thickness is <200 nm. Additionally, IgA deposits may be present in other clinical entities, such as infection-related glomerulonephritis or monoclonal gammopathy of renal significance (MGRS), which further complicates the interpretation of histopathological specimens.

### **IgA nephropathy – from pathogenesis to treatment**

During another lecture, Prof. Tomasz Hryszko, MD, PhD (Second Department of Nephrology, Hypertension and Internal Medicine with Dialysis Center, Medical University of Białystok) discussed the current guidelines for the management of IgA nephropathy. According to the 2021 KDIGO recommendations, nephroprotective treatment with RAASis is the cornerstone of therapy for patients with proteinuria > 0.5 g/day. In patients with persistent proteinuria >1 g/day despite at least three months of optimized nephroprotective therapy and with eGFR >30 mL/min/1.73 m<sup>2</sup>, immunosuppressive treatment with glucocorticoids should be considered. Emerging therapeutic approaches for IgA nephropathy include nephroprotective therapy with atrasentan (endothelin receptor antagonist), targeted-release formulation (TRF) budesonide, and sibeprenlimab.

Atrasentan is a selective endothelin-1 receptor antagonist (a vasoconstrictor peptide produced primarily by vascular endothelial cells). It significantly decreases proteinuria and exerts nephroprotective effects on the glomeruli. In a randomized, double-blind, phase 3 clinical trial published in 2025 in *The New England Journal of Medicine*, Heerspink et al. [1] evaluated the efficacy and safety of atrasentan in patients with biopsy-confirmed IgA nephropathy. After 36 weeks of treatment in a cohort of 270 patients, the drop in UPCR was significantly greater in the atrasen-

tan group (-38.1%) than in the placebo group (-3.1%). No significant differences in the incidence of adverse events were observed between the two groups. Atrasentan is currently approved for use in the United States. Budesonide, administered as an oral modified-release formulation, acts locally in the distal ileum by inhibiting mucosal B cells within Peyer's patches, which are a major site of production of aberrantly glycosylated IgA1 (Gd-IgA1). In this way, budesonide exerts a targeted effect at the early stage of the pathogenic cascade leading to IgA nephropathy. Increased first-pass metabolism limits the drug's systemic bioavailability (estimated at approximately 10%), reducing the risk of treatment-related adverse events (mainly infections). The most commonly reported mild to moderate adverse events include acne, peripheral and facial oedema, weight gain, and increased white blood cell count.

Sibeprenlimab (VIS649) is a humanized IgG2 monoclonal antibody that binds to and neutralizes the activity of proliferation-inducing ligand (APRIL). APRIL, a member of the TNF superfamily, indirectly regulates immunoglobulin production by modulating the maturation and differentiation of B cells, including Gd-IgA1 antibodies, which play a key role in the pathogenesis of IgA nephropathy. Preliminary results reported by Mathur et al. [2] in 2024 demonstrated a significant reduction in proteinuria (from 47.2 ± 8.2% to 62.0 ± 5.7%, depending on the dose) in patients with IgA nephropathy treated with sibeprenlimab over a 12-month period vs placebo (20.0 ± 12.6%).

In summary, the current guidelines for the treatment of IgA nephropathy, which are based on conventional nephroprotective therapy with RAASis and, when indicated, immunosuppressive treatment with systemic GCs, will be gradually supplemented with more contemporary agents, such as atrasentan, targeted-release formulation budesonide, and sibeprenlimab. These therapies create the opportunity for more effective treatment with a lower risk of adverse effects.

### **How to break the inertia barriers: an interdisciplinary approach to CKD therapy**

The session on the interdisciplinary approach to the treatment of CKD was led by Prof. Agnieszka Pawlak, MD, PhD (Department of Cardiology, Central Clinical Hospital of the Ministry of Interior and Administration, Warsaw), Prof. Krzysztof Pawlaczyk, MD, PhD (Clinical Department of Nephrology, Transplantation and Internal Medicine, Poznań University of Medical Sciences), and Prof. Michał Holecki, MD, PhD (Department of Internal Medicine, Autoimmune and Metabolic Diseases, Medical University of Silesia in Katowice). During the session, several important issues related to the initiation and continuation of CKD treatment, as well as organizational challenges in patient care, were discussed. Possible causes of delays in the initiation of optimal therapy were identified, which may lead to off-label treatment, including the use of suboptimal doses, omission of certain medications, or failure to implement currently recommended therapies. This issue is multifactorial and can be categorized into three main domains: factors



**Figure 2.** Participants of the 15th Congress of the Polish Society of Nephrology from Department of Internal Diseases, Nephrology and Dialysis, Military Institute of Medicine-National Research Institute with the Head of the Clinic, Professor Stanisław Niemczyk. From left: Magdalena Markowska, Mateusz Nowak, Katarzyna Romejko, Professor Stanisław Niemczyk, Anna Grzywacz, Elżbieta Głuch, Magdalena Wiśniewska, Dorota Górską-Michałek

related to the organization of the healthcare system, constraints associated with physicians' workload and clinical practice, and insufficient patient perception and understanding of the treatment process. The first domain encompasses the lack of clear recommendations from scientific societies and expert panels, difficulties in establishing optimal follow-up schedules, limited access to modern medications, communication barriers among healthcare professionals, and insufficient substantive support, including the absence of an interdisciplinary approach, which hinders effective collaboration between specialists. The second category, related to limitations in clinical practice, encompasses challenges in implementing comprehensive therapy. These include time constraints during clinical visits that impede optimal therapeutic decision-making, concerns regarding the financial burden of modern treatments for patients, problems with patient adherence, communication difficulties between physicians and patients, limited access to information on novel therapeutic options, and the absence of clear and practical treatment guidelines. The third category relates to patients' inadequate perception and understanding of the therapeutic process. This includes denial of disease presence or progression, fear of adverse effects associated with new treatments, misunderstanding of the principles of modern therapies, reluctance to receive IV treatments or polypharmacy, and financial inability to bear the costs of therapy.

These challenges may impede the implementation of optimal treatment not only in CKD but also in other clinical conditions. Knowledge of these barriers is essential for the effective implementation and maintenance of therapies aligned with current medical evidence.

During the Congress, Janusz Ostrowski, MD, PhD (Postgraduate Medical Education Center), delivered a special lecture marking the 50th anniversary of the establishment of the Department of Nephrology, Transplantation, and Internal Medicine at the Medical University of Silesia in Katowice, entitled "*History of Silesian Nephrology*", while Prof. Peter Stenvinkel (Division of Renal Medicine, Department of Clinical Science, Intervention and Technology, Karolinska Institutet, Stockholm, Sweden), an Honorary Member of the Polish Society of Nephrology, delivered a lecture entitled "*Learning from nature to make everyone healthier – a concept of planetary health*".

## Conclusions

The 15th Congress of the Polish Society of Nephrology focused in contemporary diagnostic and therapeutic strategies for patients with kidney disease. Considerable attention was devoted to current guidelines for the management of complications of CKD, including electrolyte and acid-base disturbances. Novel thera-

peutic options and preventive strategies for cardiovascular disease in CKD patients, recognized as the leading cause of mortality in this population, were discussed in detail. Nephroprotective modalities and the safety of intravenous contrast agents in patients with impaired renal function were also addressed. A substantial portion of the Congress was devoted to sessions on hereditary kidney diseases, as well as lectures focusing on the diagnosis and current therapeutic guidelines for aHUS. The workshops, which included engaging case studies of patients with kidney disease, a presentation on peritoneal dialysis, and a discussion of dietary recommendations for CKD, attracted a lot of interest. The audience had the opportunity to ask questions, participate in discussions, and share their

observations and concerns after each session. The 15th Congress was also an excellent opportunity for nephrologists to meet, exchange experiences, and establish new professional and social contacts.

#### References

1. Heerspink HJL, Jardine M, Kohan DE, et al.; ALIGN Study Investigators. Atrasentan in patients with IgA nephropathy. *N Engl J Med*, 2025; 392: 544–554. doi: 10.1056/NEJMoa2409415
2. Mathur M, Barratt J, Chacko B, et al.; ENVISION Trial Investigators Group. A Phase 2 Trial of Sibeprenlimab in Patients with IgA Nephropathy. *N Engl J Med*, 2024; 390: 20–31. doi: 10.1056/NEJMoa230563