

COST EFFECTIVENESS OF CABG VERSUS PCI FOR PATIENTS WITH CORONARY ARTERY DISEASE: A SYSTEMATIC REVIEW

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ABSTRACT

The suitability of CABG compared to PCI for patients with coronary artery disease (CAD) remains a controversial issue. Despite growing evidence supporting the clinical efficacy of these revascularization strategies, there is little evidence regarding their long-term cost-effectiveness. The aim of this study was to critically evaluate the literature regarding the cost-effectiveness of CABG compared to PCI and assess the quality of the available economic evidence. The methods is a systematic review was conducted using three databases: PubMed, Scopus and Google Scholar. Three studies were retrieved then compared the economic evaluation of CABG vs PCI measures The result is the improvement (ICER) reported across studies varied widely by perspective and timeframe. ICER calculation was reported to be favorable and cost effective for CABG. The conclusions is CABG is more cost-effective than PCI in cases of coronary artery disease. The evidence supporting this cost-effectiveness will continue to evolve and further evaluation over a period of 10 years or more is needed considering societal perspectives.

KEYWORDS

Cost Effectiveness, Cost Evaluation, CABG, PCI, Percutaneous Coronary Intervention, Coronary Artery Bypass Grafting



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INTRODUCTION

Cardiovascular disease is the leading cause of death and a major contributor to disability. Globally, the estimated number of deaths from cardiovascular disease increased from about 12.1 million in 1990 (evenly distributed between men and women) to 18.6 million (9.6 million men and 8.9 million women) in 2019 and increased to 20.5 million people who died in 2021. Cardiovascular disease affects the heart and blood vessels and is caused by a combination of socio-economic, metabolic, behavioral and environmental risk factors. In almost all regions, both

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men and women, Ischemic Heart Disease or known as Coronary Heart Disease (CHD) is the leading cause of death from heart and blood vessel disease (Weiting et al., 2022).

In the last three decades, the burden of diseases has changed from the original infectious disease to a non-communicable disease (NCD). This can be seen from the change in the main cause of Disability Adjusted Life Years (DALY) lost. In 2017, the five main causes of DALY lost were ischemic heart disease, stroke, diabetes, neonatal disease and tuberculosis. One of the DALY losses that increased sharply from 1990 to 2017 occurred in ischemic heart disease, which was 113.9%.

Coronary heart disease is a disorder of heart function caused by a lack of blood to the heart muscle due to blockage or narrowing of the coronary arteries due to damage to the lining of the blood vessel wall. CHD or ischemic heart disease is the leading cause of premature death in 146 countries for men and 98 countries for women (Cesare MD, Bixby H, 2023). Based on the study of The Global Burden Disease, it was found that the prevalence rate of ischemic heart disease is the highest in Southeast Asia, namely 12,767,227 with a mortality rate of 639,981, which is also the highest in Southeast Asia (Kemenkes, 2019). From the Sample Registration System (SRS) in 2014, CHD is the second highest cause of death after stroke in Indonesia (Lindstrom et al., 2022).

In the treatment of coronary heart disease, coronary artery bypass grafting (CABG) and Percutaneous Coronary Intervention (PCI) are two common procedures (Fakhrzad et al., 2023). In current clinical practice, CABG measures are recommended to treat patients with complex conditions, including multi-vessel disease while PCI is recommended for patients with single-vessel disease or acute myocardial infarction (Ariyaratne et al., 2016). However, it is necessary to calculate the cost-effectiveness of both interventions, especially in low- and middle-income countries where heart and vascular services are more limited than in high-income countries. In a previous study, Cohen et al. (2014) showed that CABG is a fairly interesting revascularization strategy both clinically and economically in 3-vessel or LMCAD patients. Although CABG costs more than PCI, ICER on CABG is still more profitable because the follow-up cost for 5 years on PCI actions is higher than CABG (Cohen et al., 2014).

In the United States, the cost of coronary heart disease treatment in hospitals is estimated to reach 100 billion US dollars per year. In Indonesia, based on BPJS data in 2022, the cost of services in treating heart and blood vessel diseases is 10.9 trillion rupiah. With the limited resources available in the health system, the cost-effectiveness and affordability of health services are more important factors in clinical decision-making.

RESEARCH METHOD

Economic evaluation was carried out using a random sample method on patients who had undergone CABG and PCI procedures with various types of stents (DES or BMS). All types of economic evaluations are considered, including cost-effectiveness analysis (CEA), cost-utility analysis (CUA), cost-benefit analysis (CBA), and cost minimization analysis (CMA).

Data Search Strategy

This type of research is a systematic literature review. A specific research methodology or development that is carried out to collect and evaluate research results on a specific topic. The details of the activities include the determination of strategies and/or sources of data search, the selection of studies through quality assessment according to selection criteria and quality assessment tools, data synthesis and data extraction (Moher et al., 2015; Shamseer et al., 2015).

The database sources used in searching for literature in this study include PubMed, Scopus and Google Scholar. The search for articles or journals uses keywords consisting of Cost Effectiveness, CABG, PCI, Percutaneous Coronary Intervention, Coronary Artery Bypass Grafting.

Eligibility Criteria

The eligibility criteria in this study include inclusion and exclusion criteria. The inclusion criteria in this study include: 1) literature in the form of scientific journals, 2) scientific journal sources are from PubMed, Scopus and Google Scholar, 3) articles must be accessible in full text form, 4) scientific journals must be in United Kingdom or Indonesian Language, 5) Discussion of scientific journals includes the cost-effectiveness of CABG and PCI procedures in patients with coronary artery disease or CAD by displaying data cost, Quality Adjusted Life Years (QALY) and ICER for each action, 6) years of publication of scientific journals between 2019-2024, 7) research design used qualitative or descriptive. Meanwhile, the exclusion criteria are those that do not match the inclusion criteria.

In limiting the scope of the study, the researcher uses the PICO framework as shown in table 1. The selection process of articles or journals is applied by looking at several aspects, including the continuity between the title of the scientific journal and the title of the research determined by the researcher, the abstract, and the completeness of the text (Husereau et al., 2013).

Table 1. PICO Framework Format Cost-Effective Measures of CABG Versus PCI in Patients with Coronary Heart Disease

PICOS Framework	Information
Population	Research focusing on CAD cases conducted by CABG and PCI
Intervention	CABG and PCI Actions
Comparators	N/A
Outcomes	Cost-effectiveness (ICER) on CABG or PCI
Publication Years	2019-2024
Language	Indonesian Language and United Kingdom

Quality Assessment

In building a systematic review, the author uses the PRISMA guide. The PRISMA flow chart in the study is shown in Figure 1. The three databases used by researchers in searching for scientific journal articles, 1002 journal articles were identified, 5 of which were removed because journal articles were duplicated. Then, 978 journal articles were excluded because the title and abstract did not match the

inclusion criteria. Of the 19 scientific journal articles that were screened, there were 16 articles that did not meet the eligibility criteria so that only 3 scientific journals were used in systematic literature review research.

The assessment of article quality in this study uses 24 checklist items from The Consolidates Health Economic Evaluation Reporting Standards (CHEERS). Based on the quality assessment that has been carried out by the researcher, 3 (three) scientific journals meet the 24 components of CHEERS so that they can be used as a source of literature in this study.

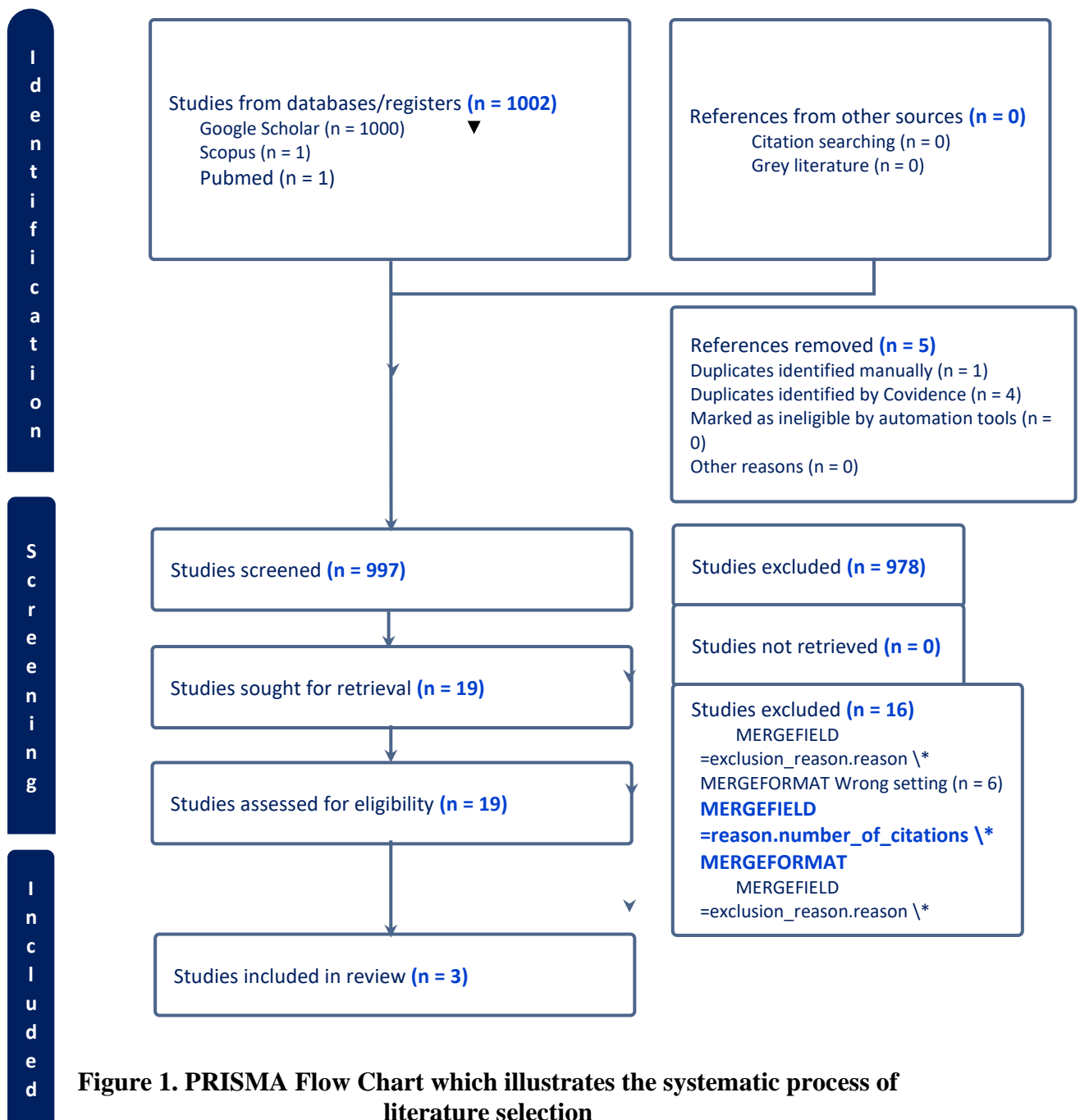


Figure 1. PRISMA Flow Chart which illustrates the systematic process of literature selection

Data Synthesis

The data synthesis process in this study was carried out by comparing literature that had met the quality assessment and inclusion criteria. Data synthesis refers to the purpose of the study, which is to determine the cost-effectiveness of CABG and PCI measures in patients with coronary artery disease which includes the cost, QALY and ICER of each action (Anderson et al., 2014).

Data Extraction

To show a meaningful comparison of economic evaluations, the Incremental Cost-Effectiveness Ratio (ICER) is expressed in US Dollars (2019). The cost-effectiveness results of this study were displayed using Cost-Effectiveness Planes (CEPs) consisting of four quadrants: top right, bottom right, top left, bottom left which presented high effectiveness, high cost (top right), high effectiveness, low cost (bottom right), low cost effectiveness (bottom left) and low cost effectiveness high (top left). In addition, the data extraction output is displayed in the form of a table consisting of the name of the researcher, year of publication, research title, research object, research design, research place, cost, QALY and ICER actions CABG and PCI.

RESULT AND DISCUSSION

Overview of the Research Population

Of the 3 studies taken, 1 study was conducted on patients visiting Singapore General Hospital. 1 study was conducted in several hospitals in Iran (Shiraz Hospital, Faqihi Hospital, Namazi Hospital and Al-Zahra Hospital) and 1 study was taken from an EXCEL study in 17 countries.

The population of the three studies was patients with Coronary Artery Disease who were randomly sampled (Magnuson et al., 2022). In terms of intervention measures, 2 studies took random samples in CAD patients who underwent CABG or PCI^{4,10}, while 1 study took samples from patients undergoing CABG, PCI with various types of stents and optimal treatment therapy (OMT) including antiplatelet therapy and statin drugs.

Characteristics of Economic Evaluation

Types of Economic Evaluation

Of these 3 studies, all of them use Cost Utility Analysis (CUA) calculations. In analytical decision modeling, the 3 studies used the Markov Model. The Markov model is used as a decision modelling in analyzing cost-effectiveness. This model describes the patient's treatment journey as well as the conditions after the intervention procedure is carried out to account for the long-term costs incurred.

Cost Calculation

The types of costs calculated in the study vary greatly depending on the economic evaluation point of view, whether it is from the point of view of the health facility or the patient's point of view. From these three studies, all of them calculated direct costs including treatment costs during hospitalization and post-treatment follow-up. However, 2 studies also calculated indirect costs such as the cost burden due to the loss of patient and family productivity or the burden of caregiver costs.

Effectiveness Measurement

The measure of effectiveness used in conducting economic evaluations in these three studies is Quality-Adjusted Life Years (QALY). The tools to measure effectiveness varied, including 1 study using the SAQ and SF-364 measuring tools, and the other 2 studies using the EuroQOL 5-dimensional questionnaire measuring tool. As for the calculation of ICER, it was carried out by the three studies.

In 1 study using the latest cost-effectiveness threshold based on GDP per capita in Singapore of 59800 USD or equivalent to 80000 Singapore Dollars, while 1 other study explored the cost-effectiveness threshold through the analysis of Willingness to Pay (WTP).

Sensitivity Analysis

Sensitivity analysis was shown in all three studies. Probabilistic sensitivity analysis (PSA) conducted to determine uncertainty parameters with the aim of estimating the amount of cost and health utility (effectiveness) was used in the 3 studies.

In 1 study, sensitivity analysis was used by assuming the impact of CABG versus PCI actions in the form of death and non-fatal events observed for 5 years. The assumptions used in this study are 3 scenarios, namely: (i) the benefits of CABG at 5-10 years. (ii) the benefits of CABG continued for life, and (iii) there was no benefit from CABG for 5 years of observation.

Another study presents a one-way sensitivity analysis using a tornado plot and a probabilistic sensitivity analysis using a scatter plot.

Cost Effectiveness of CABG versus PCI

Table 2. Cost Effectiveness of CABG versus PCI

Study/Writer	Costs (USD)		QALY		ICER	Information
	CABG	PCI	CABG	PCI		
Fakhrzad, et al (2023)	56618	85634	3.33	1.57	16581	CABG Dominant
EXCEL trial (Magnuson, et al 2022)	114404	92853	12.23	11.74	44235	CABG Dominant
Weiting, et al (2022)	10040	18789	2.19	-0.21	3645	

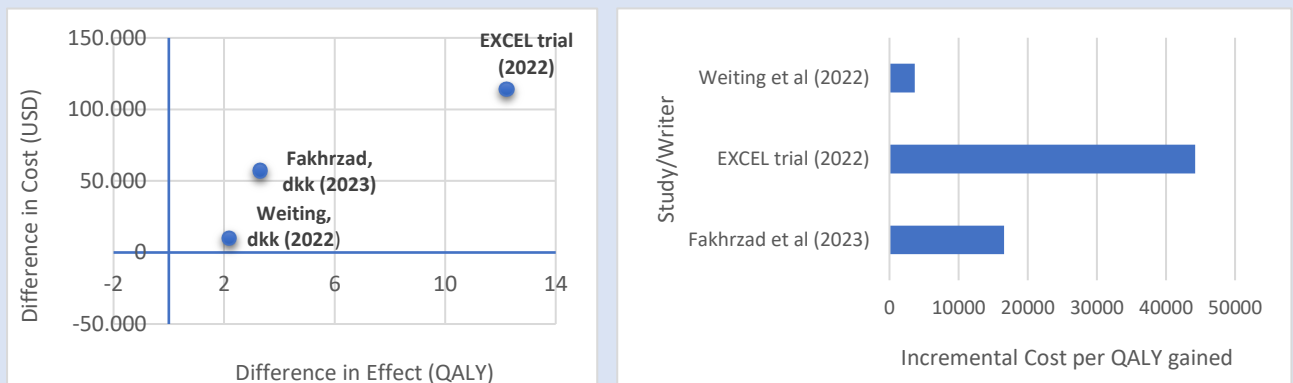


Figure 2. The Incremental cost-effectiveness per QALY gained for CABG reported by three economic evaluations

Limitations

There has been little research on the economic evaluation of cardiology treatments in the last five years. Three references were insufficient to represent a true economic evaluation of CABG and PCI treatments. Only one study was actually taken from a real trial, the rest were comparative studies. A wider search for references and a more rigorous screening process are needed to produce a good systematic review.

CONCLUSION

In conclusion, based on a systematic review of the available literature, coronary artery bypass grafting (CABG) is found to be more cost-effective than percutaneous coronary intervention (PCI) for patients with coronary artery disease (CAD). This conclusion is primarily driven by the incremental cost-effectiveness ratio (ICER) favoring CABG, particularly in long-term scenarios where CABG provides sustained clinical benefits and lower follow-up costs. Although CABG involves higher initial costs, its long-term economic advantage, especially in complex cases like multi-vessel disease, supports its cost-effectiveness. However, further studies evaluating these interventions over a longer period, considering broader societal perspectives, are needed to solidify these findings.

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