

Early Reoperations in a 5-Year National Cohort of Pediatric Patients With Congenital Heart Disease

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Background. The exact types, frequency, and consequences of early congenital cardiac reoperations are not well known. We aim to describe them and evaluate the potential of early reoperations as a metric for quality of care.

Methods. A retrospective analysis of the 2005 through 2010 National Congenital Heart Disease Audit database was performed. An early cardiac reoperation sequence was defined as one taking place within a 30-day episode.

Results. A total of 18,489 cardiac surgical procedures were analyzed, 652 (3.5%) being early cardiac reoperations, part of 588 sequences. The most common index procedures were arterial shunt, coarctation or hypoplasia of the aorta repair, and pulmonary artery banding. The most common reoperations were arterial shunt, pulmonary artery band, and ventricular septal defect procedures. The 60-day mortality was significantly higher in patients having an early reoperation, with 93 early deaths,

compared with those who did not (15.8% versus 3%; $p < 0.001$). From these 93 early deaths, 42 (45%) followed a Norwood, arterial shunt, or pulmonary artery band performed as an index or reoperation. Reoperations were classified as related and unrelated to the index procedure. A related-to-unrelated reoperation ratio was calculated, ranging from 0.2 for coarctation or hypoplasia to 9.0 for atrioventricular septal defect repair.

Conclusions. Early reoperations can be variably related to the index procedure, ranging from repeat of index to repair of associated defects and staged procedures, resulting in different patterns of reoperation types by relationship to the index. Cardiac reoperations within 30 days are associated with increased mortality, which is clustered around a small number of procedures.

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The mortality for pediatric cardiac surgery is typically in low single figures. If less than 4% of patients have 30-day mortality as a measurable end point, what other metrics for quality of care are there for the other 96%? [1]. The focus is on complications, as most patients have them, from simple ones without consequences to the more complex ones leading to death. Of the vast array of complications a prominent one is unplanned reoperation [2]. By using this relatively new concept it is envisaged that substandard procedures or aftercare can be identified and rectified. The National Health Service England adopted unplanned reoperation as a metric of performance on quality-of-care dashboards [3]. The concept is appealing, but the reoperations that generate these statistics are not well described and quantified. For example, is an early reoperation related to technical problems in the first procedure a missed diagnosis or a planned sequence? And is it possible to tease out these differences retrospectively?

Our objective was to use a national database of congenital procedures to identify the types and the

numeric burden of early reoperations. This quantitative description, the obstacles encountered, and the rationale for excluding certain procedures could form the basis for defining which reoperations might be suitable for prospective monitoring.

Patients and Methods

Dataset

The UK National Institute of Cardiovascular Outcomes Research (NICOR) collects and validates data on all surgical and catheter-based procedures from 2000 onward, having complete procedure coverage. The National Congenital Heart Disease Audit database was examined in this study. The focus of the study was on the notion of early reoperations, and therefore only surgical procedures were requested. We consider catheter-based early reinterventions to be scenarios particular enough to be best studied in a setting with more granular patient-level data. The structure and the quality of the data were

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The [Appendix](#) can be viewed in the online version of this article [<http://dx.doi.org/10.1016/j.athoracsur.2015.12.039>] on <http://www.annalsthoracicsurgery.org>.

described previously [4]. After release of anonymized data by NICOR, a block of consecutive patients operated on between 2005 and 2010 was chosen. This reduced the burden of individual verification and adjudication, while giving a representative sample, and avoided having to deal with the additional complexity of data quality improving as a function of time.

Data Cleaning

Patient and hospital identifiers were removed at the source. Data were manually checked for consistency in key fields: unique patient identifier, age, weight, and date of operation. An early reoperation sequence was defined as a group of two or more cardiac procedures, each separated from the next by no more than 30 days, the first in such a sequence being considered the index procedure. A small number of patients had consecutive operations, each separated from the next by less than 30 days. These were not broken into more than one episode, owing to the fact that each is likely to be linked to all previous procedures in this short time span, rather than only to the previous one. Any interval longer than 30 days was considered a new episode with a new index operation. The treatment variations in the United Kingdom are such (in terms of where in the hospital the procedures are done and how they are recorded) that some reoperations cannot be measured accurately. Procedures that are not included in the mandatory NICOR submission and have been variably recorded include permanent pacemaker, reopening of chest, thoracic duct ligation, and diaphragm plication. They were excluded a priori in this study, along with mechanical support and transplantation. Next, the surgical dataset was created and further direct exclusion was carried out for duplicates, illogical sequences, and vague coding as part of the data cleaning process. All exclusions are detailed in Figure 1.

Initially, the reoperations performed within 30, 60, and 90 days from the index procedure were counted, with index defined as the first procedure in chronological order. It was clear that within the first 2 or 3 months there are procedures such as a Glenn shunt that can be part of a planned sequence. The further out from the index, the harder it is to distinguish unplanned events from the natural history of surgically treated disease. Thirty-day mortality is a standard measure of early death in the United Kingdom. However, to better identify the survival cost of early reoperations, a fixed 60-day window after each index procedure was chosen here. A 30-day mortality window would be too small to describe attrition in protracted cases, whereas beyond 60 days one enters the realm of planned procedures.

The NICOR-specific hierarchical algorithm was used to classify each procedure (index or reoperation) into standardized categories [5]. The classification of each procedure was independently checked for discrepancies by three investigators. New categories were created to include procedures that were unclassifiable by the algorithm (eg, coarctation of the aorta with ventricular septal defect [VSD] closure, pulmonary artery [PA] banding, and coarctation repair); 2.6% of operations could not be

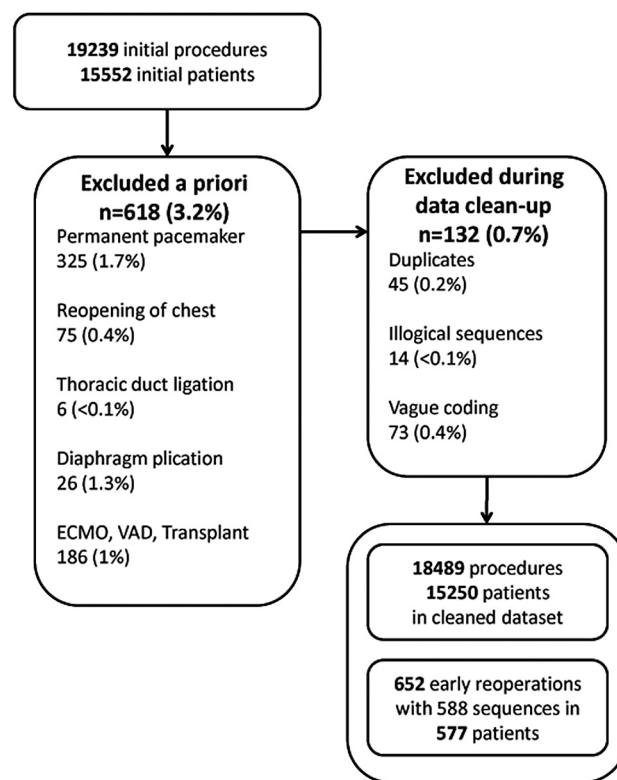


Fig 1. Flowchart showing the data cleaning process, with patients excluded at each step. (ECMO = extracorporeal membrane oxygenation; VAD = ventricular assist device.)

assigned to a specific category because of missing data or complex associated procedures.

Our initial objective was to describe unplanned reoperations, but early in the analysis it was found that even within 30 days of the index procedure there was a large variation in the types of reoperation. At one end of the spectrum, there were repeats of the index procedure—a typical example of an unplanned reoperation. At the other extreme, there were planned complex sequences. In between these extremes, the degree of planning was impossible to judge retrospectively without additional patient-level data to understand the decision-making process. We wanted to avoid drawing an arbitrary line through this retrospective dataset that would divide the procedures artificially into unplanned and planned. Instead, the retained cases were more objectively divided into related and unrelated to the index procedure. This was based around the key procedure codes, and adjudication was established independently by two researchers. A related reoperation is any repeat of or similar procedure to the index or to a concomitant procedure performed at the same time as the index (Appendix Table 1). An unrelated reoperation is any procedure that is not technically similar to any of the procedures performed at index, or a direct consequence of a surgical step performed at the index. This includes staged procedures, reoperations performed as a result of patient-related complications, corrective procedures performed after a palliation, or a repair of an associated defect (Appendix Table 2).

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