



## Smartphone Application on Perioperative Cardiac Surgery: A Systematic Review

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### ABSTRACT

Information technology used in the health sector is known as e-health. Smartphone applications are starting to be widely used for long-term condition monitoring management in the medical and health fields. Perioperative cardiac surgery procedures require long-term monitoring. This study aimed to find out about smartphone use in peri-operative cardiac surgery. A systematic review design. The reporting framework uses Featured Reporting Items for Systematic Review and Followed Meta-analysis to report findings. Data Sources, CINAHL, ProQuest, Science Direct, and Google Scholar searched for English-language articles published from January 2010 to August 2020 with the keywords "cardiac surgery," "smartphone," and "peri-operative". Six articles that met the inclusion criteria were the samples analyzed in this study. The instrument used to assess the quality of the study uses the Downs and Black checklist. In the pre-operation stage, a smartphone application has been used for surgical planning, assessment, education, training, diagnosis, telemedicine, navigation, and behavior modification interventions. In the intraoperative stage, smartphones are used for hemodynamic monitoring. In the post-operative stage, smartphones are used for monitoring surgical wounds. The benefits of smartphones in peri-operative cardiac surgery include diagnosis, telemedicine, navigation, and surgical planning, training, data collection, hemodynamic monitoring, nursing intervention media, and surgical wounds.

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#### Kata kunci:

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### ABSTRAK

Teknologi informasi yang digunakan dalam bidang kesehatan dikenal dengan istilah e-health. Aplikasi smartphone telah digunakan dalam bidang kedokteran dan kesehatan sebagai alat untuk manajemen pemantauan kondisi jangka panjang. Kondisi perioperatif pada bedah jantung memerlukan monitoring dengan jangka waktu yang panjang. Penelitian ini memiliki tujuan untuk mengetahui penggunaan smartphone pada perioperatif bedah jantung. Desain penelitian ini systematic review. Kerangka kerja dalam pelaporan menggunakan PRISMA untuk melaporkan temuan. Sumber Data ProQuest, Google Scholar, CINAHL, dan Science Direct dicari untuk mengidentifikasi bahasa Inggris asli yang diterbitkan, diterbitkan dari Januari 2010 hingga Agustus 2020 dengan kata kunci "cardiac surgery" "smartphone" dan "perioperatif". Enam artikel memenuhi kriteria inklusi menjadi sampel akhir. Instrumen untuk menilai kualitas studi dinilai menggunakan daftar periksa Downs dan Black. Smartphone digunakan dalam tahap pra operasi seperti diagnosis, telemedicine, navigasi dan perencanaan bedah, pelatihan, pengumpulan data diikuti dengan pendidikan pasien dan intervensi modifikasi perilaku. Pada tahap

intraoperatif, smartphone digunakan untuk pemantauan hemodinamik. Pada tahap pasca operasi, smartphone digunakan untuk memantau luka operasi. Manfaat smartphone dalam bedah jantung antara lain untuk diagnosis, telemedicine, navigasi dan perencanaan bedah, pelatihan, pengumpulan data, pemantauan hemodinamik, median intervensi keperawatan dan pemantauan luka bedah.



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## INTRODUCTION

Smartphones, when compared to other technologies, have a faster and faster development. The smartphone is a telecommunications device with a handheld method that combines a touch screen mobile phone with computer hardware (Kulendran et al., 2014). Smartphones have become the primary necessity of life to interact in everyday life. Through a smartphone, a person can use a smartphone personally and professionally to carry out activities not only to make calls and send emails, but more than that, such as to access information through the internet and use various applications to track and view information for their daily needs, such as information about health. Various available applications related to health care can empower health workers by providing resources to access information related to symptoms, diagnosis, and treatment of a disease that is equipped with a dose calculator, and electronic health records, so that all health workers and nurses through smartphones can increase productivity and intensity. Communicate with patients or co-workers while carrying out their duties without any obstacles. Innovative, informative, clear, and concise healthcare-related applications are increasingly used in health care. Health care professionals use smartphone applications for reference, calculation, data transfer, alerts, and notifications (Kaliyaperumal & Kamalanarayanan, 2018).

Smartphones are now starting to be used in cardiac surgical procedures. Nurses and other health workers use smartphone applications to monitor physiological indicators, such as heart rate, respiratory rate, blood pressure, temperature, oxygen saturation, and normal indicators. Various benefits of using smartphones in surgery have been proven, including improving user performance, improving patient care, increasing learning, and reducing the cost of equipment used in hospitals. This study aims to find information through a systematic literature review. Researchers synthesize knowledge and identify the use of smartphones in cardiac surgery. The research question is what are the benefits of smartphones and how are they used in cardiac surgery.

## METHOD

### *Literature Search*

The benefits of using a smartphone and how the use of a smartphone in cardiac surgery is reviewed through a systematic literature review. The Preferred Reporting Items Framework for Systematic Review and Meta-analysis (PRISMA) was used to report this study (Page & Moher, 2017). Electronic databases from Science Direct, ProQuest, CINAHL, and Google Scholar are systematically sought to identify original English language published from January 1, 2010, to

August 16, 2020. With the last ten years, the search is expected to find information on developments related to the use of smartphone applications in cardiac surgery. The search used the terms smartphone and heart surgery

### *Search Outcome*

All smartphone applications used in cardiac surgery patients in the peri-operative phase. The inclusion criteria for this study were all smartphone use in cardiac surgery, full text, and whose publication period was from January 1, 2010, to August 16, 2020. The exclusion criteria included qualitative research, did not use English and did not explain the use of smartphones in cardiac surgery.

### *Assessment of Study Quality*

Instruments from Downs and Black to assess the quality of articles. This instrument is often used to evaluate articles quality. The number of assessment scores consisting of 27 items refers to the study's strength. The authors assess whether the power is calculated and reported or not. Score 1 if possible for studies reporting strength. The final score is categorized based on the score, if the score is 26-27, then the category is very good, the score is 20-25 is good, the score is 15-19 is fair, and the score  $\leq 14$  is poor.

### *Data Abstraction*

The articles obtained by the researchers were then abstracted by all the authors independently with the same process, then followed by a research team meeting to discuss together and agree on the articles selected in a systematic review. The agreed articles were then grouped and compared based on the targeted population, intervention design, intervention technique, effectiveness analysis, and results found (Moher et al, 2009).

### *Synthesis*

In this study, the researcher did not carry out the meta-analysis stage because of the limitations of the articles obtained and the articles were heterogeneous. For example, some articles discussed smartphones in the pre-operative phase, and some were post-operative. In addition, there are also differences in the measured variables, so this study only comes to a narrative summary.

## RESULTS

The screening was carried out using a PRISMA flow chart. Figure 1 describes the study selection results obtained. (Moher et al 2009). Search get 2996 articles through keywords set in databases MEDLINE, CINAHL, ProQuest, Science Direct,

and Google Scholar. 3 duplicate articles were obtained, so the authors screened 2993 articles. After the title was obtained further, the abstract screening of 2993 articles was carried out, with the reasons determined by the researcher and all the researchers agreed. Furthermore, 2915 articles were issued so that they became 78 fulltext articles which were then

assessed for feasibility. All authors evaluated 78 full-text articles for eligibility, so the researchers deleted 71 studies on the grounds that researchers obtained seven studies, which were then carried out an in-depth review concerning the inclusion criteria. The final results were naming articles that met the full inclusion criteria to become the final sample.

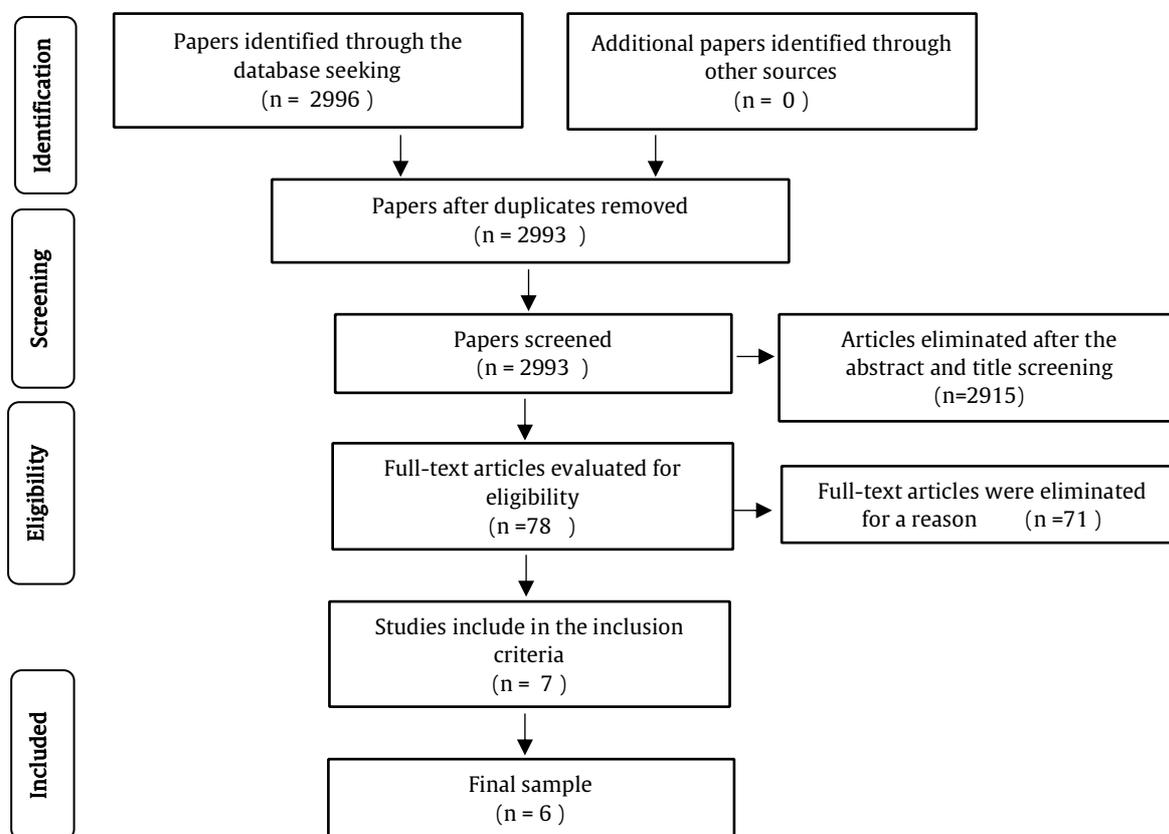


Figure 1. Article identification

Evidence of Quality Assessment is assessed between 5 and 21. Table 1 shows the overall quality assessment score and a detailed summary of the characteristics of this study. There is one article that has good value because it has a total score of 21 points. It can be seen from the design components used are large-scale, multicenter, RCT, and open labels. (Yu et al., 2020).

The results of one study are strong because the article reports internal validity, measures to address confounding and reduce bias. The other four studies were rated poorly, mainly because of threats to internal and external validity such as bias and confounding factors.

Table 1. Smartphone Studies and Quality Appraisal Scores

Authors	Place and Time of Research	Target Population	Downs and Black Checklist Quality Score
(Joosten et al., 2019)	Hopital Erasme, Université Libre de Bruxelles, Brussels, Belgium, 26 February, 2016	All patients older than 18 years old scheduled for elective coronary artery bypass grafting surgery	Poor (Score = 13)
(Edlin & Deshpande, 2013)	None	No clear	Poor (Score = 5)
(Yu et al., 2020)	Fuwai Hospital	The patient were going to be operated on the next day for the cardiovascular disorder (cardiac surgery)	Fair (Score = 16)
(Yang et al., 2017)	None	Patients meeting criteria for isolated CABG (no other cardiac surgery, such as valve replacement surgery or surgical ablation, atrial fibrillation, was performed except for CABG)	Good (Score = 21)
(Kumar & Raj, 2015)	None	Patient Peri-operative myocardial infarction	Poor (Score = 8)
			Poor (Score = 7)

**Table 2.**  
**Intervention, Study Outcomes, Key Findings**

Authors	Intervention	Study Outcomes	Findings
(Joosten et al., 2019)	The Capstesia application	COTD, COCAP, PPVCAP, PPVPC	PPVCAP and PPVPC weakly predict fluid response, especially postoperatively
(Edlin & Deshpande, 2013)	Smartphone Apps	Medical applications with the theme of cardiothoracic surgery, cardiothoracic terms, thorax, heart, heart, lungs, surgery, and their variations	Search results across 379 apps, 6% of the results were attributed to named medical professionals, 63% to user ratings, and 15% to publishers or professional communities.
	Inertial sensors embedded inside smartphones	It is used in a clinical setting in elderly patients and allows for rapid and objective assessment.	There was a significantly lower difference in debilitated patients than in non-weak patients in Smartphone-derived walking velocity ( $p < 0.01$ ). Mean Center of Pressure /COP radius ( $p < 0.01$ ) and COP area ( $p < 0.01$ ), COP path length and mean COP velocity ( $p < 0.05$ ) were found to be significantly higher in patients who are weak than that in the group of patients who are not weak
(Yu et al., 2020)	The smartphone application (Heart Health Application)	Medication adherence and secondary prevention goals, such as blood pressure (BP) and body mass index (BMI), each week through the application messaging service	There were no significant differences in the secondary and primary clinical outcome measures across the tested subgroups. The proportion of participants in the treatment group who used and operated the app during the first month after CABG was 88.1% but the rate of use decreased from 42.5% in the second month to 9.2% in the sixth month.
(Yang et al., 2017)	Remote ECG monitoring and clinician response in real-time with the use of a smartphone	ECG monitoring	The results were obtained from real-time remote monitoring of the recorded ECG signals from hospitalized patients at risk for cardiac events. Real-time remote ECG monitoring during the post-operative period has the benefit of helping prevent peri-operative myocardial infarction
(Kumar & Raj, 2015)	Reliable Smartphone-Based Wireless Healthcare Monitoring System	The relationship between abnormal heart rate and post-operative fatigue of respondents while driving, there is a warning to the patient if an abnormality is detected	If the measured pulse rate is lower than the threshold, the person experiences fatigue, or if it is greater than the threshold, then the patient is wide open for second-order attacks

## DISCUSSION

There has been a significant increase in the use of smartphones in surgical applications in the last five years. Most surgical applications use the iPhone iOS platform, and the Android application gains popularity of nearly 100 surgery-relevant applications, 41% of which are available on the iPhone iOS App Store (Kulendran et al., 2014). Smartphones are currently emerging as an integral part of our daily routine in all areas, including surgery. For example, the Capstesia™ smartphone app is a potentially transforming iOSTM device that can make sophisticated heart monitoring simpler, more affordable, and universally accessible. Can calculate cardiac output (CO), cardiac index (CI), variation in pulse pressure (PPV), rate of increase in left ventricular pressure during systole (dP / dt max), and stroke volume resistance (SVR) from pulse contour analysis. Treatment and monitoring have enormous clinical potential in intraoperative patients, extending to the intensive care unit. Smartphones can now double as innovative, real-time, sophisticated hemodynamic monitors accessible to remote operating theaters and critical care units in both developing and developed countries (Shah et al., 2018).

Smartphones are used in the preoperative stages such as diagnosis, telemedicine, navigation and surgical planning, training, data collection followed by patient education, risk assessment, research-based applications, an anatomy lecture series, a virtual surgery application, preoperative gait and posture measures, pain and anxiety intervention media and behaviour modification interventions. In the intraoperative stage, smartphones are used for hemodynamic monitoring. In the post-operative stage, smartphones are used for monitoring surgical wounds, detection of Atrial Fibrillation (AF) and other rhythm-related complications after cardiac surgery, and early mobilization intervention media (Awaludin, Nurachmah, Soetisna, & Umar, 2022; Brusco, 2010; Kulendran et al., 2014; Lamberigts et al., 2021; Pluta et al., 2022; Soangra & Lockhart, 2021). The benefits posed by smartphone application technology in heart surgery are also for the delivery of health services, patient outcomes, as well as clinical and lay education. There are still many unanswered questions regarding the regulation of smartphone applications and how to protect sensitive patient data (Edlin & Deshpande, 2013). Smartphone-based clinical measurement systems could serve as a clinical decision support system for assessing patients quickly in the cardiac surgery peri-operative period.

## LIMITATION OF THE STUDY

The number of articles analyzed is only six articles.

## CONCLUSIONS AND SUGGESTIONS

Smartphones can be used in peri-operative cardiac surgery for diagnosis, telemedicine, navigation and surgical planning, training, data collection, hemodynamic monitoring, nursing intervention media, and surgical wounds. More articles are needed to find out other benefits of smartphones in peri-operative cardiac surgery.

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## Conflict of Interest Statement

The authors declare no conflict of interest.

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