

Evidence Updates

Challenges in pediatric cardiac emergency care amid nursing and resource shortages in Germany

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ABSTRACT

Objectives: Pediatric cardiac emergency care in Germany faces critical challenges due to ICU bed shortages, rigid healthcare policies, and nursing workforce deficits. The strict adherence to the Paediatric Cardiac Surgery Directive (PCSD) often prevents critically ill children from receiving timely life-saving interventions, as policies restrict their admission to adult intensive care units (AICUs), even in urgent situations.

Study design: comparative cross-national report.

Methods: This study employs a comparative approach, analyzing pediatric cardiac care models in the United Kingdom, New Zealand, and Australia. These countries have implemented flexible, interdisciplinary strategies to address ICU capacity issues, ensuring critically ill children receive timely surgical and postoperative care. Literature from PubMed and national healthcare policy frameworks were reviewed to assess their applicability to Germany.

Results: Findings indicate that integrating pediatric and adult intensive care services, along with flexible policy adaptations, can improve emergency care accessibility. International models emphasize interdisciplinary collaboration, specialized training for adult ICU staff, and structured transitional care for pediatric cardiac patients.

Conclusions: Policy adaptations are required in the German healthcare system to enhance pediatric cardiac emergency care. Implementing flexible ICU admission protocols, cross-disciplinary training, and optimizing resource allocation can bridge critical gaps. A modernized, patient-centered approach is essential to ensuring equitable and timely access to life-saving pediatric cardiac interventions.

1. Introduction

Recently, an 8-year-old patient experienced a traumatic dissection of the left coronary ostium, a critical and life-threatening condition requiring immediate intervention and extracorporeal life support (ECLS-) therapy. Following an emergency catheterization in a major university hospital in Germany, which confirmed the severity of the injury, the need for specialized paediatric cardiac surgery was urgent. However, the child could not receive the necessary surgery immediately due to a lack of available beds in paediatric intensive care units (PICUs) in at least 4 other university hospitals. Attempts to secure a spot in an adult intensive care unit (ICU) were also unsuccessful, as hospital policies strictly prohibited the admission of children into adult ICUs. This policy barrier significantly delayed the timely care the child required, illustrating a critical gap in the healthcare system's ability to flexibly respond to

paediatric emergencies. Finally, the child was admitted to a centre with extensive expertise in paediatric cardiac surgery, and postoperative care was conducted in an adult cardiothoracic ICU until a transfer to a PICU was feasible.

The admission of critically ill children suffering from acute cardiac disease to adult AICUs has become a complex and contentious issue in contemporary healthcare. While the primary practice is to admit children to PICUs,^{1–5} various situations may necessitate the admission of paediatric patients to AICUs.⁶ This report explores the reasons behind such admissions, evaluates outcomes, resource allocation, and potential challenges and reflects our opinion on how to create feasible work-around to broaden a good clinical perspective for these patients.

Germany's healthcare system is lauded for its efficiency and effectiveness, especially in treating complex paediatric conditions such as congenital heart diseases. Governed by the stringent Paediatric Cardiac

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Surgery Directive (PCSD), which is part of the broader SGB (German Social Code Book) version V, the system mandates precise structural and staffing norms for hospitals. Despite these rigorous standards, there are significant challenges, particularly in managing emergency cardiac surgeries for critically ill children, as described above, due to a mismatch between available resources and patient needs.

Thus, this work emphasizes the pivotal role age plays in shaping admission policies. Furthermore, it delves into the ethical and legal dimensions of admitting children to AICUs, emphasizing the need for well-defined guidelines and interdisciplinary collaboration for optimal care. Also, this article sheds light on the specific challenges that the German healthcare system poses for the care of this sensitive patient group in times of nursing or other structural shortages and places them in an international context.

2. Methods

To address these challenges, this comparative cross-national report adopts a comparative approach, examining paediatric cardiac surgery care models in the United Kingdom, New Zealand, and Australia. These countries were chosen because of their innovative and flexible approaches to paediatric intensive care, which might offer viable solutions for Germany. The study involved a review of existing literature from the PubMed Database and healthcare policies from these countries, with a focus on their management of paediatric cardiac emergencies, particularly in scenarios of ICU shortages.

3. Results

The German healthcare system is governed by the SGB V and the guidelines of the Federal Joint Committee (FJC; Gemeinsamer Bundesausschuss, G-BA).⁷ The FJC defines reimbursable healthcare services and issues directives such as the "Paediatric Cardiac Surgery Directive" (PCSD), which mandates structural and personnel requirements for hospitals providing cardiac surgery to children.⁷ Section 1.2.1 of the PCSD requires additional training in paediatric intensive care for nursing staff, which restricts postoperative care for children to paediatric intensive care units (PICUs).

Despite Germany's well-established paediatric cardiac centres and adherence to quality standards through the PCSD, practical limitations emerge, especially during periods of nursing shortages. Critically ill children may be denied admission for emergency cardiac surgery due to unavailability of PICU beds, as care in adult intensive care units (AICUs) is typically not permitted under current directives. This strict adherence to the PCSD may inadvertently lead to treatment delays or denial.

Other Western countries, such as the United Kingdom, Australia, and New Zealand, have developed adaptable care models allowing paediatric patients to be safely treated in AICUs when necessary.^{6,8,9} These systems feature interdisciplinary teams and structured training programs for adult ICU staff to manage paediatric patients.

Comparative data suggest that centralization of paediatric cardiac care improves outcomes, reducing ICU length of stay and mortality.^{3-5,10} However, studies also note that extremely high-volume PICUs may experience diminishing returns in outcomes.⁴ A meta-analysis confirms that organizational factors, including staffing and infrastructure, significantly influence mortality after adjusting for case mix.¹¹

Admission of paediatric patients to AICUs in other countries is guided by well-defined protocols, interdisciplinary collaboration, and ethical considerations.^{6,8,9,12} Observational data from the UK show that performance indicators like the Paediatric Index of Mortality (PIM) function well in adult ICU settings, supporting safe and effective care for this patient group.⁹

4. Discussion

This short communication is intended as a catalyst for international

collaboration, encouraging researchers and clinicians to share current best practices, critically assess systemic shortcomings, and jointly develop flexible models of care that transcend national boundaries. Our article highlights a critical gap in the German healthcare system's ability to flexibly accommodate paediatric patients in urgent need of cardiac surgery, especially in the context of resource shortages. While the PCSD ensures high-quality care through strict regulation, it also contributes to systemic rigidity. In cases where PICU resources are unavailable, children may be denied timely surgery due to lack of viable alternatives in AICUs, despite the presence of trained cardiac surgery teams and appropriate facilities.

In contrast, countries such as the UK, Australia, and New Zealand have proactively addressed similar challenges by integrating paediatric care capabilities within adult ICUs. These nations demonstrate that with proper training, staffing, and policy support, AICUs can safely accommodate paediatric patients. Their models emphasize adaptability, interdisciplinary collaboration, and development of national care protocols.

While a quantitative component would enrich the analysis, it is beyond the scope of this work, as no comprehensive national datasets on pediatric cardiac emergencies in Germany are currently available.

Artificial intelligence offers significant potential to improve pediatric cardiac emergency care by enabling real-time triage, optimizing ICU resource allocation, and supporting rapid, evidence-based decision-making.¹³ AI-driven systems can integrate patient data, predict resource needs, and guide clinical teams in managing critical cases, particularly during capacity shortages. Embedding such technologies within a modernized policy framework could enhance flexibility, reduce treatment delays, and ensure equitable access to life-saving interventions for critically ill children.

In line, recent advances have demonstrated how AI can identify capacity bottlenecks and optimize workflow.¹⁴ Likewise, Multi-objective layout optimization of hospital outpatient clinics based on NSGA-II shows how multi-criteria optimization can improve resource allocation.¹⁵ Applied to pediatric cardiac emergencies, these methods could support "dual allocation" of both human and infrastructural resources—directing appropriately trained staff and ICU capacity (pediatric or adult) to urgent cases in real time.

This requires structured cross-training of pediatric and adult ICU teams, enabling safe care delivery across unit types, and embedding AI-supported allocation systems into operational protocols. Such integration could enhance flexibility during shortages, reduce delays, and ensure timely, equitable access to life-saving interventions. Beside, the integration of predictive analytics into clinical decision-making aligns with our own vision of leveraging innovative methods—such as AI-driven resource allocation and flexible care pathways—to improve timeliness, safety, and equity in pediatric cardiac emergency care.¹⁶

Germany's current legislative and regulatory framework under SGB V and the PCSD does not adequately support transitional or flexible care solutions, as described by the presented case of the 8 year old patient and as suggested in Fig. 1. To address these issues, Germany must consider revising the PCSD to include structured pathways for AICU admission under exceptional circumstances, supported by clear clinical guidelines and interdisciplinary training. This shift would align Germany with international best practices and ensure that children requiring urgent cardiac care are not turned away due to logistical barriers.

Ultimately, successful implementation depends not only on regulatory change but also on the commitment of healthcare professionals across disciplines. A collaborative, flexible, and patient-centered approach—supported by robust training and quality standards—can bridge current gaps and ensure optimal outcomes for paediatric cardiac patients in Germany.

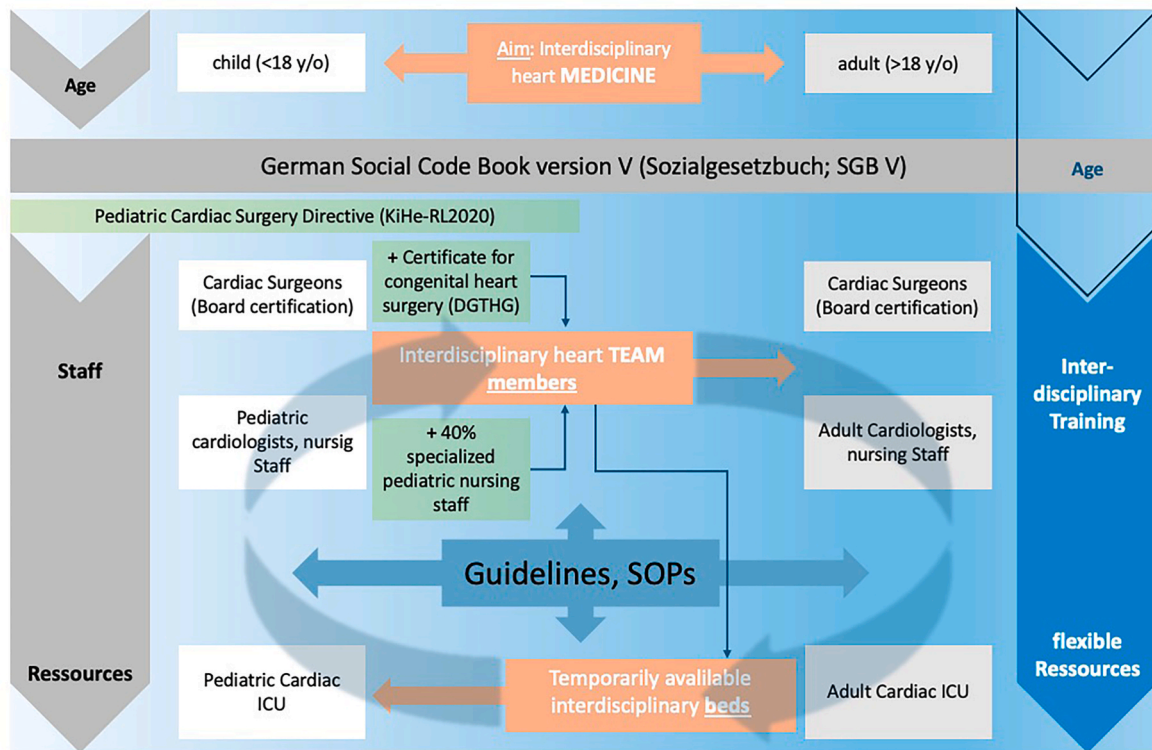


Fig. 1. Schematic overview of the current (left) and proposed (right) application of the Pediatric Cardiac Surgery Directive by the Federal Joint Committee in Germany.

Ethical approval

No ethical approval was required for this study, as no patient data were described.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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