ISSN 1305-5550
e-ISSN 2548-0669

Journal of Cardiovascular Thoracic Anaesthesia and Intensive Care Society

Volume 31 Issue 3 September 2025

KARE

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ISSN 1305-5550
e-ISSN 2548-0669

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Publisher
Kare Medya İletişim Hizmetleri Tic. Ltd. Şti.
Göztepe Mah. Fahrettin Kerim Gökay Cad. No: 200
D: 2 Göztepe, Kadıköy, İstanbul-Türkiye

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It is published quarterly as 4 issues every year (March, June, September, December). GKDAYB Journal is an open Access, free and peer-reviewed journal. It is language English.

Indexed in Excerpta Medica, EMBASE, EBSCO, Sudoc, OpenAlex, Turkish Medline National Health Sciences Periodicals Database, Turkish Citation Index, and ULAKBİM, GALE, Scilit, Open Ukranian Citation Index and ASCI.

Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

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Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society
Publication Type: Local Term
Date of issue: September 2025

Publisher: KARE MEDIA
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Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

EDITORIAL BOARD

The board ensure the determination and implementation of the publication policy of the journal. It supposed toformed from editor in chief, assistant editors and academicians who will contribute to the journal policy and the academic accumulation of the journal, and how journal should be noted up-to-date. If its possible, people from different institutions should take part.

ABOUT

The Journal of Cardio-Vascular-Thoracic Anaesthesia and Intensive Care Society (GKDAYB Journal) is an official scientific journal of Cardio-Vascular-Thoracic Anaesthesia and Intensive Care Society journal (GKDA-YBD).

The journal publishes clinical and experimental studies, case reports, editorial letters, review articles and reports of scientific meetings related to fields of Thoracic, Cardiovascular Anesthesia and Intensive Care the both in English, Review articles written upon request of the editor are not accepted.

The journal is published every three months namely in March, June, September and December. One volume is completed after publication of 4 issues (one year). GKDAYB is an open access, free and peer-reviewed journal and all published content is freely available at www.gkdaybd.org Printed copies are distributed to members of the Cardio-Vascular-Thoracic Anaesthesia and Intensive Care Society free of charge.

GKDAYB Journal is included in Excerpta Medica / EMBASE, EBSCO Database, Sudoc, OpenAlex, Turkish Medline National Health Sciences Periodicals Database, Turkish Citation Index and ULAKBIM National Database (from 2016), GALE Cengage (from 2023), Scilit (from 2023), Open Ukranian Citation Index (from 2023) and Asian Science Citation Index – ASCI (from 2024).

Scopus coverage (2003-2017). Discontinued.

AIMS & SCOPE

The aim of the Journal of Thoracic-Cardiovascular Anesthesia and Intensive Care Society is to disseminate significant and cutting-edge professional information related to the fields of thoracic, cardiac, and vascular anesthesia and intensive care. The journal serves as a platform for sharing clinical and experimental studies reflecting new advancements and research in these specialized medical areas.

Our objective is not only to publish original research and findings but also to offer a comprehensive overview of contemporary topics and issues facing today's medical practitioners within these disciplines. The Journal eagerly welcomes the submission of original research, detailed and practical reviews, and clinical observations from experienced authors in the field.

Submissions can encompass a wide range of topics including, but not limited to, surgical techniques, pharmacological advancements, perioperative care, pain management, and patient safety and recovery protocols related to thoracic, cardiac, and vascular surgery anesthesia and intensive care. Case reports offering insights or novel perspectives on clinical practices and challenges are also encouraged.

By fostering collaboration and discussion among medical professionals, researchers, and practitioners, the Journal of Thoracic-Cardiovascular Anesthesia and Intensive Care Society aims to contribute to the ongoing development and enhancement of patient care and treatment outcomes in thoracic, cardiac, and vascular anesthesia and intensive care.

Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

PUBLICATION POLICIES

The editorial and publication processes of the journal are shaped in accordance with the guidelines of the International Council of Medical Journal Editors (ICMJE), the World Association of Medical Editors (WAME), the Council of Science Editors (CSE), the Committee on Publication Ethics (COPE), the European Association of Science Editors (EASE), National Information Standards Organization (NISO) and Asian Science Citation Index - ASCI. The journal complies with the Principles of Transparency and Best Practice in Scholarly Publishing (doaj.org/bestpractice).

Originality, high scientific quality, and citation potential are the most important criteria for a manuscript to be accepted for publication. Manuscripts submitted for evaluation should not have been previously presented or published in an electronic or printed medium. The journal should be informed of manuscripts that have been submitted to another journal for evaluation and rejected for publication. The submission of previous reviewer reports will expedite the evaluation process. Manuscripts that have been presented in a meeting should be submitted with detailed information of the event, including the name of the organization, the date, and the location.

Journal of Thoracic-Cardiovascular Anesthesia and Intensive Care Society does not accept multiple submissions or duplicate submissions of articles published in a different language. Nevertheless, the articles will not be processed that are sending again by different new ID numbers which has been already rejected or that are still under processing (revised etc.).

REVİEW PROCESS

Manuscripts submitted to the Journal of Thoracic-Cardiovascular Anesthesia and Intensive Care Society will undergo a double-blind peer-review process. Each submission will be reviewed by at least two external, independent peer reviewers who are experts in their field in order to ensure an unbiased evaluation process.

The editorial board will invite an external and independent editor to manage the evaluation process of manuscripts submitted by editors or by the editorial board members of the journal. The editor-in-chief is the final authority in the decision-making process for all submissions.

Reviews are typically completed within one month of submission to the journal. Authors will be sent constructive reviewer comments intended to be useful. In general, the instructions, objections, and requests made by the reviewers should be followed. The revised manuscript should clearly and precisely indicate every step taken in accordance with the reviewers' notes. A list of responses and the corrections made to each comment should be provided.

OPEN ACCESS POLICY

The Journal of Cardiovascular-Thoracic Anaesthesia and Intensive Care Society supports the Budapest Open Access Initiative statement of principles that promotes free access to research literature. The declaration defines open access to academic literature as free availability on the internet, permitting users to read, record, copy, print, search, or link to the full text, examine them for indexing, use them as data for software or other lawful purposes without financial, legal, or technical barriers. Information sharing represents a public good, and is essential to the advancement of science. Therefore, articles published in this journal are available for use by researchers and other readers without permission from the author or the publisher provided that the author and the original source are cited. The articles in Journal of Cardiovascular-Thoracic Anaesthesia and Intensive Care Society are accessible through search engines, websites, blogs, and other digital platforms. Additional details on the Budapest Open Access Initiative and their guidelines are available at https://www.budapestopenaccessinitiative.org/

Open Access Statement

The journal is an open access journal and all content is freely available without charge to the user or his/her institution. Except for commercial purposes, users are allowed to read, download, copy, print, search, or link to the full texts of the articles in this journal without asking prior permission from the publisher or the author. This is in accordance with the BOAI definition of open access. The open access articles in the journal are licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) license.

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Publication Charges

The Journal of Thoracic-Cardiovascular Anesthesia and Intensive Care Society assesses no submission fees, publication fees, or page charges.

ETHICAL POLICY

It is targeted that all parties participating in the creation of a scientific study (author, editor, reviewer, publisher and reader) contribute to the proper progress of science. Compliance with scientific ethical principles is important in the scientific studies prepared in accordance with this target. Kare Media adopted the ethical principles based on the directive prepared by the Committee on Publication Ethics (COPE) and recommended its adoption by all individuals contributing in the creation of a scientific work. Some items of this directive are mentioned below.

Ethical Responsibilities of the Authors

In accordance with the journal's policy, an approval of research protocols by an ethics committee in accordance with international agreements "WMA Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects (last updated: October 2013, Fortaleza, Brazil)", "Guide for the care and use of laboratory animals (8th edition, 2011)" and/or "International Guiding Principles for Biomedical Research Involving Animals (2012)" is required for all research studies. If the submitted manuscript does not include ethics committee approval, it will be reviewed according to COPE's guideline (Guidance for Editors: Research, Audit and Service Evaluations). If the study should have ethical approval, authors will be asked to provide ethical approval in order to proceed the review process. If they cannot provide ethical approval, their manuscript will be rejected and also their institutions and when needed, the related bodies in their country will be informed that such studies must have ethics committee approval. If they provide approval, review of the manuscript will continue.

If the study does not need ethics committee approval after the editorial board's review, the authors will be asked to provide an ethics committee approval or a document given by a related independent committee that indicates the study does not need ethics committee approval according to the research integrity rules in their country. If the authors provide either an approval or a document showing that ethics approval is not needed, the review process can be continued. If the authors cannot provide either documents, the manuscript may be rejected.

For articles concerning experimental research on humans, a statement should be included that shows informed consent of patients and volunteers was obtained following a detailed explanation of the procedures that they may undergo. The journal may request a copy of the Ethics Committee Approval received from the relevant authority. Informed consent must also be obtained for case reports and clinical images.

Studies using human or animal subjects should be approved by the appropriate institutional and local Ministry of Health ethics committees. Ethics approval of research protocols in accordance with international agreements is required for experimental, clinical, and drug studies, as well as for some case reports. Ethics committee reports or an equivalent official document may be requested from the authors. For manuscripts involving experimental research on humans, a statement should be included that shows that written, informed consent of patients and volunteers was obtained. For studies carried out on animals, the measures taken to prevent pain and suffering of the animals should be stated clearly. A statement regarding patient consent, and the name of the ethics committee, the ethics committee approval date, and number should be stated in the Materials and Methods section of the manuscript. It is the authors' responsibility to carefully protect patients' anonymity.

Research Ethics for Vulnerable Populations

At the Journal of Thoracic-Cardiovascular Anesthesia and Intensive Care Society, we are committed to upholding the highest ethical standards in all research involving human participants, especially vulnerable populations such as children. In line with our dedication to responsible and respectful research practices, we have established the following guidelines to ensure the protection and ethical treatment of these groups:

Consent Requirements for Children

Parental/Guardian Consent: For all research involving children under the age of 18, written informed consent must be obtained from a parent or legal guardian. This consent must be informed, voluntary, and documented.

Assent from Children: In addition to parental consent, researchers are required to obtain assent from children who are capable of forming an opinion and making a decision regarding their participation in the study. This process must be age-appropriate and must respect the child's level of understanding and autonomy.

Privacy and Confidentiality: Extra precautions will be taken to protect the privacy and confidentiality of child participants. This includes using pseudonyms, removing identifiable details from published data, and securely storing data.

Ethical Review: All studies involving children must undergo a rigorous ethical review process to ensure that the research is justified, and the potential benefits outweigh any risks. The ethical review will also ensure that the study adheres to the principles of beneficence, non-maleficence, and justice.

Oversight and Monitoring

To ensure adherence to these ethical guidelines, the Journal of Cardiovascular Thoracic Anesthesia and Intensive Care Society requires that all studies involving vulnerable populations be reviewed and monitored by an Institutional Review Board (IRB) or an equivalent ethical oversight committee. This committee will oversee the study from its inception to its completion, ensuring continuous protection of the participants' rights and well-being.

For more details on our research ethics policies and procedures, or to report any concerns regarding the ethical conduct of a study published in our journal, please contact our ethics committee at kare@karepb.com.

Ethical Duties and Responsibilities of the Editors

Acting in a balanced, objective and fair manner while performing their duties without any discrimination based on gender, religious or political beliefs, ethnic or geographical origin of the authors.

To evaluate the work submitted to the journal according to its content without showing any privilege to any author.

To take necessary measures to prevent potential conflicts of interest and to evaluate existing statements, if any.

To deal with sponsored works or special studies in the same way as other studies,

In case of complaints related to violation of ethics, to enforce necessary procedures by adhering to the policies and procedures of the journal. To give the authors an opportunity to respond to the complaint, and without refraining from imposing the necessary sanctions, regardless of the identity of the owner of the work To reject the study if it does not meet the purpose and scope of the journal.

Ethical Responsibilities of the Reviewers

In order to contribute to the editor's decision-making process, the manuscript should be scrutinized in a timely fashion and reviews should only accept the critical evaluation of the study of his/her expertise.

The assessment should be done in an objective manner only in relation to the content of the study. The study should be evaluated without considering religious, political and economic interests.

To make suggestions to help improve the quality of the article to be published and to critically review the study. To communicate his/her comments to the author in a constructive and gentle language.

To protect the confidentiality of the information provided by the editor and the author, to destroy the work after the evaluation process in accordance with the principle of confidentiality, to report to the editor if there is anything contrary to the blind review process and not to evaluate this study.

To be cognizant of potential conflicts of interest (financial, institutional, collaborative, or other relationships between the author and the author), and, if necessary, to alert the editor to withdraw his or her assistance for this article.

Ethical Responsibilities of the Publisher

Among the parties involved in a creation of a scientific study, the publisher should act within all these ethical principles.

In addition to these, the publisher is obliged to use its communication power without any individual interest and to direct the target audience correctly.

It protects the ownership and copyright of each work published in its journals/books and undertakes the task of archiving every published work.

People should not hesitate to get contact with the publisher when they encounter an unethical situation.

Some of the actions considered to be against scientific research and publication ethics

Plagiarism: To adopt the original ideas, methods, data or works of others partially or wholly without referencing them in compliance with scientific rules,

Fraud: to use data that is not actually present or falsified in scientific research

Distortion: Distorting the research records or data obtained, demonstrating unused devices or materials as if they were used in the research, and distorting or shaping the results of research in the interests of the people and organizations that sponsored the study;

Republication: To present duplicates as separate publications in academic appointments and elevations

Slicing: To present the results of a research as separate publications in academic appointments and upgrades by disseminating and publishing the results of a research in a way that disrupts the integrity of the research and submit them as separate publications more than once;

Unfair authorship: to include people who are not active contributors or not to include those who are contributing to the study, to change the

ranking of the authors inappropriately without any justification and, to remove the names of those who offered their active contributions in t the previous editions, to include their names among the writers by using their influence even though they did not actively contributed to the work.

Not specifying the people, institutions or organizations that support the publications realized as a result of the researches carried out with their support, and contributions,

To use the thesis or studies which have not been submitted yet or have not been accepted as a source without the permission of the owner,

Failure to comply with ethical rules in human and animal researches, not to respect patient rights in its publications, to harm animal health and ecological balance, to refrain from obtaining necessary permissions,

To misuse resources, places, facilities and devices provided for scientific research,

To make false or misleading statements regarding scientific research and publications in academic appointments and elevations.

Artificial Intelligence (AI)-Assisted Technology

At submission, the journal should require authors to disclose whether they used artificial intelligence (AI)-assisted technologies (such as Large Language Models [LLMs], chatbots, or image creators) in the production of submitted work. Authors who use such technology should describe, in both the cover letter and the submitted work, how they used it.

Chatbots (such as ChatGPT) should not be listed as authors because they cannot be responsible for the accuracy, integrity, and originality of the work, and these responsibilities are required for authorship. Therefore, humans are responsible for any submitted material that included the use of AI-assisted technologies. Authors should carefully review and edit the result because AI can generate authoritative-sounding output that can be incorrect, incomplete, or biased. Authors should not list AI and Alassisted technologies as an author or co-author, nor cite AI as an author. Authors should be able to assert that there is no plagiarism in their paper, including in text and images produced by the AI.

Humans must ensure there is appropriate attribution of all quoted material, including full citations.

PLAGIARISM POLICY

Plagiarism (cheating) is a violation of ethics, regardless of whether it is intentional or not. It is a crime and an unacceptable code of conduct as it is unethical to submit, and publish manuscripts imitating other sources, without citing references,. For this reason, due to publication policies Kare Publishing, for all studies to be published in all of its periodicals, necessitates use of a plagiarism checker.

All studies submitted to our periodicals and passed the evaluation of the reviewers blinded to the studies, are evaluated by us using Turnitin or iThenticate software programs.

In our study, our criterion is not a percentage of matching. An auditng is carried out by a specialized team excluding percentages of matching but considering the parameters, such as identification of matching paragraphs, whether or not citations and references are properly written in accordance with the writing rules of the journal, the places of the matching sentences/ paragraphs in the article, and the sources with which they are matched. The prepared plagiarism report is sent to the relevant editor of the study. In consideration of the report, the editorial board may request from the author correction of the errors in the manuscript and sent it again or accept or reject it. The acceptance of the study is on the initiative of the editor.

The Editorial Board may act in accordance with the COPE rules against allegations, and suspicions related to plagiarism, citation manipulation and fraudulent misrepresentation of the works submitted to the journal.

COPYRIGHT TRANSFER

CONFLICT ON INTEREST

Conditions which provide financial or personal benefit bring about a conflict of interest. The reliability of the scientific process and the published articles is directly related to the objective consideration of conflicts of interest during the planning, implementation, writing, evaluation, editing and publication of scientific studies.

Financial relations are the most easily identified conflicts of interest and it is inevitable that they will undermine the credibility of the journal, the authors and the science. These conflicts can be caused by individual relations, academic competition or intellectual approaches. The authors should refrain as much as possible from making agreements with sponsors in the opinion of gaining profit or any other advantage that restrict their ability to access to all data of the study or analyze, interpret, prepare, and publish their articles In order to prevent conflicts of interest, editors should refrain from bringing together those who may have any relationship between them during the evaluation of the studies. The editors, who make the final decision about the articles, should not have any personal, professional or financial ties with any of the issues they are going to decide. Authors should inform the editorial board concerning potential conflicts of interest to ensure that their articles will be evaluated within the framework of ethical principles through an independent assessment process.

Our publication team works devotedly to ensure that the evaluation process is conducted in an impartial manner, taking all these situations into consideration.

You can review the conflict of interest form and the related link to get more detailed information and to declare an conflict of interest.

WRITING GUIDE

Double-Blind Review And Evaluation Process

The decision to publish all articles submitted to the journal belongs to the editor in chief. However, editors shape these decisions in line with the reviewers' recommendations.

The double blind review process is the process of evaluating the work completely anonymously. In this system, only the editor knows each stage. In this system authors do not know who the reviewer is, and the reviewers do not know whose work they are evaluating. Thus, biased evaluation of the work by the reviewers is prevented. In addition, since the author does not know the reviewers, he/she can not possibly get contact with the reviewer, and influence him/her through 'special routes'. From this point of view, the double- blind review process is thought to provide objective evaluation and increase the equal opportunity.

For these reasons, all studies submitted to GKDAYB Journal are subject to double-blind review. At least two reviewers expert in their fields, will evaluate each submitted work. Every effort is spent by the editors for quick evaluation of the articles. The editor is the final decision-making authority in the evaluation processes of all articles.

First Evaluation

The relevant editor or journal secretary examines the work regarding the purpose and scope of the journal, its conformity to the rules of writing, and its English and Turkish language proficiency. As a result of this assessment, the manuscripts which do not comply with the publication rules and the publication policy of the journal are returned to the responsible author.

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Preliminary Evaluation Process

In the pre-evaluation process; the study that left a positive impression on the editor is directed to the field editors. Field editors examine summary, introduction, material / method, discussion and conclusion sections of the manuscript as well as its scientific, and formal conformity to the writing rules of the journal. As a result of this review, manuscripts which are found suitable are taken into the process of reviewers' evaluation.

Reviewers' Evaluation Process

According to the content of the manuscript, at least two expert reviewers who had current studies in the relevant field are determined. Suggestions of the field editor regarding the selection of reviewers are appraised by the chief editor, and reviewers are assigned for the assessments of the manuscripts. The reviewers evaluate the study and prepare a report.

Reports of the Reviewers

The reviewers evaluate the objective, material / method, results and discussion sections of the study, and its conformity to scientific principles. The work may be accepted directly, its revision may be requested or rejected. If correction in the manuscript is required, the suggestions coming from the reviewers are communicated to the authors and the authors are asked to revise their work.The results of correction coming from the authors are reexamined by the reviewers and their decisions are reported to the editor. In case of disagreement between the assigned reviewers, the manuscript is sent to a designated third reviewer.

Statistical Analysis

Manuscripts deemed appropriate for publication by the reviewers are sent to the statistical editor. Articles that are approved by the statistical editor are accepted for publication.

Publication Printing Process

Clinical studies or experimental research articles accepted for publication are usually included in the first issue to be published. Case presentations can wait 6-9 months according to the intensity.

CHECKLIST FOR AUTHORS

- Make sure that name of the author (s), information about the institution thank you letter about ethics committee etc. are not included in the study. This issue is important according to the 'double- blind review principle' concerning the evaluation process of your work so that it can be dealt with impartially.
- You should not forget that your study will be subject to plagiarism audit if it is deemed to be adequate and appropriate in terms of the subject and you should avoid making quotations that will be covered by plagiarism when preparing the work
- If your article is derived from a study, a thesis, abstract of a case report, poster, etc. be sure to cite it in a footnote and specify its date.
- Please fill out the form and upload it to the system, as you cannot proceed to the next step without uploading the copyright transfer form to your system. It is sufficient to communicate it in the online system, you do not need to communicate this information in printed form.
- If your work has been returned to you for revision, and you have made a change in the title and summary of your work, please update it during preparation of the article
- There cannot be any changes in your article once its published. Therefore we advise you strongly to examine your article carefully when last check e-mail sent to you and if there is any neccesary revisions you have to make please send them to us before the journal is published.

MANUSCRIPT PREPARATION

Manuscripts should preferably be written using the Microsoft Word program. The manuscripts should be typed in 12 point Times New Roman characters. Manuscripts should be written double- spaced on one side of the A4 (21x29.7 cm) white paper and throughout the entire manuscript (including headings, abstracts in Turkish and English, main text, references, tables and subtitles) and justified leaving 3-cm margin from both sides. They should be written in accordance with word processor's page layout settings.

Journal Agent Online Article Collection and Evaluation System is being uploaded online, Article and Abstract Information, Information about Institute, Author Information, Responsible Author Information, Article Title, Article Turkish and English Summaries of the Article, Turkish and English Key Words, NoteEdit, File Upload (Full Text - References – Table(s) - Pictures - Graphics – Notes to the Editor) are recorded separately step by step in the system.

The authors are kindly requested to submit their ORCID numbers obtained the website from www.orcid.org and indicate them in the relevant area at this stage. Abstract and full text should not containinformation about the individuals and institutions participating in the study.

The files must be loaded in the following order.

- The electronic article file (Full Text) should be named with the title of the article in capital letters. They should only include "Title (Turkish-English) - Short Title (Turkish-English)", "**Introduction**", "**Materials and Methods**", "**Results**", "**Discussion**", "**Acknowledgement** (if) - **Conflict of Interest**". Each of the sections should be presented on separate pages. The titles of the text sections should appear at the left of the page with capital letters. All pages should be numbered sequentially from the bottom right corner.
- The file "**References**" should be recorded separately
- **Tables** should be prepared and written double-spaced on a separate sheet, and the number and title of each table must be written on top of the table. If abbreviations are given in the table, these abbreviations should be written in alphabetical order as subheadigs. . When previously printed or electronically published tables are used, written permission must be obtained from both the author and the publisher, and it must be sent by fax or mail to the editor of the journal.
- F**igures, graphics, illustrations, photos** and **legends** should be written double-spaced on a separate sheet. If the abbreviations are given in figures, graphics and illustrations, the expansions of these abbreviations should be written under the subtitle and in alphabetical order. When previously printed or electronically published figures, graphics and images are used, written permission must be obtained from both the author and the publisher, and this must be sent by fax or mail to the editor of the journal.
- **Copyright transfer form**

Authors must declare that all or part of the material in the manuscript has not been published and is not currently being evaluated elsewhere for publication. Each author must declare that he/she participated in the investigation enough to share the responsibility of its content.

This participation may involve the following issues:

- Creation of concepts and designs of experiments,
- Collection, analysis or expression of the data;
- The preparation of the draft of the mauscript or the review of the scientific content
- Approval of the final format of the manuscript ready for publication
- Ethics committee approval letter
- Original articles and review articles should not exceed 10, case reports 4, letters to editors 1 page (excluding references, tables and graphics).

In the manuscript, the sections and contents of the manuscript should be presented as follows.

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Anaesthesia and Intensive Care Society

Title: A short title should be used whenever possible. The title of the research, and review articles should not exceed 95 characters (each letter, space, and punctuation marks are considered as one character), in case of case reports, letters and presentations of surgical techniques it should not contain more than 80 characters. Abbreviations should not be used in the title. The title should be written in Turkish and English. A short title should be added as a subtitle which should not exceed 40 characters.

Funds and organizations supporting the research should be mentioned here, If the study is planned to be presented in any congress or if it has been presented before, the name, place, and date (day-month-year) of the congress should be written.

The abstracts should not exceed 250 words in the research papers Headings should not be used in summaries (the English translation of the title should be written on the title page). Abstract in Turkish should consist of four subheadings as While abstract in English should include subheadings of Aim, Material and Method, Results, and Conclusion) In case reports and review articles donot contain these sections, and abstracts should not exceed 100 words. English title, and abstract should be. English title and abstract should be word by word translation of the Turksih abstract. Letters to editor, and Editorials do not require abstracts.

Use of abbreviations should be avoided as much as possible in summaries. If absolutely required, abbreviation should be used after its definition is provided in parenthesis at the first mention of the term. Reference should not be used in the abstract.

Key words: In accordance with "Index Medicus Medical Subject Headings (MeSH)" there should be no more than five key words under the summary written both in Turkish and English. Available terms can be used if there is no appropriate term for the "Index Medicus" medical subject headings for the newly entered terms.

Introduction: The general conditions of the study settings, the structure and significance of the problem, the specific objective of the study or research tested in the study or observation should be clearly indicated. The primary and secondary objectives of the work should be clearly stated and the predefined subgroup analyzes should be transferred. Only references related to the topic should be used and the data or results of the presented work should not be included in these references.

Material and Method: The informed consent of the patient and the approval of the ethics committee should be acknowledged. A statement must be added that the informed consent was obtained from each participant in clinical trials. It should be noted in experimental studies that all animals were subjected to a humane treatment in accordance with the Guide for the Care and Use of Laboratory Animals (www.nap.edu/catalog/5140.html).

Definition of optimal working conditions, exclusion criteria and referenced population; the participants in the observational or experimental study must be clearly indicated. Since the relevance of the variables such as age and gender for the purpose of the research is not always obvious, the authors should explain the purpose of using these variables in a research article. The main principles that determine how and why the study is performed using such a method should be clear. References should be shown for established methods, brief descriptions should be given for new methods.

The methods, tools (manufacturer's name and address are written in parentheses) and the operations performed should be described in detail to the extent of interpretation of the results. The initials of the drug names should be in lower case, the pharmacological names of the drugs should be used and at their first mention in the text they should be written in brackets in the following order"Generic name, trade name, and Manufacturing firm ". Example: "midazolam (Dormicum, Roche)". The terms should be written in their explicit forms at their first mention in the text, and then their abbreviations (if any) should be enclosed in parentheses. Frequently used abbreviations should be used as accustomed (iv, im, po and sc). Units must be used in compliance with the International system of units (SIU (Le Système international d'unités),Examples: mg / kg, mL / kg, mL / kg / min, mL / kg.

Statistical methods should be provided in sufficient detail so that the readers can reach the original data and evaluate the reported results. Findings should be measured as much as possible and the appropriate margin of error and uncertainty (such as confidence intervals) should be indicated. It is important to avoid relying only on the p-values of statistical hypothesis measures that are insufficient to convey important information about the dimensions of the effects. P values must be given explicitly. Statistical terms, abbreviations and symbols should be defined. In the last paragraph of this section, statistical analyses used, and the values given by the (±) sign after the arithmetic mean or proportion should be indicated.

Results: The findings, tables and visual material obtained in the study should be written in the order of a certain logic so that the most important ones will take precedence in the text. Graphics, tables, illustrations, and figures should be numbered according to the order of their mention in the text, and should be indicated in parentheses in the text. Data contained in the tables and visual materials should not be repeated in the text. Only important observations should be emphasized or summarized. Tables and figures are placed collectively after the last reference at the end of the text. Only the top title of the table, and graphic or the subheading of figures, illustrations, photos are written in their appropriate places in the text.

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GKDA Derg 2025;31(3):105-111
Doi: 10.14744/GKDAD.2025.02438

RESEARCH ARTICLE

The Effect of "Prehabilitation" on Patients Who Underwent Thoracic Eras in Our Clinic

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ABSTRACT

Objectives: Enhanced Recovery After Surgery (ERAS) protocols have been developed to reduce postoperative complications and shorten hospital stays. In this study, we aimed to investigate the effects of prehabilitation and the ERAS protocol in patients who underwent thoracic surgery.

Methods: Between May 15, 2022, and February 15, 2023, 80 individuals scheduled for surgery were included in the study. A prehabilitation program was designed for these patients, which consisted of incentive spirometry, endurance exercises, and breathing exercises within the ERAS protocol. After the prehabilitation program, respiratory function tests were repeated, and pre- and post-program values were compared.

Results: The discharge times of patients in the ERAS group were found to be significantly shorter ($p<0.001$). A statistically significant difference ($p<0.001$) was also observed in terms of chest drain removal times. Moreover, when the results of respiratory function tests and the 6-minute walking test before and after prehabilitation were compared, a statistically significant improvement was found in all evaluated parameters following prehabilitation ($p<0.001$).

Conclusion: Prehabilitation is the first step of the ERAS protocol and the least emphasized component in previous studies. Our study highlighted the effect and importance of prehabilitation in thoracic surgery patients undergoing the ERAS protocol.

Keywords: ERAS protocol, prehabilitation, thoracic surgery

Please cite this article as: "Sinan SS, Kurak TU, Soydan D, Balcı Y, Ayan E, Yapıcı D. The Effect of "Prehabilitation" on Patients Who Underwent Thoracic Eras in Our Clinic. GKDA Derg 2025;31(3):105-111".

Introduction

Lung cancer is the leading cause of cancer-related deaths worldwide.[1] The reported postoperative complication rates in lung resections performed due to non-small cell lung cancer range from 9% to 37%.[1–3] In thoracic surgery patients, tests that measure respiratory capacity such as blood gas, RFT (Respiratory Function Test), DLCO, VO2max, and the 6-minute walking test are of great importance in determining preoperative risk and guiding the surgery to be performed if lung resection is planned.[4]

In addition to lung capacity tests, preoperative tests examining the patient's motor functions and muscle strength have begun to be used to determine preoperative risk factors. It is known that the frequency of postoperative side effects increases in the surgical treatment of elderly patients due to limited physiological reserves and the increase in sarcopenia index with age.[5] Additionally, more than half of advanced-stage cancer patients have sarcopenia.[6] Current studies have shown that the presence of preoperative sarcopenia increases the risk of postoperative complications and that survival is worse in sarcopenic patients.

The ERAS (Enhanced Recovery After Surgery) guideline, based on evidence-based practices, was published by the European Society of Thoracic Surgeons (ESTS) with the aim of improving the quality of life of patients after lung cancer surgery and reducing complications and mortality.

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Submitted: June 11, 2025 **Accepted:** August 20, 2025 **Available Online:** September 25, 2025
The Cardiovascular Thoracic Anaesthesia and Intensive Care - Available online at www.gkdaybd.org

Enhanced Recovery After Surgery (ERAS) protocols are derived from the need to minimize hospital stay duration and reduce hospital costs. In the ERAS protocol and current studies, weak preoperative exercise capacity is associated with early and late postoperative complications and survival in curative lung cancer surgery.[7–9] Therefore, we aimed to improve the preoperative respiratory functions of patients undergoing thoracic surgery through "prehabilitation" (preoperative rehabilitation), and consequently to shorten postoperative thoracic drain removal time and the length of stay in hospital and intensive care.

Methods

For our study, 80 patients who applied to the Mersin University Hospital Chest Surgery outpatient clinic between May 2022 and December 2022, who met the inclusion and exclusion criteria, and who were scheduled for elective thoracic surgery were evaluated as the study group. The data of the control group patients were obtained retrospectively from hospital records. Ethics committee approval was obtained for the study by the Mersin University Clinical Research Ethics Committee with the decision numbered 2022/314 dated 11.05.2022. This study was conducted in accordance with the Declaration of Helsinki.

The study was designed as a retrospective–prospective cohort design. After the decision for elective surgery was made for the individuals included in the study, a prehabilitation program was created within the scope of the ERAS protocol routinely applied in our clinic, and the patients were asked to continue breathing and endurance exercises until the date of surgery.

As part of the prehabilitation program, a daily walking schedule was prepared for the patients until their surgery dates, in accordance with their physical capacities. If the patients could walk for 0–5 minutes, they were asked to walk at least twice a day (optimally 3 times). If they could walk for 5–10 minutes, they were asked to walk twice a day. If they could walk for 10–15 minutes, they were asked to walk at least once. If they could walk for 15–20 minutes, they were asked to walk once a day. The patients were also given a program that included shoulder, arm, and leg exercises.

The patients were scheduled to do a daily "Diaphragmatic Breathing Exercise". As part of the exercise, patients were asked to lie down at 45 degrees, hold their breath as long as they could, take a deep breath, and slowly release it while pressing their hands on their abdomen. They were told to repeat this exercise 10 times every hour. In addition, patients were provided with a "Triflow" breathing exercise device and given training on its use. Patients were asked to practice this exercise for 30 minutes a day.

Minimally invasive surgery is the most important perioperative element of the ERAS protocol. In the study group patients to whom we applied the ERAS protocol, a hybrid method was used instead of traditional posterolateral thoracotomy in the lung resection and thoracotomy patient group. In this hybrid approach, a muscle-sparing mini thoracotomy incision with a length ranging from 5 to 8 cm was combined with a videothoracoscopic camera port placed at the level of the 7th intercostal space anterior axillary line.

PET-CT images taken in the preoperative period in 80 patients included in the study were evaluated via PACS (picture archiving and communication systems) CT slices. Right and left psoas muscle densities and areas were calculated at the level of the 3rd lumbar vertebra for the purpose of evaluating sarcopenia. Individuals with a psoas muscle mass below 1436 mm^2 for male patients and below 918 mm^2 for female patients were radiologically evaluated as sarcopenic (Fig. 1).

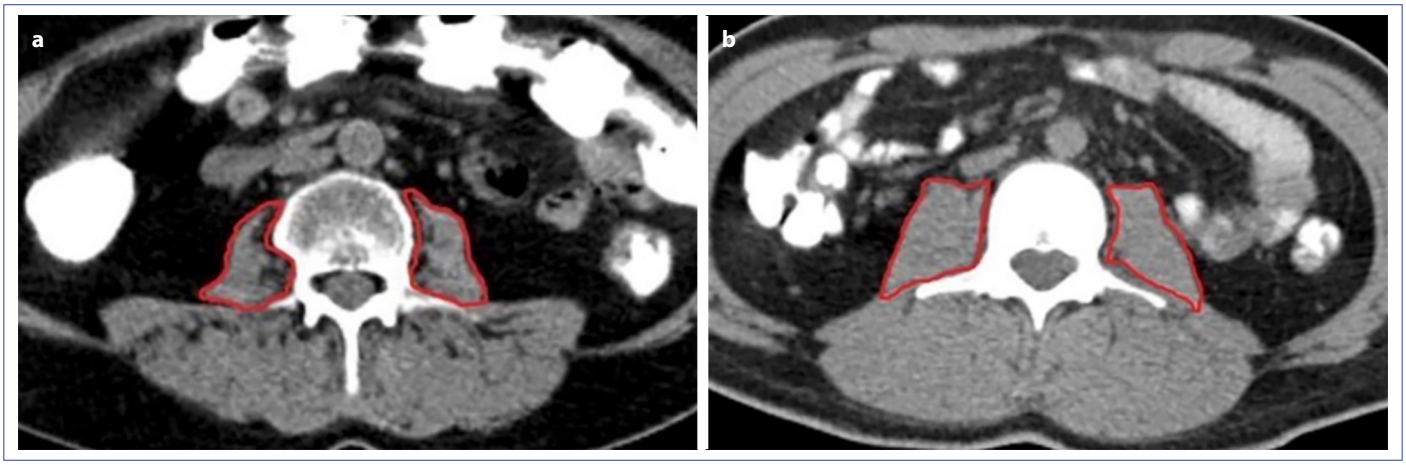

Figure 1. (a) On the left, a CT section taken from the L3 vertebra level of a 56-year-old female patient (Total psoas area: 736 mm^2), and **(b)** a CT section taken from the L3 vertebra level of a 24-year-old male patient (Total psoas area: 2403 mm^2).

CT: Confidence interval.

Table 1. Postoperative hospitalization and drain removal durations of the study group patients

Operation	Average postoperative stay duration (days)	Average intensive care unit length of stay (hours)	Average drain termination time (days)	Case number
Bronchoscopy	1	X	x	7
Mediastinoscopy	1	X	x	6
Tumor excision	10	X	x	3
Thoracotomy	4.81	25.44	3.75	16
Thoracotomy/resection	5.38	33.12	4.04	21
VATS	3.25	25.68	2.70	27
Grand total	4.01	27.84	3.40	80

VATS: Video-assisted thoracoscopic surgery.

The study group that underwent the ERAS protocol was compared with the control patient group treated in our clinic before the ERAS protocol in terms of postoperative hospital stay, need for intensive care, and tube thoracostomy termination time. In our study, the respiratory function tests and 6-minute walking tests of patients who underwent "Prehabilitation" were compared before and after "Prehabilitation".

Data Analysis

The distribution of the data was checked with the Shapiro-Wilk test. Numerical variables that did not provide the normal distribution assumption were summarized as median (25P–75P), and variables that did were summarized as mean±standard deviation. Categorical variables were summarized as numbers and percentages.

In the comparison of two independent groups, the Independent Sample t test was used when the distribution assumption was met, and the Mann-Whitney U test was used when it was not met. For more than two groups, ANOVA (post hoc test: Bonferroni) or Kruskal-Wallis test (post hoc: Dunn) was performed according to the distribution assumption, and Bonferroni correction was applied to p values.

Spearman correlation coefficient was calculated to investigate the relationship between continuous variables. Chi-square test was used to determine the relationship between categorical variables. $p<0.05$ was accepted as the statistical significance level.

The analyses were performed with Statistica v.13.3.1.

Results

In the study group, 21 patients underwent lung resection, 16 patients underwent thoracotomy, 27 patients underwent VATS, 7 patients underwent bronchoscopy, 6 patients underwent mediastinoscopy, and 3 patients underwent soft tissue tumor excision. The control group, which was not subjected to the ERAS protocol and was examined retrospectively, was randomly determined to match the number of the study group according to the type of surgery.

The average length of stay in the study group patients who underwent the ERAS protocol according to the type of operation was found to be 5.38 days for patients who underwent lung resection, 4.81 days for patients who underwent thoracotomy, and 3.25 days for patients who underwent VATS (Video-Assisted Thoracic Surgery). The average length of stay in the control group patients, who did not undergo the ERAS protocol and were operated on by the same surgeon in our clinic in 2019 and 2020, was found to be 9.33 days for patients who underwent lung resection, 7.68 days for patients who underwent thoracotomy, and 6.18 days for patients who underwent VATS. When the discharge times of patients who underwent lung resection, thoracotomy, and VATS were compared, it was found that the patients in the study group were discharged from the hospital in a statistically significant shorter time ($p<0.001$) (Table 1–3).

The mean drain removal times according to the type of operation in the study group patients were found to be 4.04 days postoperatively for lung resection, 3.75 days postoperatively for thoracotomy, and 2.7 days postoperatively for VATS. When the control group patients were evaluated, it was found to be 6.61 days postoperatively for lung resection, 6.31 days postoperatively for thoracotomy, and 4.59 days postoperatively for VATS. A statistically significant difference was found for the thoracic drain termination times for all three types of operations ($p<0.001$) (Table 1, 2, 4).

When the preoperative pre- and post-rehabilitation spirometry and six-minute walk test results of 80 patients who underwent the ERAS protocol were evaluated, after preoperative rehabilitation:

Table 2. Postoperative hospitalization and drain removal durations of the control group patients

Operation	Average postoperative stay duration (days)	Average intensive care unit length of stay (hours)	Average drain termination time (days)	Case number
Bronchoscopy	1.5	x	x	7
Mediastinoscopy	1.2	x	x	6
Tumor excision	10	X	x	3
Thoracotomy	7.68	28.32	6.31	16
Thoracotomy/resection	9.33	42.24	6.61	21
VATS	6.18	27.36	4.59	27
Grand total	6.67	32.4	5.68	80

VATS: Video-assisted thoracoscopic surgery.

Table 3. Comparison of hospitalization durations between the ERAS group and the control group

Operation	ERAS group postoperative hospitalization duration (days)	Control group postoperative hospitalization duration (days)	Difference between the two groups (days)
Lung resection	5.38	9.33	3.95
Thoracotomy	4.81	7.68	2.87
VATS	3.25	6.18	2.93

ERAS: Enhanced recovery after surgery.

Table 4. Comparison of chest tube removal times between the ERAS group and the control group

Operation	ERAS group chest tube termination time (days)	Control group chest tube termination time (Days)	Difference between the two groups (days)
Lung resection	4.04	6.61	2.86
Thoracotomy	3.75	6.31	2.27
VATS	2.7	4.59	1.89

For spirometry values: It was determined that there was a 0.07 L (2.9%) increase in FEV_1 value, a 0.06 L (1.8%) increase in FVC value, and a 1.1 unit (1.38%) increase in the FEV_1/FVC ratio.

For the six-minute walk test: There was a 0.7 unit (0.7%) increase in input saturation, a 2 unit (2.2%) increase in output saturation, a 1.6 unit (27.5%) decrease in the amount of desaturation, and a 15 m (3.4%) increase in walking distance.

When the values before and after the preoperative rehabilitation applied to the study group patients were compared, it was determined that there was a statistically significant improvement in all the parameters evaluated after the rehabilitation ($p<0.001$) (Table 5).

The correlation between total psoas area, spirometry, six-minute walk test, and hand dynamometry results in the study group patients was studied. Data analysis was evaluated with Spearman's rank correlation coefficient.

There was a statistically significant, positive, and good correlation between the handgrip dynamometry test and FEV_1 ($r=0.686$, $p<0.001$), FVC ($r=0.732$, $p<0.001$), total psoas area ($r=0.694$, $p<0.001$), and walking distance ($r=0.476$, $p<0.001$).

There was a statistically significant, positive, and moderate correlation between total psoas area and FEV_1 ($r=0.535$, $p<0.001$), FVC ($r=0.574$, $p<0.001$), and walking distance ($r=0.403$, $p<0.001$).

When the data were examined, it was seen that the total psoas muscle area measurement used in the evaluation of sarcopenia and the six-minute walk test and spirometry tests used to evaluate respiratory functions were statistically significantly correlated.

Table 5. Changes in respiratory parameters before and after prehabilitation

	Average value before prehabilitation	Average value after prehabilitation	Change amount	Percentage of change
FEV_1	2.35 lt	2.42 lt	0.07 lt	2.9%
FVC	3.23 lt	3.29 lt	0.06 lt	1.8%
FEV_1/FVC	72%	73%	%1	1.38%
Walking distance	432 m	447 m	15 m	3.4%
Desaturation rate	5.8%	4.2%	1.6%	27.5%
Input saturation	95.5	96.2	0.7	0.7%
Output saturation	90.2	92.2	2	2.2%

FEV_1: Forced expiratory volume in one second; FVC: Forced vital capacity

There was a statistically significant, positive, and moderate relationship between walking distance and total psoas area (r=0.403, p<0.001), FEV_1 (r=0.572, p<0.001), and FVC (r=0.544, p<0.001); while there was a statistically significant, inverse, and moderate relationship with age (r=-0.416, p<0.001).

Discussion

Lung cancer is one of the leading malignancies causing death worldwide. The only curative treatment option for small cell lung cancer is anatomical lung resection. The patient's cardiopulmonary capacity must be above a certain level for them to tolerate lung resection.[10] Approximately 37% of patients suitable for anatomical lung resection due to lung cancer cannot undergo surgery because of limitations in respiratory functions.[11]

The ERAS protocol has been adapted for other surgical disciplines based on evidence that it accelerates postoperative recovery, reduces hospital stay, and decreases morbidity.[12] The Thoracic ERAS program includes three main sections: preoperative, intraoperative, and postoperative. The intraoperative phase includes minimally invasive surgery and optimal analgesia. The postoperative phase includes pain control, early mobilization, early oral intake, and the prevention of nausea and vomiting. The preoperative period involves nutritional support, counseling, correction of anemia, and prehabilitation.[13]

Prehabilitation is a comprehensive set of rehabilitation programs aimed at increasing patients' respiratory and physiological capacities during the preoperative period. It starts with the clinic examination where the surgical decision is made and continues until the day of the operation.[14] In this study, we aimed to emphasize the preoperative rehabilitation phase, which is perhaps the least highlighted but one of the most important phases of the ERAS protocol in the literature.

In our study, patients in the ERAS group underwent a prehabilitation program lasting an average of 10 days. Evaluation of the preoperative and post-rehabilitation spirometry and six-minute walk test results of 80 patients who underwent the ERAS protocol revealed statistically significant increases in FEV_1, FVC, and FEV_1/FVC after preoperative rehabilitation (prehabilitation). The six-minute walk test results also showed an average increase in walking distance of 15 m, which was statistically significant. As seen in our study, sarcopenia has been observed to coexist, particularly in older patients. Initiating breathing and muscle exercises in patients is believed to be beneficial by increasing muscle activation and respiratory capacity, especially in sarcopenic patients.

The duration of traditional pulmonary rehabilitation typically varies between 8–14 weeks.[10] However, since chest surgery operations are mostly performed due to malignancies, long rehabilitation programs are not suitable for many chest surgery patients. Many associations, including the British Thoracic Society, advocate that lung resection surgery for lung cancer should not be postponed for more than 4 weeks.[15]

In our study, we found that there was a statistically significant increase in the vital and exercise capacity of patients with prehabilitation, which is consistent with the literature. When compared with the current literature, it was observed that the improvement in vital capacity and exercise capacity was statistically significant in our study, but the improvement in respiratory functions was less compared to other studies. We think that this situation is related to our short preoperative rehabilitation period. In the studies in the literature, the prehabilitation period was determined as an average of 4 weeks.

In our clinic, 16 out of 80 patients in the study group who underwent surgery were found to be sarcopenic in their radiological imaging. Fourteen of these 16 sarcopenic patients were observed to have decreased muscle strength

in the hand dynamometry test. All patients with decreased muscle strength in the hand dynamometry test were also observed to be sarcopenic radiologically.

In our study, a positive, statistically significant, and moderate correlation was observed between total psoas area, FEV_1, FVC, and walking distance values. In line with the literature, it was observed that sarcopenia values and respiratory function values were correlated in our study. This suggests that sarcopenia and decreased muscle strength may be important indicators in terms of postoperative complication risks.

In our study, the patient group operated on by the same surgeon and treated with the ERAS protocol and the patient group not treated with the ERAS protocol were compared in terms of postoperative hospitalization time, intensive care unit stay, and chest tube termination time. There was no significant difference between the ERAS and non-ERAS groups in terms of age, gender, and type of operation. However, when the ERAS and non-ERAS groups were compared, it was determined that chest tube termination time and postoperative hospitalization time were statistically significantly shortened in the patient groups that underwent lung resection, thoracotomy, and VATS. No significant difference was found between the two groups in terms of intensive care unit stay.

It was observed that the postoperative hospital stay was shortened by an average of 4 days in the resection patients who applied the ERAS protocol, 2.8 days in the thoracotomy group, and 2.9 days in the VATS group. When all types of operations were included, the average hospital stay was reduced by 2.6 days, and the chest tube termination time was improved by an average of 2 days. The best improvement in postoperative hospital stay according to the type of operation was in the resection and thoracotomy patient groups.

In the study group patients to whom we applied the ERAS protocol, the hybrid method was used instead of traditional posterolateral thoracotomy in the lung resection and thoracotomy patient groups. In the study conducted by Yamamoto et al.,[16] no significant difference was found between the hybrid approach and the 3-port VATS approach in terms of bleeding, chest tube termination time, and postoperative hospital stay in patients who underwent anatomic lung resection.

In a study conducted by Senturk et al.,[17] they particularly emphasized the "awareness" aspect of Thoracic ERAS for clinicians and noted that even considering the implementation of the ERAS protocol contributes to the success of perioperative care.

With the ERAS protocol, the postoperative hospitalization period of our study patients was statistically significantly shortened in accordance with the current literature. With the ERAS protocol, prehabilitation was applied to the patients, and they entered the operation more prepared in terms of mental and exercise capacity. The thoracotomy incision was reduced, and a muscle-sparing hybrid incision was applied. The traditional approach in chest tube termination criteria was abandoned, and chest tubes were removed earlier in line with ERAS recommendations. After discharge, none of the study group patients required rehospitalization. Although our prehabilitation period can be considered short, significant improvements were obtained in patients' respiratory and exercise capacity in this short time. It was observed that prehabilitation provided meaningful benefits in hospitalization period and morbidity.

One of the limitations of our study is that all ERAS group patients were selected and planned from a recent period (2022), while the patients in the control group were selected and planned from the 2019–2020 period.

Conclusion

Prehabilitation, the first step of the ERAS protocol, is the stage where standardization has still not been equally achieved across centers. While its importance has not been sufficiently emphasized in studies conducted to date, it is a crucial step for accelerating recovery. Considering the results obtained in our study, prehabilitation becomes even more significant, especially in surgeries with high mortality and morbidity rates, such as thoracic surgery.

Disclosures

Ethics Committee Approval: The study was approved by the Mersin University Clinical Research Ethics Committee (no: 2022/314, date: 11/05/2022).

Informed Consent: Informed consent was obtained from all participants.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study received no financial support.

Use of AI for Writing Assistance: No AI technologies utilized.

Authorship Contributions: Concept – E.A., D.Y., Y.B.; Design – E.A., S.S.S.; Supervision – E.A., S.S.S., D.Y.; Materials – S.S.S., Y.B., E.A.; Data collection and/or processing – S.S.S., Y.B., D.S.; Analysis and/or interpretation – E.A., S.S.S., T.U.K.; Literature search – S.S.S., E.A., T.U.K.; Writing – S.S.S., T.U.K., E.A.; Critical review – D.Y.

Peer-review: Externally peer-reviewed.

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Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

GKDA Derg 2025;31(3):112-117
Doi: 10.14744/GKDAD.2025.63825

RESEARCH ARTICLE

Acute Kidney Injury Following Congenital Heart Surgery and Its Associated Risk Factors

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ABSTRACT

Objectives: This study aimed to determine the incidence of acute kidney injury (AKI) and identify risk factors associated with its development in pediatric patients undergoing congenital heart surgery with cardiopulmonary bypass (CPB).

Methods: A prospective study was conducted between May 1, 2022, and May 1, 2023, in a pediatric cardiac intensive care unit. Children under 16 years of age who underwent congenital heart surgery with CPB were included. Postoperative AKI was classified using the pRIFLE criteria. Various clinical and perioperative factors were analyzed for their association with AKI.

Results: A total of 640 patients were included, with a median age of 12 months (IQR 6–24); 52% were male. AKI occurred in 24% of patients: 10% were classified as "Risk," 10% as "Injury," and 4% as "Failure." Patients with AKI had significantly longer durations of mechanical ventilation, ICU and hospital stays, and higher mortality rates. Independent risk factors for AKI included prolonged CPB time (>120 minutes), age<6 months, preoperative pulmonary hypertension, low preoperative serum albumin (<3.5 g/dL), STAT score≥3, red blood cell transfusion>50 mL/kg, and inotrope score≥8.

Conclusion: AKI is a frequent and serious complication after congenital heart surgery. Several modifiable and non-modifiable risk factors contribute to its development, emphasizing the need for early risk stratification and preventive strategies in high-risk pediatric patients.

Keywords: Acute kidney injury, children, congenital heart surgery

Please cite this article as: "Güzelbağ AN, Karaoğlu AS, Genç HZ, Çoban Ş, Sağlam S, Recep E, et al. Acute Kidney Injury Following Congenital Heart Surgery and Its Associated Risk Factors. GKDA Derg 2025;31(3):112-117".

Introduction

Acute kidney injury (AKI) is a common complication observed in the intensive care unit following congenital heart surgery in pediatric patients. Various studies have reported an incidence ranging between 20% and 50%, with higher rates noted in neonates during the postoperative period.[1,2]

The presence of AKI is associated with poor surgical outcomes. It contributes to increased morbidity by potentially progressing to chronic kidney disease, prolonging mechanical ventilation and ICU stays, and increasing healthcare costs.[3,4]

Several risk factors have been identified in the development of AKI in these patients, including prematurity, younger age, high-dose inotropic support, prolonged CPB time, degree of hypothermia, greater surgical complexity, and the presence of postoperative low cardiac output syndrome.[5]

Different scoring systems such as pediatric RIFLE (pRIFLE) criteria—Risk, Injury, Failure, Loss, and End-stage renal disease, KDIGO (Kidney Disease: Improving Global Outcomes), and AKIN (Acute Kidney Injury Network) are used to evaluate AKI. The pediatric RIFLE (pRIFLE) criteria are commonly utilized for assessing AKI in critically ill

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Submitted: June 27, 2025 **Accepted:** June 28, 2025 **Available Online:** September 25, 2025

The Cardiovascular Thoracic Anaesthesia and Intensive Care - Available online at www.gkdaybd.org

pediatric populations and have been shown to reliably indicate AKI incidence in various studies.[1–3]

This study aimed to investigate the incidence of AKI and the risk factors affecting its development in pediatric patients undergoing congenital heart surgery with cardiopulmonary bypass.

Methods

Study Design and Patient Selection

Our study was a single-center, retrospective study. The study was designed in accordance with the tenets of the Declaration of Helsinki and obtained the necessary approval from the local ethics committee (Ethics Committee of Istanbul Basaksehir Çam and Sakura City Hospital, University of Health Sciences of Türkiye, Protocol Code: 2022/166, date: 25.05.2022). This prospective study was conducted between May 1, 2022, and May 1, 2023, and included pediatric patients under the age of 16 who were followed in the pediatric cardiac intensive care unit and underwent congenital heart surgery with cardiopulmonary bypass. Data were obtained from the hospital's electronic medical records system. Patients with a history of kidney disease or those who had received peritoneal dialysis or hemodialysis prior to surgery were excluded from the study.

Clinical and Laboratory Parameters

- Preoperative data included patient weight, sex, diagnosis of heart disease (cyanotic & acyanotic, single ventricle & biventricular), and laboratory values such as serum creatinine (Cr) and blood urea nitrogen (BUN).
- Intraoperative data comprised CPB time, aortic cross-clamp time, and surgical complexity scores based on the Society of Thoracic Surgeons-European Association for Cardio-Thoracic Surgery (STAT) classification.
- Postoperative data included intensive care unit monitoring outcomes such as serum creatinine, BUN, lactate levels, duration of mechanical ventilation, mortality, morbidity, vasoactive-inotropic score (VIS), and data from classification systems used to evaluate AKI (RIFLE criteria).

All operations were performed by one of four surgeons experienced in pediatric cardiac surgery for over ten years with more than 150 surgeries per year. Midazolam (0.1–0.3 mg/kg) and fentanyl (1–2 µg/kg) were used for induction of anesthesia. Anesthesia was maintained by inhalation anesthetics or total intravenous anesthesia. For CPB, arterial cannulation was performed in the ascending aorta, and venous cannulations were bicaval or in the right appendage according to the type of surgery. For CPB, high-performance, low prime volume oxygenators were used to reduce the pump priming volume. Modified ultrafiltration was conducted in the operating room during the CPB weaning process.

For the STAT, the scale ranged from 0.1 to 5.0, and a corresponding mortality category level between 1 and 5 was assigned (level 1: 0.1–0.3; level 2: 0.4–0.7; level 3: 0.8–1.2; level 4: 1.3–2.6; level 5: 2.9–5.0).[6] The types and doses of inotropic agents used were recorded, and the daily VIS was calculated for each patient. VIS was calculated using the following formula:

VIS=Dopamine dose (µg/kg/min)+Dobutamine dose (µg/kg/min)+100×Epinephrine dose (µg/kg/min)+10×Milrinone dose (µg/kg/min)+10,000×Vasopressin dose (µg/kg/min)+100×Norepinephrine dose (µg/kg/min).

A VIS score of<8 was considered low inotropic support, while a VIS score of≥8 was defined as high inotropic support.[7]

Acute Kidney Injury and Definitions

The pediatric RIFLE (pRIFLE) classification system was used to define AKI. The pRIFLE criteria are based on the postoperative reduction in glomerular filtration rate (GFR) compared to the baseline GFR. The modified Schwartz formula was used to estimate GFR:

eGFR (mL/min/1.73 m^2)=k×Height (cm)/SCr, where k=0.413, Height=patient height in cm, and SCr=serum creatinine in mg/dL.[8,9]

Baseline BUN and serum creatinine values were taken from laboratory results obtained within 24 hours prior to surgery. Each patient was categorized into a pRIFLE class—R (Risk), I (Injury), or F (Failure)—based on the postoperative decline in creatinine clearance. Class R, I, and F correspond to decreases in GFR of 25%, 50%, and 75%, respectively, relative to baseline values. Patients with a postoperative GFR of<35 mL/min/1.73 m^2 were also classified as class F.[9,10]

Urine output was not used as a criterion for kidney injury due to its susceptibility to intraoperative factors and postoperative diuretic use.

Statistical Analysis

Data were analyzed using SPSS for Windows version 23.0 software. Descriptive statistics were performed in relation to the distribution of variables and characteristics of the study population. Categorical variables were represented as frequencies, and numeric variables as mean or median with the respective measures of dispersion. The Student's t test or the Mann-Whitney test was used in univariate analysis of continuous variables, and the chi-square test or Fisher's exact test was used to analyze categorical variables. A logistic regression model was constructed for multivariate analysis.

Table 1. Characteristics of the study population

Variables	Total n =640		AKI (-) n =486		AKI (+) n=154		p
	n	%	n	%	n	%	
Male	333	52	256	53	77	50	NS
Age (months old)	12 (6–24)		15 (12–18)		6 (4–8)		**0.030**
Weight (kg)	7.2 (6–8.4)		8.5 (7.5–10)		5.5 (4–7.5)		**0.020**
Newborn	256	40	166	34	90	58	**<0.001**
Genetic disorders	39	6	24	5	15	9.7	NS
Cyanotic heart disese	256	40	191	39	65	42	NS
Single ventricle	192	30	152	31	40	26	NS
Preoperative pulmonary hypertension	220	34	145	29	75	48	**<0.001**
Preoperative use of nephrotoxic drugs	133	20	95	19	38	24	NS
Creatinine (mg/dL)	0.40 (0.36–0.44)		0.42 (0.38–0.45)		0.38 (0.36–0.40)		NS
Preoperative Albumin (g/dL)	3.9 (3.7–4.2)		4.1 (3.8–4.5)		3.6 (3.4–3.8)		**<0.001**
POD1 albumin (g/dL)	4.1 (3.9–4.3)		4.1 (3.9–4.3)		4 (3.8–4.2)		NS
Preoperative hematocrit (%)	35.5 (33–37)		36 (32–40)		34 (30–38)		**0.003**
POD1 Hematocrit (%)	34 (32–36)		34 (30–36)		35 (33–38)		NS
Platelet count ($\times 10^3/\mu L$)	310 (300–320)		310 (280–340)		320 (300–340)		NS
Lactic acid (mmol/L)	1.8 (1.6–2)		1.8 (1.5–2.1)		1.9 (1.7–2.2)		NS
STAT score ≥3	320 (50)		224 (46)		96 (62)		**<0.001**
CPB time (min)	105 (110–115)		100 (90–110)		130 (110–150)		**<0.001**
Aorta cross clamp time (min)	55 (50–65)		50 (40–60)		65 (55–75)		**0.025**
Packed red blood cells (ml/kg)	40 (30–50)		30 (20–40)		55 (45–65)		**<0.001**
Total circulatory arrest	5	0.8	3	0.6	2	1.3	NS
Fresh frozen plasma (ml/kg)	15 (10–20)		10 (5–20)		25 (20–35)		**<0.001**
Platelet concentrate (ml/kg)	0 (0–5)		0 (0–5)		0 (0–10)		NS
Intraoperative urine output (ml/kg)	15 (12–18)		14 (12–16)		15 (11–18)		NS
Total fluid intake during postoperative three days (ml/kg/day)	258 (245–270)		260 (220–280)		250 (230–290)		NS
High (≥8) Vazoactive Inotropic score	189	29	97	20	92	60	<0.001
Baseline cerebral NIRS (%)	52 (42–56)		51 (40–58)		50 (41–57)		NS

n (%); Median (IQR). AKI: Acute kidney injury; POD: Postoperative day; STAT: The society of thoracic surgeons-european association for cardio-thoracic surgery; CPB: Cardiopulmonary bypass; NS: Not significant; NIRS: Near-infrared spectroscopy.

Postoperative AKI was defined as the dependent variable. A p value of<0.05 was considered statistically significant.

Results

During the study period, a total of 640 cases were included. The median age was 12 months (IQR: 6–24 months). Of the cases, 52% were male and 48% were female. Forty percent were neonates, and 40% were diagnosed with cyanotic congenital heart disease. According to the pRIFLE classification, AKI was diagnosed in 24% of the cases. In terms of subgroups, 10% were classified as "Risk," 10% as "Injury," and 4% as "Failure." There was no statistically significant variation observed across different types of heart disease. Table 1 shows the characteristics of the population under study. The distribution of specific cardiac diagnoses and their association with AKI incidence is presented in Table 2.

The parameters of the postoperative course are presented in Table 3. In patients with acute kidney injury, neurological complications (18% vs. 2%), days of mechanical ventilation after surgery (3 vs. 1 days), postoperative ICU stay (7 vs. 3 days), length of hospital stay after surgery (13 vs. 9 days), and mortality (13.6% vs. 4%) were significantly higher (p<0.05).

The results of the multivariate analysis identifying predictors of AKI following pediatric cardiac surgery are presented in Table 4. Prolonged CPB time (>120 minutes), age<6 months, neonatal status, preoperative pulmonary hypertension, low preoperative albumin levels (<3.5 g/dL), high STAT scores (≥3), transfusion of packed red blood cells (>50 mL/kg), and a high vasoactive-inotropic score (≥8) were independently associated with postoperative AKI in children undergoing cardiac surgery.

Table 2. Distribution of cardiac diagnoses and AKI Incidence

Cardiac diagnoses	Total		AKI (-)		AKI (+)		p
	n	%	n	%	n	%	
Cyanotic congenital heart disease	256	40.0	191	39.3	65	42.2	NS
Tetralogy of fallot	70	10.9	51	10.5	19	12.3	NS
Transposition of great arteries	45	7.0	32	6.6	13	8.4	NS
Hypoplastic left heart syndrome	25	3.9	16	3.3	9	5.8	NS
Truncus arteriosus	40	6.3	26	5.3	14	9.1	NS
Total anomalous pulmonary venous return	41	6.4	29	6.0	12	7.8	NS
Others*	35	5.5	27	5.6	8	5.2	NS
Acyanotic congenital heart disease	384	60.0	295	60.7	89	57.8	NS
Ventricular septal defect	110	17.2	88	18.1	22	14.3	NS
Arcus hypoplasia / coarctation of aorta	76	11.9	55	11.3	21	13.6	NS
Atrioventricular septal defect	70	10.9	53	10.9	17	11.0	NS
Atrial septal defect	50	7.8	40	8.2	10	6.5	NS
Patent ductus arteriosus	36	5.6	25	5.1	11	7.1	NS
Others**	42	6.6	31	6.4	11	7.1	NS

*: Others in cyanotic group include: Double outlet right ventricle, pulmonary atresia with intact ventricular septum, Ebstein's anomaly, single ventricle variants; **: Others in acyanotic group include: Partial anomalous pulmonary venous return, aortic stenosis, pulmonary stenosis, mitral valve disease, anomalous coronary arterie. AKI: Acute kidney injury; NS: Not significant.

Table 3. Parameters of postoperative course

Variables	AKI (-)		AKI (+)		p
	n	%	n	%	
ECMO	6	1.2	10	6.4	NS
Infection	29	6	11	7.1	NS
Bleeding	15	3	6	3.8	NS
Cardiorespiratory arrest	20	4.1	9	6	NS
Neurological complications	10	2	27	18	**0.005**
Liver complications	5	1	3	1.9	NS
Postoperative pulmonary hypertension	29	6	10	6.4	NS
Arrhythmia	39	8	25	16.2	NS
Delayed chest closure	15	3	27	18	**0.002**
Death	19	4	21	13.6	**0.030**
Days of MV after surgery	1 (0–2)		3 (2–4)		**<0.001**
Postoperative ICU stay (days)	3 (1–5)		7 (5–10)		**<0.001**
Length of hospital stay after surgery (days)	9 (7–11)		13 (10–16)		**<0.001**

n (%); Median (IQR). AKI: Acute kidney injury; ECMO: Extracorporeal membrane oxygenation; ICU: Intensive care unit; MV: Mechanical ventilation.

Discussion

In this prospective study, we investigated the incidence of AKI and the risk factors influencing its development in pediatric patients under 16 years of age who underwent congenital heart surgery with cardiopulmonary bypass at our center. Using the pRIFLE criteria, we identified an AKI incidence of 24%. We found that prolonged cardiopulmonary bypass time (>120 minutes), younger age at surgery (<6 months), presence of preoperative pulmonary hypertension, low preoperative serum albumin levels (<3.5 g/dL), high STAT score (≥3), excessive red blood cell transfusion (>50 mL/kg), and high inotropic score (≥8) were independent risk factors for the development of AKI. Furthermore, AKI was associated with increased morbidity and mortality. Given these findings, our study stands as a significant contribution to the existing literature, particularly due to its prospective design and comprehensive evaluation of perioperative risk factors in a large pediatric cohort.

Table 4. Multivariate analysis: Predictors of acute kidney injury after pediatric cardiac surgery

Variables	Odds ratio	(95% CI)	p
Prolonged CPB time (>120 minutes)	1.6	1.2–2.8	**<0.001**
Age (<6 months)	1.2	1–2.1	**0.02**
Newborn	3.6	2.4–8	**<0.001**
Preoperative pulmonary hypertension	0.9	0.5–1.6	**0.045**
Preoperative albumin (<3.5 g/dL)	0.8	0.6–1.2	**0.030**
STAT scores (≥3)	6	3.2–12	**<0.001**
Packed red blood cells (>50 ml/kg)	0.7	0.4–1.5	**0.040**
High (≥8) vazoactive inotropic score	2	1.2–6	**<0.001**

CPB: Cardiopulmonary bypass; STAT: The society of thoracic surgeons-european association for cardio-thoracic surgery

AKI is one of the most common complications following cardiac surgery in pediatric patients undergoing CPB and is closely associated with postoperative outcomes.[11,12] Depending on the scoring system and biochemical parameters used, the reported incidence of AKI varies between 20% and 50%. In a cohort of 570 patients with a median age of 12 months, Xiao et al.[11] reported an AKI incidence of 36.1%. Graziani et al.,[13] using the KDIGO criteria, found an incidence of 35%. Park et al.[14] reported an AKI incidence of 41.8% in a cohort of 220 patients aged 10 days to 19 years, also based on KDIGO criteria. A large meta-analysis that included 61 studies and a total of 19,680 participants (7,257 with AKI and 12,423 without) reported an overall AKI incidence of 34.3%.[12] In contrast, Cardoso et al.,[9] using the pRIFLE criteria, reported a lower incidence of 12.3% in their cohort.

In our study, the incidence of AKI was found to be 24%. This variability in AKI incidence across studies may be attributed to the heterogeneity of congenital heart defects, differences in patient age distributions, and the use of different scoring systems for AKI evaluation.

AKI adversely affects both short- and long-term outcomes following pediatric cardiac surgery and contributes to increased morbidity and mortality. In the study by Park et al.,[14] patients with AKI had significantly longer durations of mechanical ventilation (median 4.8 vs. 2.4 days), ICU stay (median 7 vs. 4 days), and hospital stay (median 14 vs. 13 days) compared to those without AKI. However, no significant difference in mortality was observed between the groups (1.1% vs. 0%). Similarly, in the study by Graziani et al.,[13] although there was no statistically significant difference in mortality between AKI and non-AKI groups (11.4% vs. 3.7%), the incidence of complications such as bleeding (22.7% vs. 4.9%), neurological complications (18.2% vs. 2.5%), and liver complications (6.8% vs. 0%) was significantly higher in patients with AKI.

In our study, both mortality (13.4% vs. 4%) and the incidence of neurological complications (18% vs. 2%) were significantly higher in patients with AKI. Similar to studies in the literature, we also observed longer durations of mechanical ventilation, intensive care unit stay, and hospital stay in the AKI group.

Risk factors for AKI after cardiac surgery can be classified into two types: renal and extrarenal. The latter includes constitutional, hemodynamic, or inflammatory causes. In pediatric patients, younger age, prolonged CPB time, prolonged ventilation time, pump failure, sepsis, and hematological complications predispose to AKI after cardiac surgery.[3,4,8,15] In the study by Aydin et al.,[2] younger age, higher RACHS-1 (Risk-Adjusted Classification for Congenital Heart Surgery) category, and longer cardiopulmonary bypass time were found to be associated with the development of AKI. In the study by Cardoso et al.,[9] younger age and higher postoperative serum creatinine, blood urea nitrogen, and lactate levels were strong predictors of renal injury in this population. Similarly, in the study by Lee et al.,[4] preoperative serum albumin level, age<12 months, preoperative pulmonary hypertension, and cardiopulmonary bypass duration were identified as risk factors for postoperative AKI in children who underwent congenital heart surgery. In another study involving 840 patients who underwent congenital heart disease (CHD) surgery, prolonged CPB time>120 minutes (adjusted OR [AOR]: 1.87; 95% CI: 1.22–2.88; p=0.004) and hemoglobin>16 g/dL (AOR: 1.80; 95% CI: 1.16–2.78; p=0.008) were found to be associated with the development of AKI in multivariate analysis.[16]

In our study, prolonged CPB time (>120 minutes), younger age at surgery (<6 months), presence of preoperative pulmonary hypertension, low preoperative albumin levels (<3.5 g/dL), high STAT scores (≥3), transfusion of packed red blood cells (>50 mL/kg), and a high vasoactive-inotropic score (≥8) were identified as independent risk factors for the development of AKI.

Limitation

This study has several limitations. First, it was a single-center study with limited follow-up data; therefore, the management practices of our center may not be generalizable to the entire population. Second, there was a wide variety of cardiac surgeries, categorized as cyanotic, acyanotic, and single-ventricle heart diseases, which made it difficult to establish a clear association between the type of surgery and the development of AKI. Third, we used the pRIFLE criteria to determine the incidence of AKI; the use of alternative scoring systems might have resulted in different incidence rates. Lastly, since many patients received diuretics, which could affect the accuracy of urine output as a diagnostic criterion, we did not include urine output in the definition of AKI.

Conclusion

AKI is a common complication following congenital heart surgery and has a negative impact on prognosis. Prolonged CPB time (>120 minutes), younger age at surgery (<6 months), presence of preoperative pulmonary hypertension, low preoperative albumin levels (<3.5 g/dL), high STAT scores (≥3), transfusion of packed red blood cells (>50 mL/kg), and a high vasoactive-inotropic score (≥8) can increase the risk of AKI development.

Disclosures

Ethics Committee Approval: The study was approved by the Istanbul Basaksehir Çam and Sakura City Hospital, University of Health Sciences of Türkiye Ethics Committee (no: 2022/166, date: 25/05/2022).

Informed Consent: Informed consent was obtained from all participants.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study received no financial support.

Use of AI for Writing Assistance: No AI technologies utilized.

Authorship Contributions: Concept – A.N.G., E.Ö., A.C.H., Ş.Ç., S.S.; Design – A.N.G., E.Ö., A.S.K.; Supervision – A.N.G., E.Ö., H.Z.G.; Funding – A.N.G., E.Ö., Ş.Ç., A.S.K.; Materials – A.N.G., E.Ö., S.S.; Data collection and/or processing – A.N.G., E.Ö., A.C.H.; Data analysis and/or interpretation – A.N.G., E.Ö., E.R.; Literature search – A.N.G., E.Ö., S.C., A.S.K.; Writing – A.N.G., E.Ö., E.R.; Critical review – A.N.G., E.Ö., S.S.

Peer-review: Externally peer-reviewed.

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Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

GKDA Derg 2025;31(3):118-123
Doi: 10.14744/GKDAD.2025.80270

RESEARCH ARTICLE

Catheter-associated Bacteremias in Neonates and Infants Following Congenital Cardiac Surgery: A Single-center Experience

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ABSTRACT

Objectives: Congenital heart diseases (CHD) are among the most common reasons for intensive care unit (ICU) admission in neonates and infants. Catheter-associated bacteremias (CAB) can lead to increased morbidity and mortality in these patients. This study aimed to investigate the incidence of CAB and the risk factors influencing its development in neonates and infants undergoing congenital heart surgery.

Methods: This retrospective study included patients younger than 12 months who underwent congenital heart surgery and were monitored in a pediatric cardiac intensive care unit between January 1, 2022, and January 1, 2025. The type, location, duration of catheterization, and associated complications were recorded. Demographic data, clinical characteristics, and outcomes were summarized on a per-patient basis. Each case was matched with two control patients based on age and date of surgery. The results were analyzed statistically.

Results: During the study period, congenital heart surgery was performed in 1,200 patients under the age of 12 months. Catheter-associated bacteremia was detected in 32 cases (2.6%). Among the isolated bacterial agents, 84% were gram-negative organisms and 16% were gram-positive organisms. Independent risk factors associated with CAB were: RACHS-1 ≥ 4 (OR 1.2, 95% CI 1–1.5), central venous catheter (CVC) duration > 10 days (OR 1.9, 95% CI 1.2–5), ECMO support (OR 0.8, 95% CI 0.6–2), and delayed sternal closure ≥ 2 days (OR 0.6, 95% CI 0.4–2). The mortality rate due to catheter-associated bacteremia was 18.7%, which was 5.8 times higher compared to the control group.

Conclusion: Catheter-associated bacteremias are a significant cause of morbidity and mortality in neonates and infants undergoing congenital heart surgery, and the majority are caused by gram-negative microorganisms.

Keywords: Catheter-associated bloodstream infection, congenital heart surgery, pediatric cardiac intensive care unit

Please cite this article as: "Özalp O, Genç HZ, Sağlam S, Recep E, Öztürk E, Hatemi AC. Catheter-associated Bacteremias in Neonates and Infants Following Congenital Cardiac Surgery: A Single-center Experience. GKDA Derg 2025;31(3):118-123".

Introduction

Congenital heart disease (CHD) comprises a group of malformations of varying complexity, with over 300 possible diagnoses and a range of palliative or definitive surgical interventions. These conditions significantly impact morbidity, mortality, and quality of life. Children with CHD may have a distinct risk profile for infections. Pediatric cardiac surgery patients are often neonates or small infants who undergo major surgical procedures and are exposed to the inflammatory and immunosuppressive effects of cardiopulmonary bypass. Additionally, the perioperative period is frequently characterized by the use of multiple invasive devices.[1,2]

The role of transthoracic monitoring lines is well established in patients undergoing corrective or palliative procedures for congenital or acquired heart diseases. These lines are routinely used in many centers, in conjunction with CVCs placed in the neck or femoral vein. Moreover, additional

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Submitted: June 29, 2025 **Revised:** July 31, 2025 **Accepted:** August 13, 2025 **Available Online:** September 25, 2025

The Cardiovascular Thoracic Anaesthesia and Intensive Care - Available online at www.gkdaybd.org

CVCs are increasingly utilized for access, particularly in neonates with complex intraoperative courses, prolonged postoperative recovery, single-ventricle physiology undergoing palliative surgery, or those undergoing cardiac transplantation requiring extended operative times. Central venous catheters may also be necessary for medication infusion, hemodialysis, and parenteral nutrition.[3,4]

Catheter-associated bacteremias (CAB) are a major cause of morbidity and mortality in pediatric cardiac intensive care units. Higher infection rates have been reported with non-antibiotic-coated catheters, multi-lumen catheters, administration of blood transfusions, parenteral nutrition, certain catheter insertion sites and durations, the presence of a gastrostomy tube, and underlying cardiac diagnoses. Additionally, catheter-associated thrombosis has been implicated as a contributing factor to CAB development.[2–5]

There are limited published data on the incidence of CAB in children with congenital heart disease undergoing cardiac surgery. However, it is known that this critically ill population is predisposed to immunodeficiency and disruption of natural barriers to infection. Furthermore, patients undergoing non-elective procedures appear to be at greater risk for developing CAB.[4]

This study aims to determine the frequency of CAB in patients under 12 months of age undergoing cardiac surgery in a pediatric cardiac intensive care unit and to evaluate potential risk factors associated with CAB.

Methods

The study was conducted as a retrospective case-control study on cases under the age of 1 year who were admitted to the pediatric cardiac intensive care unit between January 1, 2022, and January 1, 2025. Our unit is a Level 3 heart center with a capacity of 39 beds, where all congenital heart diseases, except for heart transplants, are monitored and treated.

Patients were divided into two groups: the CAB group and the control group. Our patients' blood cultures for the first 14 days postoperatively were retrospectively reviewed. Microbial growth within the first 2 days after CVC placement was not considered clinically significant, as it was not associated with the central catheter, following previous literature. Patients with microbial growth in blood cultures between days 3 and 14, along with their antibiotic susceptibility test results, were recorded. If the blood culture from CVC was positive, the CVC was removed and sent for culture analysis. We established the diagnosis of CAB in our patients when the following criteria were met: (a) clinical findings correlated, (b) a recognized pathogen was cultured from blood cultures between days 3 and 14, (c) signs were unrelated to an infection at another site, (d) inflammatory blood biomarkers were increased in the laboratory, and (e) a recognized pathogen was cultured from the tip of the catheters.[6] The isolated pathogens were recorded. We defined bacteremia as the isolation of bacterial species from at least 1 blood culture. If multiple episodes of bacteremia occurred in the same patient during the study period, only the first episode was considered for the study. Control patients were admitted to the same pediatric cardiac intensive care unit (PCICU) as case patients, in the same period (range of up to ±30 days) and with the same age range (±10%) but did not develop bacteremia.[7] Two matched control patients were recruited for each case patient.

The study was planned in accordance with the Helsinki Declaration after obtaining approval from the local committee.

Upon admission to the operating room, electrocardiography, noninvasive blood pressure, pulse oximetry, and near-infrared spectroscopy monitoring were performed, and induction drugs were administered. All cases were planned to be extubated in the shortest time possible. In perioperative anesthesia management, the appropriate medications were administered within the framework of the protocol used in the clinic where this study was conducted. According to this protocol, in children aged six months, 0.1 mg/kg midazolam, 1 µg/kg fentanyl, and 0.6 mg/kg rocuronium were administered at induction; and 0.1 µg/kg/minute remifentanil, 5 µg/kg/minute rocuronium, and a minimum of 1–1.2 alveolar concentration sevoflurane were administered for maintenance. In children older than six months, 0.1 mg/kg midazolam, 1 µg/kg fentanyl, and 0.6 mg/kg rocuronium were administered at induction; and 0.25 µg/kg/minute remifentanil, 5 µg/kg/minute rocuronium, a minimum of 1–1.2 alveolar concentration sevoflurane, and 0.5 µg/kg/hour dexmedetomidine were administered for maintenance. The effects of neuromuscular agents were antagonized by sugammadex. Remifentanil and rocuronium were discontinued after the sternum was closed. Sevoflurane was discontinued before the skin was closed. Dexmedetomidine was continued until the patient was transferred to the pediatric cardiac intensive care unit.[8]

After the intubation process, CVC and arterial cannulas were placed by anesthesiologists experienced in pediatric cardiac anesthesia. CVC placement was performed according to the recommendations of the Centers for Disease Control and Prevention, with maximum sterile barrier precautions. The practitioner applied surgical hand

antisepsis procedures, wore a mask, cap, sterile gloves, and gown, and a large sterile drape was used in the field. After swabbing the entry sites twice with 10% povidone-iodine solution, they were allowed to dry. All neonates were administered a 4 Fr 5 cm double-lumen catheter, and the procedure was routinely performed under ultrasound guidance. The choice of catheter localization was made according to the preference of the practitioner. The intensive care dressings for catheters were changed every 2 days or when deemed necessary. Catheter or dressing materials containing self-antiseptics were not used.[6]

A five-component hand hygiene practice is routinely implemented in our unit (CVC insertion and care protocol, solution preparation protocol, unit/patient surface hygiene and cleaning protocol, introduction of a liaison nurse, discussion during handoffs about the need to continue or not with CVC in each patient in the unit).

A data collection form was created for each case. This form included preoperative data (demographic characteristics, preoperative clinical status, cardiac diagnosis, echocardiographic findings, and the presence of syndromes); intraoperative data (use of cardiopulmonary bypass [CPB], duration of surgery, and Risk Adjustment for Congenital Heart Surgery 1 [RACHS-1] score); and postoperative data (length of stay in the intensive care unit and hospital, mortality, presence of a central venous catheter (CVC) for more than 48 hours, and any complications that occurred).

Catheter-related bacteremia was defined according to the Infectious Disease Society of America guidelines.[9] Crude mortality, defined as the rate of death within 30 days of bacteremia, was assessed.[10] The following primary measures were estimated to establish the impact of the program: rate of CVC-related bacteremias/1000 days of CVC use, rate of CVC use/100 patient days, standardized infection ratio (SIR) according to the surveillance definition by the Centers for Disease Control and Prevention (CDC).[9,11]

Bacterial colonies were identified using matrix-assisted laser desorption/ionization-time-of-flight (MALDI-TOF) Microflex LT/SH Smart MS (Bruker Daltonics, Germany) and the MALDI-Biotyper Compass IVD 4.2.90 database. Antibacterial susceptibility testing of bacterial strains isolated from blood samples was performed using Sensitised YeastOne (SYO) kits (Thermo Fisher Diagnostics, The Netherlands) according to the manufacturer's guidelines. Minimum inhibitory concentration (MIC) values were determined after 24 hours of incubation based on the CLSI M27-A4 and M60-2nd edition standards.

This study was conducted in compliance with the Declaration of Helsinki and was approved by the University of Health Sciences Türkiye, Basaksehir Çam and Sakura City Hospital Ethics Committee (Approval Number: KAEK/23.10.2024.22).

Statistical Analysis

The data were analyzed using SPSS Statistics 21. The demographic data were presented as the number, percentage, and median (interquartile range, IQR). Categorical variables between the bacteremia and control groups were compared using the chi-square or Fisher's exact test. Continuous variables were compared using the Mann–Whitney U test. Multivariable logistic regression was used to examine the in-depth associations between the groups and potential variables to identify potential independent predictors. p values of<0.05 were considered statistically significant.

Results

During the study period, a total of 1,200 cardiac operations were performed. The incidence of bacteremia was 21.8 episodes per 1,000 cardiac PICU admissions. The total length of patient stay was 6,900 patient-days, with 4,100 catheter-days, resulting in a catheter utilization rate of 59%. The rate of CVC-related bacteremias was 7.8 per 1,000 catheter-days. The expected number of bacteremia episodes was 45, and the standardized infection ratio (SIR) was calculated as 0.71.

A total of 96 patients, including 32 bacteremia cases and 64 matched controls, were included in the study. The median age of patients with bacteremia was 2 months (IQR 1–3). Fifty percent of the cases were male.

Bacteremia developed a median of 9 days (IQR 6–12) after surgery. Bacteremia species were detected in the blood cultures of 32 out of 1,200 patients (2.6%). Klebsiella pneumoniae (n=12, 37.5%), Enterobacter cloacae (n=5, 15.6%), Pseudomonas species (n=3, 9.3%), Escherichia coli (n=3, 9.3%), Enterococcus faecium (n=3, 9.3%), methicillin-resistant coagulase-negative Staphylococci (n=2, 6.2%), Acinetobacter species (n=2, 6.2%), Stenotrophomonas maltophilia (n=1, 3.1%), and Citrobacter species (n=1, 3.1%) were isolated.

Factors associated with the development of bacteremia in the cardiac PICU were first analyzed by univariable analysis (Table 1). Subsequent multivariable logistic regression analysis identified the risk factors (Table 2) that remained independently associated with CAB: RACHS-1 score≥4 (OR=1.2, 95% CI: 1.0–1.5), duration of central venous catheterization>10 days (OR=1.9, 95% CI: 1.2–5.0), requirement for ECMO support (OR=0.8, 95% CI: 0.6–2.0), and delayed sternal closure≥2 days (OR=0.6, 95% CI: 0.4–2).

The 30-day crude mortality rate for bacteremia was 18.7% (6/32).

Table 1. Demographic and clinical variables for patients with catheter-associated bacteremias patients and control patients

Variables	CAB (n=32)		Control (n=64)		p
	n	%	n	%	
Background ilness	8	25	7	11	NS
Age,months	2 (1–3)		2 (1–3)		NS
Weight,kg	3.9 (3.5–5)		4 (3.6–4.5)		NS
Birth weight (kg)					NS
≥2.5	29 (91)		60 (84)		
<2.5	3 (9)		4 (6)		
Male	16	50	32	50	NS
Genetic syndrome	3	9	5	7.8	NS
Single ventricle physiology	12	37.5	25	40	NS
Cyanotic heart disease	16	50	34	53	NS
Duration of preoperative mechanical ventilation (days)	2 (0–4)		1 (0–2)		NS
CPB use	29	91	60	94	NS
CPB time (min)	90 (80–100)		85 (75–95)		NS
RACHS-1 ≥4	20	62	16	25	**<0.001**
Localization of CVC					NS
Femoral vein	19	59.4	37	57.8	
Jugular vein	10	31.3	22	34.3	
Umblical vein	3	9.3	5	7.8	
Central venous catheter duration (days)	12 (8–16)		5 (3–10)		**<0.001**
Transfusion	29	91	32	50	**0.002**
TPN	16	50	8	12.5	**<0.001**
Duration of TPN (days)	10 (6–14)		2 (1–3)		**<0.001**
ECMO	6	18.8	2	3.1	**<0.001**
Arrhythmias	3	10	7	11	NS
Acute Kidney Injury	5	15	7	11	NS
LCOS	7	21	10	16	NS
Chylothorax	2	6.2	2	3.1	NS
Delayed sternal closure ≥2 days	9	28	2	3.1	**<0.001**
Previous antibiotic use	4	12.5	7	11	NS
ICU stay (days)	18 (15–21)		8 (6–10)		**<0.001**
Post-op hospital stay (days)	30 (25–36)		14 (12–16)		**<0.001**
Mortality	6	18.7	2	3.2	**<0.001**

Median (IQR); n (%). CAB: Catheter-associated bacteremias; CPB: Cardiopulmonary bypass; RACHS-1: Risk adjustment for congenital heart surgery; CVC: Central venous catheter; TPN: Total parenteral nutrition; ECMO: Extracorporeal membrane oxygenation; LCOS: Low cardiac output syndrome; ICU: Intensive care unit; NS: Non-significant.

Discussion

In this study, we investigated the incidence of catheter-associated bacteremia (CAB) and the contributing risk factors in neonates and infants who underwent congenital heart surgery. The incidence of CAB was found to be 2.6%. The majority of CAB cases were caused by gram-negative microorganisms. Independent risk factors associated with CAB included a RACHS-1 score≥4, duration of central venous catheterization>10 days, requirement for ECMO support, and delayed sternal closure≥2 days. Mortality was observed to be 5.8 times higher in the CAB group compared

Table 2. Multivariate logistic regression analysis of factors associated with the development of catheter-associated bacteremias

Variables	p	OR	95% CI
RACHS-1 ≥4	0.01	1.2	1–1.5
ECMO	0.005	0.8	0.6–2
Central venous catheter duration ≥10 days	<0.001	1.9	1.2–5
Delayed sternal closure ≥2 days	0.02	0.6	0.4–2

OR: Odds ratio; CI: Confidence interval; RACHS-1: Risk adjustment for congenital heart surgery; ECMO: Extracorporeal membrane oxygenation.

to the control group. With these characteristics, our study is among the limited number of studies in the literature addressing CAB in this specific patient population.

Hospital-acquired infections remain a major concern across all healthcare settings; however, their consequences may be particularly severe in resource-limited environments of the developing world. Due to budget constraints, the higher cost of care for infected survivors may limit access to surgery for other patients with congenital heart disease. Bloodstream infections are among the most common nosocomial complications, especially in intensive care units. While surgical intervention itself is a risk factor, the use of CVCs in children has been reported to increase the risk of catheter-associated bloodstream infections (CABSI) by approximately 1.0%–3.9%.[12] In a study by Abou Elella et al.[13] this rate was found to be 8.6%. A more recent study reported the incidence of CABSI as 1.5% in neonates and 0.8% in infants.[4] In our study, the incidence of CAB was found to be 2.6%. This variation may be attributed to differences in diagnostic criteria used.

Neonates and infants are at high risk for numerous medical complications. Patients diagnosed with critical congenital heart disease are at an even greater risk due to early invasive procedures and prolonged hospital stays. Reducing potential complications is key to improving adverse outcomes. Defining the incidence of CAB in this population helps promote advancements in catheter care and usage, as well as facilitates the evaluation of current CAB prevention practices and their outcomes. Ruvinsky et al.[11] evaluated cases of CAB in a pediatric cardiac intensive care unit between 2008 and 2018. They reported that, through the implementation of a catheter care program, the bacteremia rate decreased from 11.9 per 1,000 catheter-days in 2008–2009 to 3.8 per 1,000 catheter-days by 2018.

The National Nosocomial Infections Surveillance System (NNIS) surveyed 161,314 patients from 54 general pediatric intensive care units (PICUs) in the United States and reported a mean CABSI rate of 6.6 per 1,000 central line days.[14] In our study, this rate was found to be 7.8 per 1,000 catheter-days.

The spectrum of microorganisms causing CABSI in our PCICU differs from those reported by the NNIS.[14] Gram-negative organisms predominated in 84% of our patients, whereas the NNIS identified gram-positive microorganisms, particularly coagulase-negative Staphylococci, as the primary etiology of CABSI.[14] Other investigators from specialized PCICUs and some general pediatric ICUs have reported findings essentially consistent with ours.[13,15]

Various independent risk factors have been reported for CABSI. In one study, lower patient weight, higher surgical complexity score, open sternum postoperatively, and longer duration of central line use were identified as independent risk factors.[13] Costello et al.[16] reported independent risk factors including operative weight less than 5 kg, Pediatric Risk of Mortality (PRISM) III score greater than 15, receipt of more than three units of blood products, and mechanical ventilation for more than 7 days. In our study, independent risk factors were RACHS-1 score ≥4, central venous catheter duration >10 days, ECMO support, and delayed sternal closure ≥2 days.

The mortality rate was higher among patients with CAB. Haughey et al.[4] reported higher mortality in infected neonates (17.8% vs. 9.7%) and infants (16.6% vs. 1.9%) compared to controls. In a study including 317 cases, mortality was found to be 5.5 times higher in infected patients compared to controls (11% vs. 2%).[13] In our study, mortality was 18.7% in infected patients and 3.2% in those without infection.

Limitations

The main limitations of this study include its retrospective design, single-center setting, and relatively small sample size. The heterogeneity of patient pathologies, differing physiological outcomes, and inclusion of only bacteremia cases also constitute limitations.

Conclusion

Catheter-Associated Bacteremias are a significant cause of morbidity and mortality in neonates and infants undergoing congenital heart surgery. It is predominantly caused by gram-negative organisms. Efforts should be focused on correcting preventable factors to reduce its incidence.

Disclosures

Ethics Committee Approval: The study was approved by the University of Health Sciences Türkiye, Basaksehir Çam and Sakura City Hospital Ethics Committee (no: 23.10.2024.22, date: 07/11/2024).

Informed Consent: Not applicable due to the retrospective nature of the study.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study received no financial support.

Use of AI for Writing Assistance: No AI technologies utilized.

Authorship Contributions: Concept – O.Ö., E.Ö.; Design – O.Ö., E.Ö.; Supervision – O.Ö., E.Ö.; Funding –O.Ö., H.Z.G., S.S., E.R.; Materials – O.Ö., H.Z.G., S.S., E.R.; Data collection and/or processing – O.Ö., H.Z.G., S.S., E.R.; Data analysis and/or interpretation – O.Ö., H.Z.G., S.S., E.R.; Literature search – O.Ö., E.Ö.; Writing – O.Ö., E.Ö.; Critical review – E.Ö., A.C.H.

Acknowledgments: The authors would like to express their gratitude to their colleagues in the Infectious Diseases and Clinical Microbiology departments, whose contributions were instrumental in the management and treatment of our patient cohort.

Peer-review: Externally peer-reviewed.

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Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

GKDA Derg 2025;31(3):124-129
Doi: 10.14744/GKDAD.2025.09581

RESEARCH ARTICLE

Is Blood Transfusion a Trigger for Bloodstream Infections in the Pediatric Burn Intensive Care Unit?

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ABSTRACT

Objectives: This study aims to evaluate potential triggers of bloodstream infections in pediatric patients admitted to burn intensive care units.

Methods: In this retrospective, cross-sectional study, we analyzed data from 70 pediatric patients, aged between 3 and 211 months, who were followed in the Burn Intensive Care Unit of our hospital over a five-year period between 2020 and 2024.

Results: The mean age of the 70 pediatric patients was 79±87 months. The causes of burns were flame in 34%, scalding with hot water in 54%, and electrical burns in 9% of cases. The majority of patients (83%, n=58) had partial-thickness burns. The most commonly affected body region was the trunk (12.96%), followed by the head and neck region (6.21%). Total body surface area (TBSA) burned, length of ICU stay, and number of surgical interventions were higher in the transfused group. The mean pre-transfusion hemoglobin (Hb) level was 8.61 g/dL, which increased to 8.97 g/dL post-transfusion. In total, 29 patients received an average of 6.67 units of erythrocyte suspension (ES) and 4.09 units of fresh frozen plasma (FFP). Blood cultures revealed coagulase-negative *Staphylococci* (CoNS) in five patients and *Acinetobacter baumannii* in another five.

Conclusion: In pediatric patients (aged 0 to 215 months) followed in the Burn Intensive Care Unit, an increase in total body surface area (TBSA) burned is associated with longer ICU stays, a higher number of surgical interventions, increased transfusion of blood components, and a greater incidence of bloodstream infections.

Keywords: Blood transfusion; bloodstream infections; burn intensive care unit; pediatric burns

Please cite this article as: "Kaya B, Yakupoğlu S, Bombacı E, Filinte G, Demirhan R. Is Blood Transfusion a Trigger for Bloodstream Infections in the Pediatric Burn Intensive Care Unit?. GKDA Derg 2025;31(3):124-129".

Introduction

Burn injuries are among the leading causes of accidental death in the pediatric population. The extent and depth of skin damage resulting from burns are critical determinants of clinical severity. Key factors influencing burn-related tissue injury include the temperature of the burning agent, duration of exposure, skin thickness, and the specific mechanism of injury. While scald injuries are generally superficial, flame and electrical burns tend to cause deeper tissue damage. Although burn injuries may initially appear localized, their physiological effects are systemic.

In the acute phase, significant complications may arise, such as immune system suppression, disruption of the skin barrier that increases susceptibility to infections, respiratory involvement in cases of smoke inhalation, cardiac arrhythmias associated with electrical burns, and potential neurological sequelae due to nerve damage. In the medium and long term, patients may experience

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Submitted: May 13, 2025 **Revised:** August 17, 2025 **Accepted:** September 05, 2025 **Available Online:** September 25, 2025

The Cardiovascular Thoracic Anaesthesia and Intensive Care - Available online at www.gkdaybd.org

limb loss, organ dysfunction, joint contractures, aesthetic deformities, and psychological trauma.

Burn injuries are classified based on etiology into scalds, flame burns, electrical burns, contact burns, and chemical burns. Among pediatric patients, scald burns are the most common, followed by flame and electrical burns.

Burn injuries resulting from domestic accidents represent a significant public health concern. The skin serves as the body's first line of defense against microbial invasion. Pediatric burn patients require specialized care due to their unique anatomical and physiological characteristics, which make them more susceptible to complications. Hospitalization rates due to burn injuries vary between countries and are influenced by healthcare reimbursement systems. However, trends in most countries indicate a reduction in the length of hospital stays and an increase in the proportion of patients treated in specialized burn centers.

According to data from the Turkish Statistical Institute (TurkStat), the mortality rate due to external injuries and poisonings in Türkiye increased by 63.53% between 2009 and 2019 compared to previous years. Moreover, TurkStat's 2019 statistics on causes of death reveal that the majority of deaths among children aged 1–17 years (0–215 months) were attributable to external injuries and poisonings.[1]

Children, despite having smaller body sizes, possess a relatively larger body surface area per unit of mass compared to adults. Cardiac function, circulating blood volume, and baseline hemoglobin (Hb) concentrations in pediatric patients are age-dependent, resulting in a higher transfusion volume requirement per kilogram of body weight. An optimal Hb threshold for initiating transfusion in pediatric burn patients has not yet been established. To improve clinical outcomes and patient safety, patient blood management programs have been developed to optimize the use of blood products. Following evidence from prospective clinical trials demonstrating the safety of transfusions at lower hemoglobin thresholds, a restrictive transfusion approach is now advocated in scenarios where the risk of impaired oxygen delivery is increased.[2,3] Recent studies have focused on establishing evidence-based transfusion thresholds for pediatric burn patients who frequently require erythrocyte suspension (ES) transfusions during hospitalization. Considering the immunosuppressive state induced by severe burns and the potential immunomodulatory effects of transfusion, a restrictive transfusion strategy may offer particular benefits in this population. Data from prospective studies in adult burn patients have shown comparable clinical outcomes between restrictive and liberal transfusion strategies.[4–6] Normal hemoglobin (Hb) levels in children vary according to age and differ from adult reference ranges. Newborns typically are born with an Hb concentration of approximately 19 g/dL, which decreases to a nadir of 11.2 g/dL between two and three months of age. Subsequently, levels stabilize around 13 g/dL during later childhood.[7] The increased transfusion rate relative to blood volume in pediatric patients elevates the risk of transfusion-associated metabolic disturbances. These include hyperkalemia, hypomagnesemia, hypothermia, acidosis, and hypocalcemia, which may arise from both transfused erythrocyte suspensions and preservative solutions such as citrate used in blood storage.[8]

Methods

This retrospective cross-sectional study was conducted in the Burn and Wound Intensive Care Unit of Health Sciences University Kartal City Hospital, which consists of six mixed (adult and pediatric) intensive care beds. A total of 70 pediatric patients, aged between 3 and 211 months, who were admitted and treated in the burn center between 2020 and 2024 were included in the study. Patient data were retrospectively obtained through medical records and digital hospital databases.

The variables collected included age, gender, causes of burns, total body surface area (TBSA), burn depths, hemoglobin (Hb) levels at admission to and discharge from the ICU, surgical interventions performed, length of ICU stay (days), mean Hb values before and after transfusion, and microorganisms isolated from blood cultures.

The causes of burns included flame, scalding with boiling water, electrical injury, and exposure to hot oil. The total body surface area (TBSA) affected by burns was recorded based on clinical documentation in patient files. Blood culture samples obtained from treated patients and sent to the medical microbiology laboratory were analyzed using the BacT/ALERT 3D automated blood culture system (BioMérieux, France). Positive cultures were first inoculated onto blood agar, eosin methylene blue (EMB), and chocolate agar media for bacteriological identification and incubated. Colony morphology of the isolated microorganisms was examined by Gram staining, and appropriate biochemical tests (catalase, oxidase, coagulase tests) were performed. Identification and antibiotic susceptibility testing were conducted using the Vitek 2 Compact automated system (BioMérieux, France).

Ethical Approval

Approval was obtained from the Scientific Research Ethics Committee of University of Health Sciences, Kartal Dr. Lütfi Kırdar City Hospital (Approval date: March 26, 2025; Approval number: 2025/010.99/14/18). This study was conducted in accordance with the Declaration of Helsinki.

Table 1. Clinical characteristics of burn patients with and without blood transfusion

Variables	Transfusion group (n=29)		Non-transfusion group (n=41)		Total (n=70)	
	n	%	n	%	n	%
Mean age (months)	98		55		73	
Gender						
Male	23	79.3	25	61.0	48	68.6
Female	6	20.7	16	39.0	22	31.4
Flame burn	15	51.7	9	22.0	24	34.3
Electrical burn	3	10.3	3	7.3	6	8.6
Scald burn (hot water)	11	37.9	27	65.9	38	54.3
Hot oil burn	0	0.0	2	4.9	2	2.9
Inhalation injury	1	3.4	0	0.0	1	1.4
TBSA (%)	32.24		17.66		24.11	
Partial-thickness burn	25	86.2	33	80.5	58	82.9
Partial/Full-thickness burn	0	0.0	5	12.2	5	7.1
Full-thickness burn	4	13.8	3	7.3	7	10.0
Burn ICU length of stay (days)	16.93		4.22		9.49	

Data are presented as mean±standard deviation (SD) or number (percentage). TBSA: Total body surface area; ICU: Intensive care unit.

Statistical Analysis

Data obtained in the study were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Shapiro-Wilk test. Variables with a normal distribution were expressed as mean±standard deviation (SD). Independent samples t-test was used to compare continuous variables between two groups. For variables not showing normal distribution, the Mann-Whitney U test was applied. The distribution of categorical variables between groups was analyzed using the chi-square test or Fisher's exact test when the sample size was insufficient. A p-value of<0.05 was considered statistically significant.

Results

Of the 70 patients, 69% (n=48) were male and 31% (n=22) were female. The mean age of the transfused group was 98 months, whereas the control group had a mean age of 55 months. Flame burns were observed in 24 patients (34%), of whom 63% (n=15) were in the transfused group, and this difference was statistically significant (p=0.021). Only one of these children had inhalation injury. Among 38 children (54%) who sustained scald burns from boiling water, 71% (n=27) did not receive transfusion. There was no significant association between transfusion and exposure to boiling water burns (p>0.05). Of the six patients (9%) with electrical burns, half (n=3) received transfusions while the other half did not. Neither of the two patients (3%) exposed to hot oil received transfusions (Table 1). Burn rates in all regions except the right gluteal and genital areas were higher in the transfused group (Table 2). The most affected areas were the anterior trunk (6.76%) and posterior trunk (6.20%), followed by the head (4.48%). Surgical interventions, including grafting, debridement, fasciotomy, and escharotomy, were significantly clustered in the transfused group (p<0.0001, Table 3).

Table 2. Percentage of body surface area affected by burn

Burn areas	Transfusion group (%)	Non-transfusion group (%)	Total (%)
Head	4.96	4.10	4.48
Neck	2.36	0.98	1.73
Anterior trunk	8.09	5.63	6.76
Posterior trunk	6.74	5.58	6.20
Right upper arm	2.50	1.50	2.03
Right forearm	2.00	1.36	1.74
Right hand	2.07	0.95	1.53
Left upper arm	2.68	1.69	2.15
Left forearm	1.78	1.59	1.68
Left hand	1.59	0.84	1.19
Right thigh	4.09	3.58	3.83
Right leg	3.73	2.91	2.91
Right foot	3.21	1.47	2.34
Left thigh	4.71	2.92	3.85
Left leg	3.35	1.44	2.56
Left foot	2.44	0.81	1.73
Right gluteus	1.88	1.90	1.88
Left gluteus	2.33	1.10	1.77
Genital	0.80	1.00	0.83

Table 3. Comparison of various parameters between transfusion and non-transfusion groups

Parameters	Transfusion group	Non-transfusion group	p
Grafting (%)	2.10	0.05	<0.0001
Debridement (%)	2.00	0.10	<0.0001
Fasciotomy (%)	1.00	0.00	<0.0001
Escharotomy (%)	6.12	0.03	<0.0001
Hemoglobin at ICU admission (g/dL)	13.53	12.17	
Hematocrit at ICU admission (%)	40.14	45.14	
Platelet count at ICU admission ($\times10^3$/μL)	400.6	323.2	
WBC count at ICU admission ($\times10^3$/μL)	21.81	15.43	
Hemoglobin at ICU discharge (g/dL)	9.27	10.69	
Hematocrit at ICU discharge (%)	27.61	48.04	
Platelet count at ICU discharge ($\times10^3$/μL)	368.9	356.4	
WBC count at ICU discharge ($\times10^3$/μL)	11.02	12.07	
Pre-transfusion hemoglobin (g/dL)	8.61	–	
Post-transfusion hemoglobin (g/dL)	8.97	–	

ICU: Intensive care unit; WBC: White blood cell.

The mean hemoglobin (Hb) level upon ICU admission in the transfused group was 13.53 g/dL, which decreased to 9.27 g/dL on the day of ICU discharge. In the non-transfused group, the mean Hb level at ICU admission was 12.17 g/dL and 10.69 g/dL on the day of ICU discharge. Among the 29 patients who received transfusions, an average of 6.67 units of erythrocyte suspension (ES) and 4.09 units of fresh frozen plasma (FFP) were administered. The mean Hb level before ES transfusion was 8.61 g/dL, which increased to 8.97 g/dL post-transfusion (Table 3).

No microorganisms were isolated from blood cultures in the non-transfused group. In the transfused group, a total of 11 microorganisms were isolated from eight patients. Among these, five were *Acinetobacter baumannii*, five were coagulase-negative *Staphylococci* (including *Staphylococcus haemolyticus, Staphylococcus epidermidis, Staphylococcus hominis*), and one was *Pseudomonas aeruginosa*.

Discussion

Burns affecting more than 20% of the total body surface area (TBSA) are classified as severe burns and lead to pathophysiological changes both at the burn site and in distant tissues due to a cytokine storm.[9,10] In our study, a total of 70 pediatric patients were admitted to the burn ICU and monitored over a five-year period. Of these, 29 patients received blood transfusions, while 41 patients comprised the non-transfused control group. Although patient numbers were uneven due to the retrospective nature of the study, the data remain reliable. In both groups, male patients predominated (Table 1). The mean age of patients in the transfused group was higher compared to the control group (98 months vs. 55 months, Table 1).

Children are particularly vulnerable to burn injuries, which constitute the fifth most common cause of non-fatal childhood trauma. Children and women are frequently burned in domestic kitchen accidents involving overturned containers, hot liquids, or stove explosions with open flames. While burn-related mortality rates have declined in high-income countries, they remain approximately seven times higher in low- and middle-income countries.[11] Compared to previous literature, the distribution and prevalence of burn types have changed, which may be attributed to shifts in socioeconomic conditions, heating methods, and improved public education regarding the prevention of childhood burns.

Analysis of burn distribution revealed that 49.1% of burns involved the trunk and extremities, 36% affected the head-face-neck region, 10.3% involved the hands, 3.4% the perineum, and 1.1% affected both the hands and face.[12] In a recent study conducted in Türkiye, one of the few in this field, the mean age of 828 patients was found to be 3.4±4.9 years. Among these, 77.3% sustained scald burns, 9.3% flame burns, and 6.7% electrical burns. The most frequently affected areas were the extremities and trunk (59.1%), head-neck-face (30.5%), hands (19.2%), and perineum (4.7%).[13]

In our study, the most common cause of burns was scalding from boiling water (54%), with children frequently affected while eating or in the kitchen. The second most common cause was exposure to flames (34%). Flame exposure generally resulted from domestic accidents, although some cases occurred during picnics. Among adult burn patients, flame exposure was more often related to occupational hazards, and inhalation burns were more common compared to children. Only one inhalation burn was identified in the pediatric group, which was not severe

and did not result in mortality.

When comparing flame burns to scald burns, we found that patients exposed to flames were more likely to require blood transfusions (Table 1). This was attributed to the larger total body surface area (TBSA) affected and the deeper nature of flame burns. Six children sustained electrical burns while playing with electrical outlets at home. Although the burn incidence was low (0.3–0.5%), careful evaluation is necessary as all tissue layers were affected. Half of these cases required blood transfusion. Two patients suffered burns from hot oil in the kitchen; however, due to the low TBSA involved, surgical intervention was not needed, nor was blood transfusion required.

The percentage of total body surface area (TBSA) played a decisive role in the need for surgical intervention and blood transfusion. Approximately 83% of the patients sustained partial-thickness burns (Table 1). Regardless of burn depth, an increase in affected TBSA was associated with a higher likelihood of requiring surgery and transfusion. Since most injuries resulted from domestic accidents, partial/full-thickness burns (7%) and full-thickness burns (10%) were relatively uncommon (Table 1). Patients who received blood transfusions had an average length of stay in the intensive care unit (ICU) of 16.93 days, compared to 4.22 days in the control group (Table 1).

Regarding the burn locations, the anterior and posterior trunk were the most frequently affected areas, with an average involvement of 12.96%. This was followed by the head (4.48%), right lower extremity (9.03%), left lower extremity (8.14%), right upper extremity (5.3%), and left upper extremity (5.02%) (Table 2). The genital region was the least affected, with an average involvement of 0.83%.

Debridement, escharotomy, fasciotomy, and grafting procedures were performed almost exclusively in the transfused group of burn patients, and this association was statistically highly significant ($p<0.0001$, Table 3). Within the transfused group, a significant correlation was observed between patients' hemoglobin (Hb) levels on the first and last days of their intensive care unit (ICU) stay ($p<0.05$). The mean Hb value at admission was 13.53 g/dL, which decreased to 9.27 g/dL on the day of ICU discharge despite transfusion. In the control group, where no transfusions were administered, the decrease in Hb levels was not statistically significant ($p>0.05$). This finding was attributed to the higher TBSA involvement and the more frequent surgical interventions in the study group.

Optimization of transfusion practices requires a comprehensive understanding of burn pathophysiology, the risks and benefits of transfusion, and appropriate clinical indications. The age of the child also plays a significant role in determining transfusion requirements. Pediatric physiology differs from that of adults and must be taken into account prior to the administration of blood and blood products.[8] In a single-center study conducted by García-Diaz et al.,[14] 27.2% of 147 pediatric burn patients required an average of 8 units of blood transfusion.

In the transfused group, an average of 6.67 units of red blood cell suspension were transfused per patient. The same group received an average of 4.09 units of fresh frozen plasma per patient. In our study, the difference between pre- and post-transfusion hemoglobin (Hb) levels was not statistically significant ($p>0.05$, Table 3). The mean Hb level before transfusion was 8.61 g/dL, and after transfusion, it was maintained at 8.97 g/dL, reflecting the implementation of a restrictive transfusion strategy. This restrictive transfusion approach did not have an adverse effect on mortality.

Microbial growth was observed exclusively in the transfused group, which was not incidental. As the TBSA affected by burns in pediatric patients increases, the need for surgical intervention, length of stay in the ICU, and risk of blood transfusion also increase. Longer ICU stays in the study group, associated with higher TBSA (32.24% compared to 17.66% in the control group), further elevate the risk of bloodstream infections. Both burn injury and blood transfusion suppress immunity, facilitating the development of bloodstream infections. In one study, bloodstream infections were identified in 1.9% of patients, with CoNS responsible for 40% of the cases, and a reported mortality rate of 1%.[13]

In a multicenter study evaluating blood transfusions in burn patients conducted by Palmieri et al.,[6] bloodstream infections were observed in 24% of 217 participants. Santarelli and colleagues reported that the most common causative agents of bloodstream infections in the pediatric burn intensive care unit were Gram-positive bacteria such as *Staphylococcus aureus* and CoNS, as well as *Pseudomonas aeruginosa*.[15] Our study supports these findings. Among the 11 isolated microorganisms, five were CoNS, five were *Acinetobacter baumannii*, and one was *Pseudomonas aeruginosa*.

In another national study, the average length of stay in the intensive care unit (ICU) was reported as 14 days, with a mortality rate of 2.08%.[16] Advances in ICU resources and surgical techniques have contributed to reductions in morbidity and mortality; however, they have also led to prolonged ICU stays.

Cohort studies investigating changes in transfusion practices in pediatric burn patients have demonstrated that restrictive transfusion strategies do not adversely affect patient outcomes and may be cost-effective. Nevertheless, current transfusion practices and adherence to existing guidelines in pediatric populations have not been

sufficiently studied.[17] We advocate for the implementation of a restrictive transfusion strategy in the pediatric burn ICU.

Conclusion

Children represent a significant proportion of burn injury cases worldwide and often sustain severe injuries requiring critical and surgical interventions. However, critical care capacity in contributing centers is frequently limited, making the improvement of healthcare systems a priority to prevent avoidable mortality and morbidity. Due to age-related physiological differences, variations in body mass proportions, and immature cardiac and immune systems, children have variable and complex transfusion needs following burn injuries. Optimizing the treatment of pediatric burn patients necessitates a thorough understanding of these specific challenges and careful evaluation of the impact of transfusion on patient outcomes.

In pediatric burn intensive care units, the development of bloodstream infections is influenced by older age, increased total body surface area (TBSA), prolonged length of stay in the ICU, and a higher number of surgical interventions. Blood transfusion and bloodstream infections are also integral components of this process.

Disclosures

Ethics Committee Approval: The study was approved by the Kartal Dr. Lütfi Kırdar City Hospital Scientific Research Ethics Committee (no: 2025/010.99/14/18, date: 26/03/2025).

Informed Consent: Written informed consent was obtained from all patients.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study received no financial support.

Use of AI for Writing Assistance: No AI technologies utilized.

Authorship Contributions: Concept – B.K., S.Y., E.B., G.F., R.D.; Design – B.K., S.Y., E.B., G.F., R.D.; Supervision – B.K., S.Y., E.B., G.F., R.D.; Funding – B.K., S.Y., E.B., G.F., R.D.; Materials – B.K., S.Y., E.B., G.F., R.D.; Data collection and/or processing – B.K., S.Y., E.B., G.F., R.D.; Data analysis and/or interpretation – B.K., S.Y., E.B., G.F., R.D.; Literature search – B.K., S.Y., E.B., G.F., R.D.; Writing – B.K., S.Y., E.B., G.F., R.D.; Critical review – B.K., S.Y., E.B., G.F., R.D.

Peer-review: Externally peer-reviewed.

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Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

GKDA Derg 2025;31(3):130-132
Doi: 10.14744/GKDAD.2025.80664

CASE REPORT

Extravascular Course of Central Venous Catheter: A Rare Subclavian Complication Detected via Thoracoscopy

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ABSTRACT

Central venous catheterization via the subclavian vein is commonly performed due to its advantages, including lower infection rates and greater patient comfort. However, mechanical complications such as malposition may occur. We present a rare case in which a subclavian central venous catheter traversed extravascularly through the thoracic cavity before re-entering the superior vena cava, detected incidentally during video-assisted thoracoscopic surgery. The catheter was successfully removed without complications. This case highlights the importance of verifying catheter placement, as blood aspiration from all lumens does not guarantee correct positioning. In this report, the extravascular course and management of the subclavian catheter in the thoracic cavity during thoracoscopic surgery are discussed.

Keywords: Catheter malposition, extravascular course of subclavian catheter, video-assisted thoracoscopic surgery

Please cite this article as: "Küçükosman G, Yüksel Ayar Ş. Extravascular Course of Central Venous Catheter: A Rare Subclavian Complication Detected via Thoracoscopy. GKDA Derg 2025;31(3):130-132".

Introduction

Central venous catheters (CVCs) are invasive procedures frequently used in many clinical indications such as intensive care, major surgeries, long-term intravenous treatments, and hemodynamic monitoring to provide temporary or long-term vascular access. Although the subclavian vein is frequently preferred due to its advantages such as low infection rate, high patient comfort, and ease of nursing care in central catheter placement, it also carries risks of mechanical complications.[1]

The most common complications during CVC placement include malposition, hemothorax, pneumothorax, cardiac tamponade, vascular erosion, air embolism, and arrhythmia.[2,3] Malposition is one of the mechanical complications that may lead to serious consequences as the catheter advances outside the vessel, into the arterial system, mediastinum, or thorax. According to the literature, 14–81% of all complications are due to malposition.[3,4] The risk of malposition is higher, especially in the right subclavian vein compared to the internal jugular vein (9.1% vs. 1.4%).[5] Superior vena cava (SVC) perforation due to CVC is a rare complication (0.5%) that may result in hemothorax, pneumothorax, or pneumomediastinum. Therefore, it is important to verify the catheter position after the procedure and to recognize complications early.[6,7] In this report, the extravascular course and management of the subclavian catheter in the thoracic cavity during thoracoscopic surgery are discussed.

Case Report

Written informed consent was obtained from the patient for the presentation. A 27-year-old, 55-kg, female patient with a history of smoking and diabetes mellitus, who was scheduled for wedge resection with video-assisted thoracoscopic surgery (VATS) due to a right lung nodule, was evaluated as ASA II. The patient had exertional dyspnea, while other physical examination findings and laboratory tests were normal. The patient was consulted to cardiology due to exertional dyspnea.

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Submitted: July 02, 2025 **Revised:** July 03, 2025 **Accepted:** July 28, 2025 **Available Online:** September 25, 2025

The Cardiovascular Thoracic Anaesthesia and Intensive Care - Available online at www.gkdaybd.org

The patient was taken to the operating room and monitored with routine anesthesia monitoring and Bispectral Index (BIS) monitoring, as well as left radial artery cannulation for continuous blood pressure monitoring. The patient's basal blood pressure was 120/70 mmHg, pulse rate was 75/min, and peripheral oxygen saturation was 98%. After 3 min of preoxygenation with 100% O_2, routine anesthesia induction was performed, and after sufficient muscle paralysis was achieved, the patient was intubated with a 35 Fr double-lumen left endobronchial tube. After the endobronchial tube location was confirmed by auscultation and bronchoscopy, the tube distance was determined. Anesthesia maintenance was provided with 2% sevoflurane in 50/50 O_2/air and 0.05 mcg/kg/min remifentanil infusion at BIS 40–60. After intubation, a triple-lumen CVC was placed in the right subclavian vein in a single attempt by an experienced anesthesia assistant without any problems. Blood flow from all lumens was confirmed by aspiration, the lines were flushed with physiological serum, and the catheter was fixed.

The patient was placed in the left decubitus position and prepared for VATS. During thoracoscopic access, the surgeon noticed that the catheter had exited the subclavian vein, advanced into the thoracic cavity, and reached the SVC extravascularly (Fig. 1). The course of the catheter in the thorax and its entry into the SVC were directly observed. Open surgery was performed. After wedge resection, the catheter was removed in a controlled manner by the cardiovascular surgeon by suturing around the catheter (Fig. 2). After bleeding and leakage control, a thoracic tube was placed. At the end of the three-hour operation, the patient was extubated without any problems and taken to intensive care. She was transferred to the ward the next day without any complications.

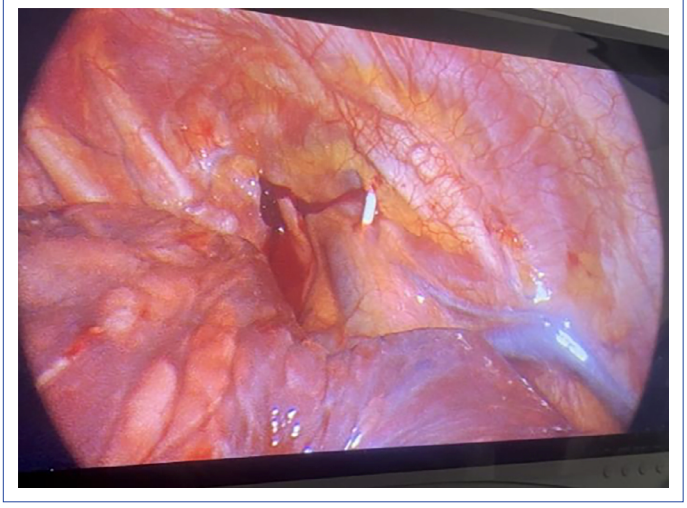

Figure 1. Thoracoscopic view of the CVC.
CVC: Central venous catheter.

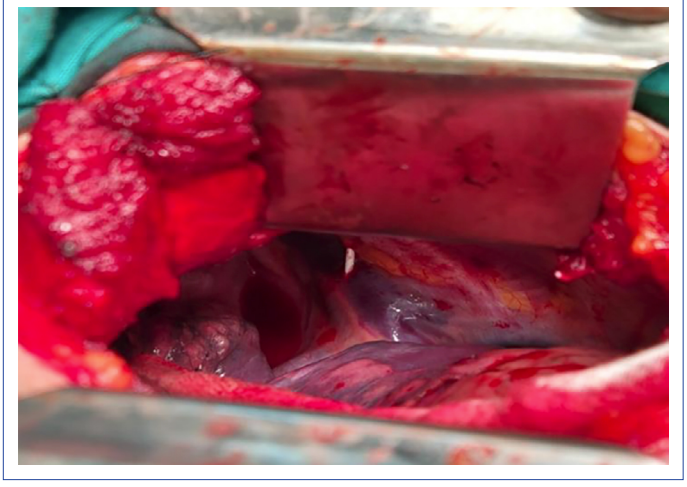

Figure 2. Appearance of the CVC after conversion to open surgery.

Discussion

Central venous catheter application is an invasive procedure that is common in modern medicine but can cause serious complications.[8] Catheter malposition, one of the most common complications of CVC application, can sometimes be asymptomatic.[9] While passage to the internal jugular vein is particularly common in subclavian catheterizations, progression to the thoracic cavity is less common.[10,11] If the catheter does not work and blood cannot be aspirated or infused quickly enough, this may indicate catheter malposition.[12] Hohlrieder et al.[13] reported that aspiration of blood from central catheter lumens does not rule out catheter malposition. In our case, the catheter was placed in a single attempt, and although venous blood return was observed from all lumens, the extravascular course of the catheter was detected during thoracoscopy. The asymptomatic course of the malposition suggests a controlled perforation in the low-pressure venous system. In addition, the short distance advancement of the catheter in the thorax may have prevented serious tissue damage.

Complication rates for CVC placement are 5–19%; therefore, post-procedural radiological confirmation is recommended.[14] However, in some studies, routine radiography was found to be unnecessary in experienced hands and under certain conditions.[14,15] This case shows that a CVC placed with classical techniques can rarely exit the vessel and re-enter the venous structure. In our case, intraoperative observation provided direct diagnosis, no additional imaging was required, and the complication was resolved surgically. This approach can be considered one of the rare clinical situations where the position of the catheter can be directly monitored during the procedure.

Our case suggests that chest radiography may be insufficient in the diagnosis of malposition in central catheters placed outside of thoracic and cardiovascular surgery. Specifically, in this case, the extravascular course of the catheter was so short that it could have been missed on the chest film. It also reminded us that complications may arise not only during catheter insertion but also during removal.

Conclusion

Although blood flow from all lumens during CVC placement suggests that the catheter is in the correct position, this is not always a reliable finding and may delay diagnosis. Therefore, careful technique, operator experience, and the use of additional verification methods when necessary are critical in CVC placement. This case highlights the importance of multidisciplinary coordination and vigilant intraoperative monitoring to optimize outcomes.

Disclosures

Ethics Committee Approval: This is a single case report, and therefore ethics committee approval was not required in accordance with institutional policies.

Informed Consent: Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study received no financial support.

Use of AI for Writing Assistance: We used artificial intelligence for English translation.

Authorship Contributions: Concept – G.K., Ş.Y.A.; Design – G.K., Ş.Y.A.; Supervision – G.K., Ş.Y.A.; Materials – G.K., Ş.Y.A.; Data collection and/or processing – G.K., Ş.Y.A.; Literature search – G.K., Ş.Y.A.; Writing – G.K., Ş.Y.A.; Critical review – G.K.

Peer-review: Externally peer-reviewed.

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Journal of The Cardiovascular Thoracic Anaesthesia and Intensive Care Society

GKDA Derg 2025;31(3):133-134
Doi: 10.14744/GKDAD.2025.47123

LETTER TO THE EDITOR

Cholangiocarcinoma Diagnosed with Pericardial Tamponade: A Diagnostic Challenge

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Please cite this article as: "Kayar Çalılı D, Bölükbaşı D, Kayan T, İzdeş S. Cholangiocarcinoma Diagnosed with Pericardial Tamponade: A Diagnostic Challenge. GKDA Derg 2025;31(3):133-134".

Dear Editor,

Cholangiocellular carcinoma (CCA) is a rare primary liver tumor originating from bile ducts.[1] The aim of this letter is to highlight an atypical presentation of CCA, which was diagnosed through pericardial fluid analysis despite the absence of symptoms and clinical findings in the early stages.

A 64-year-old male patient with no known medical history other than diabetes mellitus (DM) presented to the emergency department with complaints of fatigue and jaundice of three days' duration. His history revealed that his symptoms had developed a few days after starting a recently prescribed metformin+vildagliptin regimen. On examination, he was found to be confused and hypotensive. Laboratory tests revealed elevated transaminase levels (ALT=1311; AST=1199 U/L), impaired renal function (glomerular filtration rate=18 ml/dk/1.73m^2), hyperbilirubinemia (total=7.7, direct=5.5 mg/dL), and acidosis.

The patient was admitted to the intensive care unit (ICU) with a pre-diagnosis of acute toxic hepatitis. He was intubated due to respiratory distress and high vasopressor requirements. Transthoracic echocardiography (TTE) performed to investigate the etiology of shock in the patient with fluid-refractory hypotension revealed the presence of pericardial effusion (PEEF) of 6.5 cm with signs of tamponade, prompting an urgent pericardiocentesis. A large pericardial effusion was confirmed by chest tomography performed in the emergency department. Approximately 1000 mL of hemorrhagic effusion was drained, and cytopathology was performed on the sample obtained. Further investigations were initiated to exclude other potential causes of liver failure.

During follow-up, the patient's transaminase levels declined, and viral hepatitis serology and autoimmune markers were negative. Non-contrast tomography was performed due to acute renal failure. Abdominal CT and USG showed a normal gallbladder, intrahepatic and extrahepatic bile ducts, and only a small amount of perihepatic fluid. However, bilirubin continued to rise rapidly. A control TTE showed a 2 cm PEEF without evidence of tamponade. Cytopathological analysis of the pericardial fluid revealed a poorly differentiated CCA. However, before anatomical and histological classification and metastatic screening could be performed, the patient died in the ICU due to multiple organ failure.

CCA is usually asymptomatic in the early stages, leading to late diagnosis and poor prognosis.[2] The incidence of CCA has been increasing in recent years, and patients typically present to healthcare facilities with symptoms such as abdominal pain, weight loss, pruritus, and changes in stool and urine color.[3] Our patient, however, had no complaints other than fatigue and new-onset jaundice. The acute onset of symptoms after a new drug regimen was initially considered a pre-diagnosis of toxic hepatitis. However, the presence of massive hemorrhagic PEEF necessitated further investigations for differential diagnosis.

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Submitted: July 06, 2025 **Revised:** July 07, 2025 **Accepted:** July 21, 2025 **Available Online:** September 25, 2025

The Cardiovascular Thoracic Anaesthesia and Intensive Care - Available online at www.gkdaybd.org

PEEF can be seen in aggressive malignancies, but it is extremely rare in CCA.[4–6] Malignant PEEF may occur with cardiac tamponade, as seen in our patient.[6] Interestingly, despite a very short symptom onset, our patient had pericardial metastases of CCA.

In conclusion, we believe that this case is important to emphasize that poorly differentiated CCA can cause distant metastases without symptoms.

Disclosures

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study received no financial support.

Use of AI for Writing Assistance: No AI technologies utilized.

Authorship Contributions: Concept – D.K.Ç., S.İ.; Design – D.B., T.K., S.İ., D.K.Ç.; Supervision – S.İ.; .; Materials – D.K.Ç., T.K., S.İ., D.B.; Data collection and/or processing – T.K., D.B., D.K.Ç.; Data analysis and/or interpretation – D.K.Ç.; Literature search – D.K.Ç., S.İ., T.K., D.B.; Writing – D.K.Ç., S.İ.; Critical review – S.İ., T.K., D.B.

Peer-review: Externally peer-reviewed.

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