Journal of Cardiothoracic and Vascular Anesthesia 000 (2026) 1–8

Contents lists available at ScienceDirect

Journal of Cardiothoracic and Vascular Anesthesia

journal homepage: www.jcvaonline.com

Special Article

Adding the Missing Link—Integration of Anesthesia and Perfusion Variables into Europe's Largest Congenital Cardiac Surgery Outcomes Database: Methods and First List of Candidate Variables by an ECHSA-EACTAIC-EBCP Collaboration

Sascha Meier, MD, PhD[*,1], Theofili Kousi, MD, PhD[†], Sara C. Arrigoni, MD[‡], Jeffrey P. Jacobs, MD[§], Vladimiro Vida, MD[‖], Attilio A. Lotto, MD[¶], George E. Sarris, MD[**], Filip de Somer, PhD[††], Normunds Sikora, MD, PhD[‡‡], Dedre Buys, MSc[‡], Lindy Liebenberg, MSc[‡], Marloes van Hoeven, MSc[§§], Zdzislaw Tobota, MD[‖‖], Justin B. Long, MD[¶¶], David F. Vener, MD[***], Steffen Rex, MD, PhD[†††,‡‡‡], Gudrun Kunst, MD, PhD[§§§,‖‖‖], on behalf of EACTAIC Paediatric & Congenital Subspecialty Committee Database Group

[*]*Department of Anesthesiology, University Medical Center Groningen, University of Groningen, Groningen, the Netherlands*

[†]*Onassis Cardiac Surgery Center, Athens, Greece*

[‡]*Department of Cardiothoracic Surgery, University of Leiden, University Medical Center Leiden, Leiden, The Netherlands*

[§]*Congenital Heart Center, Division of Cardiovascular Surgery, Departments of Surgery and Pediatrics, University of Florida, Gainesville, FL*

[‖]*Pediatric and Congenital Cardiac Surgery Unit, Department of Cardiac, Thoracic, Vascular Sciences and Public Health, University of Padua, Padua, Italy*

[¶]*Pediatric Cardiac Surgery, Alder Hey Children's Hospital, Liverpool, UK*

[**]*Athens Heart Surgery Institute, Athens, Greece*

[††]*Heart Centre University Hospital Ghent, Ghent, Belgium*

[‡‡]*Pauls Stradins Clinical University Hospital, Riga Stradins University, RSU Red Cross Medical College, Riga, Latvia*

[§§]*Department of Cardiothoracic Surgery, Catharina Hospital, Eindhoven, the Netherlands*

[‖‖]*Pediatric Cardiothoracic Surgery, Children's Memorial Health Institute, Warsaw, Poland*

[¶¶]*Department of Anesthesiology, Emory University School of Medicine and Children's Healthcare of Atlanta, Atlanta, GA*

[***]*Departments of Pediatrics and Anesthesia, Baylor College of Medicine and Texas Children's Hospital, Houston, TX*

[†††]*Department of Anaesthesiology, University Hospitals Leuven, Leuven, Belgium*

[‡‡‡]*Department of Cardiovascular Sciences, KU Leuven–University of Leuven, Leuven, Belgium*

[1]*Address correspondence to* Sascha Meier, MD, PhD, University Medical Center Groningen, Department of Anesthesiology, EB 32, PO Box 30001, Hanzeplein 1, 9700 RB, Groningen, the Netherlands.

E-mail address: s.meier@umcg.nl (S. Meier).

https://doi.org/10.1053/j.jvca.2026.03.023

[§§§]Department of Anaesthetics and Pain Therapy King's College Hospital NHS Foundation Trust, London, UK
[¶¶¶]School of Cardiovascular and Metabolic Medicine & Sciences, King's College London, UK

Objectives: Numerous databases exist in the field of cardiac surgery across Europe, but none of them combine the entire captured data of all clinical specialties involved in the care process of patients, including anesthesia and perfusion. To fill this gap, the European Congenital Heart Surgeons Association (ECHSA) and the European Association for Cardiovascular Anesthesia and Intensive Care along with the European Board of Cardiovascular Perfusion propose to build a database module for Anesthesia and Perfusion data collected during congenital cardiac surgery and interventional procedures and coupling these data within the existing largest congenital cardiac surgery database in Europe—the ECHSA Congenital Cardiac Database (ECHSA-CCDB). This report will review the state of the development of this database module to date and propose an initial set of variables for collection. The report also outlines the methodology to be followed for the final selection of variables and sets a course for the start of data collection. The scope of procedures to be captured includes pediatric cardiac surgery operations with or without cardiopulmonary bypass and interventional cardiology procedures.
Design: Descriptive study/methods study.
Setting: Congenital cardiac surgery/cardiology/anesthesiology.
Participants: Congenital cardiac anesthesiologists, surgeons, and perfusionists.
Interventions: None.
Measurements and Main Results: We discuss a literature review, survey, and panel meetings for the development of an anesthesia and perfusion variables module being integrated into ECHSA-Congenital Cardiac Database by identifying the first set of variables to be available for outcome research in surgical operations and transcatheter interventional cardiology procedures across Europe.
Conclusions: This multisocietal collaboration will lead to the most comprehensive approach to patient outcome research in congenital cardiac surgery and Interventional Cardiology in Europe to date. The article describes the initial concept of the modules and the process steps used to identify candidate variables for anesthesia outcomes in the setting of congenital cardiac surgery.

Key Words: database; pediatric, congenital heart disease; pediatric heart disease; interventional cardiology; cardiac surgery; anesthesiology; perfusion

RECORDING OF VITAL SIGNS during surgery, as first documented by Ernest Codman and Harvey Cushing in 1895, laid the foundation of clinical outcome research in anesthesiology.[1] Merel Harmel's case series of the first 100 Blalock-Taussig-Thomas operations in 1946 is considered as the first large-scale outcome research publication in congenital cardiac anesthesia.[2]

Almost 80 years after these pioneering steps, multiple national quality registration systems and databases for outcome research in congenital cardiac surgery have been established across Europe, such as the National Institute for Cardiovascular Outcomes Research (NICOR) in the United Kingdom,[3] the Swedish Web system for enhancement and development of evidence-based care in heart disease evaluated according to recommended therapies (SWEDEHEART) in Sweden,[4] and the German Society for Thoracic and Cardiovascular Surgery (GSTCVS) registry.[5]

A common limitation of these registries is the lack of input from several other key specialties influencing patient outcome in congenital cardiac surgery, namely, anesthesiology, clinical perfusion, and intensive critical care medicine.

In striving to overcome these limitations in a data registration project for congenital cardiac surgical patients, the European Association of Cardiothoracic Anesthesiology and Intensive Care (EACTAIC), together with the European Board of Cardiovascular Perfusion (EBCP), endeavored in a collaboration to build specialty-specific registration modules to be aligned with the existing ECHSA Congenital Cardiac Database (ECHSA-CCDB), the largest congenital cardiac surgery database in Europe. This will serve to combine data for each patient across surgery, anesthesia, and perfusion.[6]

EACTAIC was founded in 1985 by a multinational group of congenital cardiothoracic anesthesiologists during a symposium in Leiden, the Netherlands. It now has more than 750 members from 27 European Union states, the United Kingdom, nine European Union candidate states and two member states of the European Economic Area (EEA)/European Free Trade Association (EFTA, Switzerland and Norway) and many from non-European global countries.

Organized in Subspecialty Committees, EACTAIC is an international forum in Europe for scientific discussions and the exchange of ideas in the field of cardiothoracic anesthesia and related topics, promoting education and development in this field.[7]

EACTAIC's Paediatric & Adult Congenital Subspecialty Committee has been the initiating committee to reach out to work with the ECHSA and the EBCP to explore possibilities of adding intraoperative anesthesia and perfusion records to develop the ECHSA-CCDB registry, which will combine surgical, anesthesia, and perfusion procedural and outcome data. While the Society for Thoracic Surgeons (STS) Congenital Heart Surgery Database (CHSD) has contained structural anesthesia-related variables since 2010, and the ECHSA-CCDB currently includes data fields for a limited number of anesthesia-related factors.[8,9]

Existing multidisciplinary, multi-institutional databases have been credited with contributing to the significant improvement observed in pediatric cardiac surgical mortality over time.[10,11] Now, looking beyond mortality as the marker

for success, multidisciplinary, multi-institutional databases are necessary to track more factors that may impact other outcomes of interest, including neurodevelopmental outcomes and other markers of quality of life among congenital heart disease survivors.[12]

The relatively low rate of complications directly attributable to anesthesia or perfusion care and the low volume of pediatric cardiac surgical and interventional cardiology cases overall limit the ability of single-center studies to elucidate anesthesia and perfusion-related factors that may contribute to overall patient outcomes.[13]

Methods

Development of the Database Module

In May 2025, the first meetings between the EACTAIC, ECHSA, and EBCP, together with representatives from STS and the Congenital Cardiac Anesthesia Society (CCAS), took place.

The STS CHSD collaboration with CCAS served as the prototype for the development of the collaboration between EACTAIC, ECHSA, and the EBCP.[8] Agreement was reached to develop an EACTAIC Anesthesia Variables Module and, in collaboration with the EBCP, a module for clinical perfusion variables, which will be integrated into the ECHSA-CCDB.

Identification of Candidate Variables

In the first pass, gathering information from existing large-scale databases in congenital cardiac surgery is limited. While the STS CHSD contains structural anesthesia-related variables, the ECHSA-CCDB includes data fields for a limited number of anesthesia-related factors.[8,9]

In the process of identifying candidate variables for the new to be built EACTAIC Anesthesia Variables Module the STS CHSD Training Manual (Version 6.23.2) served as a source to screen for existing variables that could be adopted without modification.[14]

Adopting as many variables as possible with their existing definition and format from the STS CHSD will offer the ability to combine data from the STS CHSD and ECHSA-CCDB, which will strengthen research collaboration opportunities and strengthen statistical signal detection for rare events.

Adopting existing variables offers the advantage that, in future research projects, a greater number of shared variables will strengthen statistical signal detection, when combining and comparing data from the STS CHSD and the ECHSA-CCDB.

Bearing in mind that the US health care system differs in several key aspects from the variety of health care systems across Europe, existing variables were screened for necessary adaptations to ensure their suitability for use within the European context.

For example, we identified a couple of blood product types that are either not routinely used or not available in many European countries but are commonly used in the United States.

Consequently, some variables could not be retained as commonly shared variables.

However, acknowledging such differences will allow comparisons of practices and outcomes between the two databases.

Due to the complexity of data collection of (mainly) continuous variables during cardiopulmonary bypass, the selection process of candidate perfusion variables as preliminary suggested by the authors (Table 1) will be discussed in a separate manuscript by an expert group of perfusionists from the EBCP.

In addition to examining the STS CHSD variable definitions, EACTAIC's Paediatric & Congenital Subcommittee held several meetings to discuss potential new candidate variables for inclusion in the database module.

Aside from searching for existing template variables, EACTAIC's Paediatric & Congenital Subcommittee held a couple of informal brainstorming sessions to identify new candidate variables to include in outcome research.

The principles guiding the inclusion of candidate variables were clinical relevance, feasibility, standardization, and data burden.

Following initial meetings, a survey was sent out to the members of EACTAIC's Paediatric & Congenital Subcommittee to gather the most relevant information for building an anesthesia data registration module.

Table 1
Proposed Basic Variables Set by the Authors for the Perfusion Variables Module

Type of pump (roller, centrifugal) and make/manufacturer
Type of oxygenator and manufacturer/make
Prime volume
Type of prime, additives
Maximal flow rate
Pulsatile perfusion or not
Minimum temperature (site recorded)
Hyperoxic, normoxic, hypoxic perfusion
Arterial pO_2 and sat on CPB, min, max
Mixed venous sat on CPB, min, max
pCO_2 and pH on CBP, min, max
Any periods of low flow, duration, and at what temperature (site measured)
Any DHCA, duration (min) and at what temperature (site measured)
Any use of intermittent DHCA including at what temperature and duration of interposed reperfusion periods
Any use of retrograde cerebral perfusion, temperature, and flow
Cardioplegia data (blood *v* crystalloid, type, administration site (antegrade including root or direct ostial, retrograde, single or multiple shot and intervals
Ph management (alpha-stat, ph-stat)
Duration of CPB total
Duration of drifting, active cooling, rewarming
Maximal temperature on bypass
Target Hct on bypass
Minimum Hct on bypass
Filtration yes/no
MUF yes/no
Volume filtered
Cell saver use
RBC volume recovered by Cell Saver

Abbreviations: min, minimum; max, maximum; CPB, cardiopulmonary bypass; DHCA, deep hypothermic circulatory arrest; Hct, hematocrit.

Survey Methods

Each member was asked to provide the following structural data regarding their current charting and database participation:

- The modality of current anesthesia patient chart record methodology—whether fully electronically, partially electronically, or fully on paper
- Presence of a national outcome registry/database on congenital cardiac anesthesia
- Existence of a local outcome registry/database or quality control system to which anesthesia patient record data are submitted
- Participation of the congenital cardiac surgery unit program in the ECHSA-CD

Each member was asked to provide feedback on the following potential database characteristics:

- If the database record was collected completely on paper, how many variables would the member be willing to fill in: fewer than 20, 20 to 50, or more than 50
- Which team member should be responsible for submission of anesthesia data to the module: attending anesthesiologist, anesthesia fellow/resident, nurse anesthetist, or a database specialist/administrative assistant

Each member was also asked to rank 6 categories (and example variables) by order of importance/relevance for outcomes research in a combined surgical, anesthesia, and perfusion database for pediatric cardiac surgery:

- **Hemodynamics**: Heart rate, blood pressure, central venous pressure, and other hemodynamic variables at certain time points during the procedure
- **Blood transfusion and coagulation management**: Point-of-care devices used, transfusion algorithms, and blood products utilized
- **Anesthetic pharmacology**: Anesthetic drugs detailed in their combination with opioids and neuromuscular blocking agents as well as their mode of delivery (*e.g.*, target-controlled infusion)
- **Mechanical ventilation parameters**: FiO_2, tidal volume, peak pressure, positive end-expiratory pressure, and inspiratory-to-expiratory ratio
- **Anesthetic technique applied**: General anesthesia and regional anesthesia
- **Vascular access**: Arterial line and central venous line with detailed information on the use of ultrasound for line placement

Each category was ranked by personal choice from highest to lowest importance.

After gathering input from EACTAIC's subcommittee members, a video meeting call was held on September 8, 2025, to present the first draft of possible candidate variable set and collect substantial feedback (Tables 2-5).

Table 2
Proposed Variables "Anesthesia Staff"

Anesthesiologist present
Primary anesthesiologist attending name
Primary anesthesiologist national provider identifier
Secondary anesthesiologist attending
Fellow or resident present
Anesthetic nurse present
Anesthetic nurse dedication

NOTE. The data uploaded to the database will be anonymized; therefore, the names of anesthesiologists, fellows, residents, nurses, perfusionists, and other team members will stay locally, available only to the registration site.

Together with ECATAIC's Scientific Committee, a roadmap for a Delphi process was drawn.[15–17]

Phase 1: Systematic Review of the literature (Starting in January 2026)

Initiation phase 1 began in January 2026.

First, use the variables identified in the STS CHSD Training Manual (Version 6.23.2).

Second, combine these variables with the list. An exhaustive review will be conducted to identify candidate variables, and the STS CHSD Training Manual (Version 6.23.2) will serve as a source to screen for existing variables that could be adopted.

Results from the systematic review will be combined with variables suggested by EACTAIC's Paediatric & Congenital Subspecialty Committee members to generate a draft set of variables.

Third, an expert panel (nominated by EACTAIC's Paediatric & Congenital Subspecialty Committee and Scientific Committee) will then seek agreement on this draft set of variables using data from the systematic review of the literature, which may identify additional values neither captured in the STS CHSD nor suggested by EACTAIC's Paediatric & Congenital Subspecialty Committee.

Phase 2: Expert Panel Voting (March 2026)

Phase 2 is expected to begin in March 2026.

A survey will be conducted to find agreement on a final set of variables by the expert penal.

In the first round, participants of the expert panel will be presented with a list of the candidate variables identified during phase 1 grouped into 6 categories:

- Anesthetic pharmacology
- Anesthetic technique applied
- Blood transfusion and coagulation management
- Hemodynamics
- Mechanical ventilation parameters
- Vascular access

Panelists will be asked to rate each variable in each category according to how strongly they agree or disagree that it should be included using a 5-point Likert scale:

1 = "strongly disagree"

2 = "disagree"
3 = "neutral"
4 = "agree"
5 = "strongly agree"

Participants will also be able to provide a rationale for their rating and suggest additional variables for consideration.

A second survey should then be conducted.

Data from the second round will be summarized and analyzed by calculating the overall median and IQR for each respective variable to complete the following elimination process:

- Variables with a median score of 1 (strongly disagree) or 2 (disagree) will be provisionally excluded from the final set.
- Variables with a median score of 5 (strongly agree) will be provisionally included in the final set.
- Variables with median scores between 3 (neutral) and 4 (agree) will be brought forward for further discussion at the final consensus meeting.

Phase 3: Final Consensus Meeting (December 2026)

During this phase, there will be a series of meetings of phase 1 and 2 participants to reach a final consensus on the set of variables. This phase is expected to conclude in December 2026. Communication with representatives from the STS CHSD and CCAS collaboration will continuously occur as database updates are expected from the current version during this year, and it may present an opportunity for variable harmonization in certain instances.

- The final consensus meeting establishes the definitive set of variables.
- Participants of rounds 1 and 2 will be invited by the Steering Committee to a zoom meeting. The live online consensus meeting takes place to discuss and vote on which borderline variables (median scores between 3 and 4) should be included in the final set.
- Variables deemed for inclusion (median score 5) and exclusion (median scores 1 or 2) will also be ratified during the meeting.

Candidate Variables

First Results. The first sets of proposed candidate variables are shown in the following tables by the authors regarding

- Perfusion module variables (Table 1)
- Anesthesia staff (Table 2)
- Anesthesia: preoperative status, monitoring, and adverse events (Table 3)
- Anesthetic drugs, electroencephalography monitoring, and ventilation (Table 4)
- Transfusion and coagulation management (Table 5)

Table 3
Proposed "Anesthesia Preoperative Status, Monitoring and Adverse Events" Variables

Preoperative medications taken
Preoperative medication category
Preoperative anticoagulation type
Preoperative pulmonary vasodilators
Preoperative baseline oxygen saturation
Preoperative oxygen supplementation
Transport to procedure location date and time
Arterial line
Arterial line location
Percutaneous central pressure
Percutaneous central pressure monitoring locations
Ultrasound guidance used for catheter placement
Ultrasound guidance location
Neurologic monitoring
Neurological monitoring type
Lowest recorded intraoperative temperature
Lowest intraoperative temperature monitoring site
Highest recorded intraoperative temperature
Highest intraoperative temperature monitoring site
Intraoperative transesophageal echocardiography usage
Induction date and time
Anesthesia ready time/end of Induction
Regional anesthetic
Regional anesthetic site
Intercostal nerve infiltration by surgeon or anesthesia
incisional field block by surgeon or anesthesia
Airway in situ (ETT or tracheostomy)
ETT or tracheostomy replaced for procedure
Airway type
Cuffed
Airway site
Endobronchial Isolation (DLETT, Bronchial Blocker)
Endobronchial isolation method
Type of ventilator used intraoperative
Disposition under anesthesia
Perianesthetic demise (within 24 hours of last anesthesia end time)
Anesthesia adverse event occurred
Anesthesia adverse event
Anesthesia adverse event required additional intervention

Abbreviations: ETT, endotracheal tube; DLETT, double-lumen endotracheal tube; ICU, intensive care unit.

Discussion and Significance

Patient outcomes research in congenital cardiac care has historically been dependent on data generated by surgeons and cardiologists, focusing on procedural factors related to their specialty.

Anesthesia outcome registration has traditionally been perceived as a single disciplinary measure to improve patient safety by identifying risks mostly rooted in the technical aspects of anesthesiology (e.g., airway management, pharmacology used, monitors applied).[18] However, anesthesia has a low incidence of major immediate complications, and the impact of anesthetic and perfusion techniques used may have implications for outcomes that extend far beyond those immediately recognizable.[8] Combining efforts across specialties into this in the context of the multidisciplinary approach of

Table 4
Candidate Variables for the EACTAIC ECHSA Anesthesia DB Module–Category "Anesthetic Pharmacology, EEG and Ventilation"

Anesthetic induction method
Anesthesia induction agent 1
Anesthesia induction agent 2
Anesthesia induction opioid 1
Anesthesia induction opioid 2
Anesthesia maintenance agent 1
Anesthesia maintenance agent 2
Anesthesia maintenance opioid 1
Anesthesia maintenance opioid 2
TCI hypnotic agent 1 (model)
TCI hypnotic agent 2 (model)
TCI opioid 1 (model)
TCI opioid 2 (model)
Type of anesthesia ventilator
Mode of ventilation
Ventilation FiO_2 at induction
Ventilation FiO_2 at skin incision
Ventilation F_iO_2 at weaning from CPB
Ventilation F_iO_2 5 min prior to end of operation
Ventilation Vt after intubation
Ventilation Vt at weaning from CPB
Ventilation Vt 5 min prior to end of operation
Ventilation Ppeak after intubation
Ventilation Ppeak at weaning from CPB
Ventilation Ppeak 5 min prior to end of operation
Ventilation PEEP after intubation
Ventilation PEEP at weaning from CPB
Ventilation PEEP 5 min prior to end of operation
EEG variables recorded
EEG SEF unilateral after induction of anesthesia
EEG SEF unilateral 5 min prior to end of operation
EEG SEFL after induction
EEG SEFR after induction
EEG SEFL 5 min prior to end of operation
EEG SEFR 5 min prior to end of operation
Intraoperative medication given
Intraoperative pharmacology (Including CPB)

Abbreviations: CPB, cardiopulmonary bypass; EEG, electroencephalography; FiO_2, fraction of inspired oxygen; Vt, tidal volume; PEEP, peak end-expiratory pressure; Ppeak, peak inspiratory pressure; SEF, spectral edge frequency; SEFL, spectral edge frequency left; SEFR, spectral edge frequency right; TCI, target-controlled infusion.

congenital cardiac surgery and cardiology allows the value recognition of long-term follow-up and the ability to recognize anesthesia interventions. Anesthesia itself becomes a "variable," and thus outcome registration for the entire care process has to be tailored to the setting as variables in the ultimate outcome of the procedure.

We describe the first steps undertaken by EACTAIC, the EBCP, and ECHSA to develop a more comprehensive vision of patient outcome research by joining anesthesiology and clinical perfusion to contribute important clinical variables intraoperative/intraprocedural variables to the ECHSA-CCDB.

Identifying system-level contributors to outcomes through multidisciplinary efforts like this collaboration is key to robust outcome research aiming for coordinated practice changes, based on thorough evidence that will enhance patient safety.[19,20]

Table 5
Proposed "Transfusion and Coagulation Management" Variables

CellSaver/cell salvage
CellSaver/cell salvage in mL
Blood products transfused—packed red blood cells (PRBC) in mL—initiated before leaving OR
Blood products transfused—fresh frozen plasma (FFP) in mL—initiated before leaving OR
Blood products transfused—fresh plasma in mL—initiated before leaving OR
Blood products transfused—platelets in mL—initiated before leaving OR
Blood products transfused—cryoprecipitate in mL—initiated before leaving OR
Blood products transfused—fresh whole blood in mL—initiated before leaving OR
Blood products transfused—packed red blood cells (PRBC) in mL—transfused within 24 hours postprocedure
Blood products transfused—fresh frozen plasma (FFP) in mL—transfused within 24 hours postprocedure
blood products transfused—fresh plasma in ml—transfused within 24 hours postprocedure
Blood products transfused—platelets in mL—transfused Within 24 Hours postprocedure
Blood products transfused—cryoprecipitate in mL—transfused within 24 hours postprocedure
Tranexamic acid load in mg
Tranexamic acid infusion rate in mg/kg/hr
Factor VIIa (Novoseven) μg—dose 1
Factor VIIa (Novoseven) μg—dose 2
Factor VIIa (Novoseven) μg—dose 3
Factor VIIa (SevenFact) dose 1
Factor VIIa (SevenFact) dose 2
Factor VIIa (SevenFact) dose 3
Prothrombin complex concentrate—4 (PCC-4, KCentra) units—dose 1
Prothrombin complex concentrate—4 (PCC-4, KCentra) units—dose 2
Prothrombin complex concentrate—4 (PCC-4, KCentra) units—dose 3
Prothrombin complex concentrate—4 with factor VIIa (FEIBA) units—dose 1
Prothrombin complex concentrate—4 with factor VIIa (FEIBA) units—dose 2
Prothrombin complex concentrate—4 with factor VIIa (FEIBA) units—dose 3
Octaplex prothrombin concentrate units—dose 1
Octaplex prothrombin concentrate units—dose 2
Octaplex prothrombin concentrate units—dose 3
Fibrinogen concentrate mg—dose 1
Fibrinogen concentrate mg—dose 2
Fibrinogen concentrate mg—dose 3
Antithrombin 3 concentrate units—dose 1
Antithrombin 3 concentrate units—dose 2
Antithrombin 3 concentrate units—dose 3
Desmopressin (DDAVP) μg—dose 1
Desmopressin (DDAVP) μg—dose 2
Desmopressin (DDAVP) μg—dose 3
Haemate P units—dose 1
Haemate P units–dose 2
Haemate P units—dose 3
Point-of-care coagulation testing utilized intraoperatively
Point-of-care coagulation testing type
AT III measured preoperatively
Transfusion/bleeding algorithm utilized for postprotamine bleeding
Labs checked during CPB
Labs during CPB
Fibrinogen value—mg/dL
Platelet count value
Labs checked in OR after CPB
Labs in OR after CB
Post CPB—fibrinogen value—mg/dL
Post CPB—platelet count value

Abbreviations: AT III, antithrombin III; CPB, cardiopulmonary bypass; DDAVP, desmopressin; FFP, fresh frozen plasma; OR, operating room; PCC, prothrombin complex concentrate; PRBC, packed red blood cells.

By fostering collaborative relationships with other perioperative stakeholders, anesthesiologists, surgeons, and perfusionists are advancing value-based care and driving health care transformation in the best interests of patients.

The development of an anesthesia and perfusion variables module being integrated into ECHSA-CCDB is another milestone in improving pediatric and congenital cardiac care across Europe, as it will add new variables to be available for outcome research in surgical operations and transcatheter interventional cardiology procedures.

Limitations

One of the most challenging issues in the creation of this database in this matter is how to transform the rich amount of data typically recorded during a routine anesthesia to the usual pattern of a number of variables and a number of time points that will be monodisciplinary outcome variable registration to be feasible on this large-scale combination of multidisciplinary variables to collect in this database without limiting potentially useful detection of practice patterns and anesthetic interventions. Many anesthetic data variables are continuous, like waveforms and vital signs. In anesthesia, we are used to recording continuous variables such as vital signs. Anesthetic drug concentrations and ventilatory settings often vary frequently during the time course of a procedure. This generates a large amount of data, which makes it problematic to enter and store in databases like for entry into databases such as the Society of Thoracic Surgeons (STS) Congenital Heart Surgery Database and ECHSA-CCDB are being developed. Even if continuous data could be transferred into such databases, the wide variety of anesthesia information management systems (AIMS) and the use of some paper anesthesia records would make data entry impossible.[21,22] Therefore, a balance must be struck between data entry feasibility and granularity necessary for meaningful interpretation.

Potential feasibility challenges across heterogeneous European centers might occur when trying to implement a large variable set. Therefore, prioritization (e.g., core *v* optional variables set) will be discussed after agreement of the first definitive set of variables.

There are many limitations to multicenter data collection and analysis that include data consistency issues and underreporting of critical events. To that end, we plan to use the audit process already established by the ECHSA-CCDB to ensure the highest data fidelity possible. Due to low volumes at any given center, no single-center study can feasibly replace the value of a multidisciplinary, multi-institutional long-term outcomes database.[23-25]

The presented variable set in this report is preliminary and has not yet been implemented or validated. Outcome analyses will be addressed in future publications.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Generative AI Use

During the preparation of this work, the authors used ChatGPT 5.2 (OpenAI) to generate the first version of a graphical abstract. After using this tool/service, the authors reviewed and edited the graphic as needed and took full responsibility for the content of the published article.

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.

CRediT authorship contribution statement

Sascha Meier: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Conceptualization. **Theofili Kousi:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Formal analysis. **Sara C. Arrigoni:** Writing – review & editing, Supervision, Project administration. **Jeffrey P. Jacobs:** Writing – review & editing, Conceptualization. **Vladimiro Vida:** Writing – review & editing, Resources. **Attilio A. Lotto:** Writing – review & editing, Resources. **George E. Sarris:** Writing – review & editing, Supervision, Resources, Conceptualization. **Filip de Somer:** Writing – review & editing, Resources. **Normunds Sikora:** Writing – review & editing. **Dedre Buys:** Writing – review & editing. **Lindy Liebenberg:** Writing – review & editing. **Marloes van Hoeven:** Writing – review & editing. **Zdzislaw Tobota:** Writing – review & editing. **Justin B. Long:** Writing – review & editing. **David F. Vener:** Writing – review & editing. **Steffen Rex:** Writing – review & editing, Resources. **Gudrun Kunst:** Writing – review & editing, Resources.

Acknowledgments

This project was endorsed by the EACTAIC. The authors thank EACTAIC for providing logistical support during the conduction of the project.

References

1 Sundararaman LV, Desai SP. The anesthesia records of Harvey Cushing and Ernest Codman. Anesth Analg 2018;126(1):322–9.
2 Harmel MHLA. Anesthesia in the surgical treatment of congenital pulmonic stenosis. Anesthesiology 1946;7(5):477–98.
3 Ratneswaren A, de Belder MA, Timmis A. Cardiac audit, data and registries: evolution of a national programme. Heart 2022;108(10):807–12.
4 Back M, Leosdottir M, Hagstrom E, et al. The SWEDEHEART Secondary Prevention and Cardiac Rehabilitation Registry (SWEDEHEART CR registry). Eur Heart J Qual Care Clin Outcomes 2021;7:431–7.
5 Beckmann A, Dittrich S, Arenz C, et al. German Registry for Cardiac Operations and Interventions in Patients with Congenital Heart Disease: Report 2020-comprehensive data from 6 years of experience. Thorac Cardiovasc Surg 2021;69:e21–31.

6 Protopapas E, Padalino M, Tobota Z, et al. The European Congenital Heart Surgeons Association Congenital Cardiac Database: A 25-year summary of congenital heart surgery outcomes. Eur J Cardiothorac Surg 2025;67.

7 European Association for Cardiothoracic Anaesthesiology and Intensive Care (EACTAIC); 2025. Available at: https://www.eactaic.org.

8 Vener DF, Guzzetta N, Jacobs JP, et al. Development and implementation of a new data registry in congenital cardiac anesthesia. Ann Thorac Surg 2012;94:2159–65.

9 Vener DF, Gaies M, Jacobs JP, et al. Clinical databases and registries in congenital and pediatric cardiac surgery, cardiology, critical care, and anesthesiology worldwide. World J Pediatr Congenit Heart Surg 2017;8:77–87.

10 Kumar SR, Goldstone AB, Heuerman H, et al. The Society of Thoracic Surgeons Congenital Heart Surgery Database: 2024 Update on outcomes and research. Ann Thorac Surg 2025.

11 Jacobs JP, He X, Mayer JE Jr, et al. Mortality trends in pediatric and congenital heart surgery: An analysis of the Society of Thoracic Surgeons Congenital Heart Surgery Database. Ann Thorac Surg 2016;102:1345–52.

12 Holcomb RM, Undar A. Are outcomes in congenital cardiac surgery better than ever? J Card Surg 2022;37:656–63.

13 Vener DF, Pasquali SK, Mossad EB. Anesthesia and databases: Pediatric cardiac disease as a role model. Anesth Analg 2017;124:572–81.

14 STS. Congenital Heart Surgery Database Training Manual Version 6.23.2; 2025. Available at: https://www.sts.org/sites/default/files/Database%20Manuals/2025-07_CHSD%20TM%20Version%206.23.2.pdf.

15 Junger S, Payne SA, Brine J, et al. Guidance on Conducting and REporting DElphi Studies (CREDES) in palliative care: Recommendations based on a methodological systematic review. Palliat Med 2017;31:684–706.

16 Hansel J, Fuchs A, Radcliffe G, et al. International consensus-based core outcome set for airway management clinical trials and observational studies: The Airway Terminology and Outcome Measures (ATOM) protocol. BMJ Open 2025;15:e096886.

17 Valetopoulou A, Newall N, Khan DZ, et al. A core outcome set for pituitary surgery research: An international Delphi consensus study. Pituitary 2025;28:88.

18 Peden CJ, Campbell M, Aggarwal G. Quality, safety, and outcomes in anaesthesia: What's to be done? An international perspective. Br J Anaesth 2017;119:i5–i14.

19 Norskov AK, Jakobsen JC, Afshari A, et al. Collaboration for Evidence-based Practice and Research in Anaesthesia (CEPRA): A consortium initiative for perioperative research. Acta Anaesthesiol Scand 2023;67:804–10.

20 Mahajan A, Esper SA, Cole DJ, et al. Anesthesiologists' role in value-based perioperative care and healthcare transformation. Anesthesiology 2021;134:526–40.

21 Cravero JP, Sriswasdi P, Lekowski R, et al. Creation of an integrated outcome database for pediatric anesthesia. Paediatr Anaesth 2016;26:345–55.

22 Colquhoun DA, Shanks AM, Kapeles SR, et al. Considerations for integration of perioperative electronic health records across institutions for research and quality improvement: The approach taken by the Multicenter Perioperative Outcomes Group. Anesth Analg 2020;130:1133–46.

23 Cravero J, Brown ML. Database and registry research in pediatric anesthesiology. Curr Opin Anaesthesiol 2025;38:217–21.

24 Disma N, Habre W, Veyckemans F. Lessons learned from big data (APRICOT, NECTARINE, PeDI). Best Pract Res Clin Anaesthesiol 2024;38:111–7.

25 Abdel-Kader AK, Eisenkraft JB, Katz DJ. Overview and limitations of database research in anesthesiology: A narrative review. Anesth Analg 2021;132:1012–22.