Adult cardiac surgical cost variation around the world: Protocol for a systematic review

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Abstract

Introduction: Globally, over one million cardiac operations occur each year, whereas cardiac surgery is expensive and largely inaccessible without insurance or philanthropic support. Substantial cost variation has been reported within cardiac surgery in the United States and among non-cardiac surgical procedures globally, but little is known on the global procedural cost variation for common adult cardiac surgical procedures.

Objectives and significance: This review seeks to assess variation in procedural costs of coronary artery bypass grafting (CABG), mitral valve repair, mitral valve replacement, aortic valve repair, aortic valve replacement, and combined CABG-mitral or CABG-aortic valve procedures between and within countries. Results may give insights in the scope and drivers of cost variation around the world, posing cost reduction lessons. Results may further inform the potential of economies of scale in reducing procedural costs, benefiting patients, hospitals, governments, and insurers.

Methods and analysis: A systematic review will be performed using the EconLit, Embase, PubMed/MEDLINE, Web of Science, and WHO Global Index Medicus databases to identify articles published between January 1, 2000 and June 1, 2020. Studies describing procedural costs for CABG, mitral valve repair, mitral valve replacement, aortic valve repair, aortic valve replacement, and combined CABG-mitral or CABG-aortic valve procedures between and within countries. Results may give insights in the scope and drivers of cost variation around the world, posing cost reduction lessons. Results may further inform the potential of economies of scale in reducing procedural costs, benefiting patients, hospitals, governments, and insurers.

Ethics and dissemination: This study protocol has been prospectively registered on the International Platform of Registered Systematic Review and Meta-analysis Protocols. This review requires no institutional review board approval. Results of this study will be summarized and disseminated in a peer-review journal.

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different states, due to variation in local case volume, billing prac-
tices, health networks, insurers, practice patterns, and surgical out-
comes [5,6]. Similarly, non-cardiac surgical procedures have large
differences in cost around the world, especially due to differences
in health systems and insurance models, surgical supply chains,
(de-)centralization, and modern health care technologies [7,8].
However, little is known about the variation in costs for adult car-
diac surgical procedures around the world.

Overall, procedural costs are lower in LMICs compared to HICs,
in part due to reduced staff and overhead costs and the common
reliance on donated or discounted surgical supplies. However,
the lack of public health insurance, health care infrastructure,
and lower socioeconomic status introduce substantial barriers to
accessing care [9]. Nevertheless, lessons may be drawn from
country-level variation to reduce surgical costs around the world
and, subsequently increase international access to life-saving car-
diac surgical services.

Here, we aim to perform a systematic review of medical and
economic literature to assess cost variation of common adult car-
diac surgical procedures (coronary artery bypass grafting (CABG),
mitral valve repair and replacement, aortic valve repair and
replacement, and combined CABG-mitrval or CABG-aortic valve pro-
cedures) around the world in order to better understand global dis-
parities and draw lessons to reduce procedural costs and improve
the cost-effectiveness of cardiac surgery.

2. Objectives and significance

The main objective of this review is to assess the variation in
procedural costs of CABG, mitral valve repair, mitral valve replace-
ment, aortic valve repair, aortic valve replacement, and combined
CABG-mitrval or CABG-aortic valve procedures between and within
countries. These procedures are chosen based on their common
occurrence globally, including the repair-oriented focus in LMICs,
where prosthetic valves, reinterventions, and anticoagulation
introduce longitudinal difficulties in ensuring optimal context-
specific patient outcomes. Results of these analyses may give
insights into the scope and drivers of procedural cost variation
around the world, enabling potential cost reduction. This is impor-
tant in light of the overall high costs associated with cardiac surgic-
el episodes and the financial barriers these impose for uninsured
or under-insured patients. In LMICs, where the overall human devel-
opment index and socioeconomic status is comparatively lower,
financially disadvantaged patients are even more common. Results
from this review may also illustrate the potential of economies of
scale in reducing procedural costs, benefitting patients, hospitals,
governments, and insurers.

The results from this review may further inform future studies
by generating novel research questions. For example, follow-up
studies may look at pre- and post-procedure costs, the location
of recovery after hospital discharge, the impact on patients’
employment status, and the variations of all of these factors within
and between countries.

3. Methods

3.1. Literature search

A systematic review will be performed according to the PRISMA
guidelines using the EconLit, Embase, PubMed/MEDLINE, Web of
Science, and WHO Global Index Medicus databases to identify arti-
cles published between January 1, 2000, and June 1, 2020 (Fig. 1)
[10]. The search strings per database include combinations of the
keywords “cardiac surgery” and “cost”. The Supplementary Mate-
rials present individual database queries and their respective
yields. We will further manually review reference lists of all arti-
cles that will be included after screening. Articles describing other
types of cardiac surgery, concomitant aortic surgery, only describ-
ing costs related to non-surgical care, or with incomplete cost data
will be excluded from the analysis. No exclusion will be done solely
based on article type or language, whereas eligible procedures with
a concomitant maze procedure will be included.

3.2. Screening and data extraction

Literature search yields will be uploaded and screened in Covi-
dence by six independent reviewers in a way that every article is
screened by two reviewers in the abstract and full-text screening
stages. Screening conflicts will be resolved by a third independent
reviewer. Articles included after screening will be extracted for
information regarding the study design, costing method, country,
hospital, procedures, costs per procedure and, where available,
costs of overall hospital stay, individual (non-medical) expenses,
operating time, length of stay, perioperative mortality, and periop-
erative complications. Upon the extraction of a study’s country, the
health care system model (Beveridge, Bismarck, National Health
Insurance, or out-of-pocket) is identified.

3.3. Costing comparisons

All identified costs will be converted to 2019 USD to account for
local currency unit (LCU) inflation and LCU-USD exchange fluctua-
tions. Exchange rates, for USD per LCU and year-specific data, will
be obtained from the World Bank World Development Indicators
database. Country-level comparisons will be made between HICs
and LMICs as defined by the World Bank Country and Lending
Groups classification.

3.4. Data analysis

Cost variables are assumed to have non-normal distributions.
For other variables, normality of data will be assessed using the
Shapiro-Wilk’s test. Continuous variables will be analyzed using
the independent student’s t-test (normality) or Mann-Whitney U
test (non-normality). Categorical variables will be analyzed using
chi-square or Fisher’s exact tests. Multi-set comparisons will be
performed using ANOVA or Kruskal-Wallis tests. Continuous
variables will be reported as mean with standard deviation
(if normally distributed) or median with interquartile range
(if non-normality). Categorical variables will be reported as counts
and percentages. R Statistical Software version 4.0.1 (R Foundation
for Statistical Computing, Vienna, Austria) will be used to perform
the data analysis. Statistical significance will be accepted at
p-values < 0.05.

3.5. Quality assessment

Due to the variation in study designs (no exclusion is done
based on study design) and the primary outcome of interest (i.e.,
direct procedural costs), no appropriate quality assessment check-
list has been identified. Instead, quality assessment will be per-
formed by the authors based on the following criteria: 1) is there
a clear description of the procedure performed and does it fit the
procedures eligible for inclusion, 2) is there a clear description of
the cost definitions (procedural costs versus total hospital costs),
3) is the study sample representative for the patient population
studied, and 4) is data reporting complete?
3.6. Registration

This study protocol has been prospectively registered on Research Registry (Review Registry UIN reviewregistry949).

4. Ethics and dissemination

This study uses peer-reviewed published literature; as a result, there is no need for institutional review board approval. Results of this study will be summarized in English and disseminated by submission for publication in a peer-review journal.

5. Limitations

This review is anticipated to have several limitations. First, our analysis will focus on direct procedural costs, rather than pre- and postoperative costs and non-medical expenditure. These costs are commonly of great burden to patients (if paying completely or partially out-of-pocket) and insurers, but not commonly included in procedure-based cost analyses. Second, in some studies, charges (the price paid by patients, governments, or third-party payers) and costs (true costs for hospitals) are often used interchangeably. However, in most countries, the cost-to-charge variation is stable and costs and charges approximately equal, and, therefore, we anticipate little impact thereof on the results that will be obtained from this review. Third, our search did not include grey literature (e.g., Ministry of Health reports on government spending, non-governmental organization data on per-procedure costs) due to the overall lack of granularity of cost reporting in such reports.

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CRediT authorship contribution statement

Dominique Vervoort: Conception and design, Methodology, Writing, Critical review and approval. Camila R. Guetter: Methodology, Writing, Critical review and approval. Lena Trager: Methodology, Writing, Critical review and approval. Priyansh Shah: Methodology, Writing, Critical review and approval. Carlos Eduardo Diaz-Castrillon: Methodology, Writing, Critical review and approval.
and approval. **Eric W. Etchill**: Methodology, Writing, Critical review and approval. **Rawn Salenger**: Methodology, Writing, Critical review and approval.

**Guarantor**

Dominique Vervoort.

**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.

**Appendix A. Supplementary data**

Supplementary data to this article can be found online at https://doi.org/10.1016/j.isjp.2020.07.004.

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