

**Nursing approach to rehabilitation
after open-heart surgery with
standard sternotomy: systematic
review**

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Abstract <p>Cardiovascular diseases represent one of the main causes of worldwide mortality with a significant economic burden on health care systems. Cardiosurgical progress made it possible to provide better medical care resulting in the effective treatment and survival benefits. Nurse-led post-surgery rehabilitation programs have already demonstrated positive outcomes on cardiac mortality in the short and long-term recovery. The objective of this systematic review was to evaluate the effectiveness of home-based nurse-led interventions following open-heart surgery using standard sternotomy. The aim was to investigate the effects of home-based nursing-led programs on the quality of life of the patients following the surgery. 329 patients aged over 18 years who underwent cardiac bypass surgery were included in this study in order to evaluate the effect of nurse-led post-surgery interventions compared to standard care. Only randomized clinical trials in English published between 2005–2019 were considered. The CINAHL, Scopus, Pubmed and ClinicalTrials.gov databases were searched for completed clinical trials. No meta-analysis was done as the data was heterogeneous. Only 3 studies were identified that fulfilled the inclusion criteria. Home-based nursing cardiac intervention programs were assessed at six weeks to six months, no suitable studies that evaluated the re-admission frequencies were found. The home-based nurse-led programs showed a significant improvement in the quality of life of the patients after coronary artery bypass surgery in the post-surgery period. There is sparse literature and only few studies available to evaluate the effectiveness of nursing-led interventions on the quality of life of the patients who underwent cardiac artery bypass surgery graft. Therefore, there is a need to perform standardized randomized control studies evaluating the effect of the programs on the short and long-term recovery after the open-heart surgery.</p>		
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1 Introduction

According to Carroll, Rankin, and Cooper (2007), cardiovascular diseases (CVD) represent the leading cause of death and long-term disability worldwide and thus represent one of the main challenges for health care systems as the primary cause of early death, long-term disability, hospitalization, and significant healthcare expenditures globally. In particular, in 2008, there were 57 million deaths, 17.3 million (30%) of them resulting from CVDs; moreover, it is expected that the death rate from CVDs will reach 25 million by 2030 (Mendes, Puska & Norrving 2011). In Australia, for instance, there were 3.5 million (17%) Australians living with chronic CVD (Australian Institute of Health and Welfare 2011). According to the Australian Institute of Health and Welfare (2018), CVD resulted in 1.1 million hospitalizations in 2015–2016 amongst Australians. Moreover, the economic burden of CVD is a very significant issue since, for instance, in 2016, CVD cost the USA \$555 billion, but by 2035 it is expected to increase up to \$1.1 trillion including direct and indirect costs such as long-term disability and rehabilitation (Heidenreich, Trogdon, Khavjou et al. 2011). In addition to that, it should be underlined, that Kazakhstan has also one of the highest mortality rates from ischemic heart diseases, in particular, 97 per 100 000 in 2012 (Nowbar, Gitto, Howard, Francis & Al-Lamee 2019).

Surgical procedures such as coronary artery bypass grafting (CABG) using standard sternotomy reduce mortality and morbidity significantly (Worcester, Murphy, Elliott, Le Grande, Higgins & Goble 2007,) as well as improving the patients' quality of life (Lee 2009). Despite constant advances in interventional cardiology, there are 1.5 million standard sternotomy operations for CABG taking place worldwide (Shapira 2018). According to (Katijahbe, Denehy, Granger, Royse, Royse, Bates, Logie, Clarke & El-Ansary 2017), (Deb, Wijesundera, Ko, Tsubota, Hill & Femes 2013) argue that this method is preferred as it presents the best clinical results for patients with multiple-vessel disease and different concomitant diseases. One example of those patients could be elderly patients with multiple comorbidities (Barsoum, Azab, Shah, Patel, Shariff, Lafferty, Nabagiez & MacGinn 2014). Open-heart surgeries involve many pain-sensitive structures because they underlie a median sternotomy, retraction of the ribs as well as muscles and visceral tissues (Jensen & Andersen

2004). Sternum manipulations resulted from its retraction and the use of electrocautery to dissect the chest can lead to nerve damage resulting in intercostal neuralgia (King, Parry, Southern, Faris & Tsuyuki 2008). Furthermore, main post-operative complications include dehiscence (Huh, Bakaeen, Chu, & Wall 2008), sternal instability/non-union (Balachandran 2015), mediastinitis (Mekontso, Vivier, Girou, Brun-Buisson & Kirsch 2011), mild cognitive impairment after the surgery (Royse, Saager, Whitlock, Ou-Young, Royse & Vincent 2017) which can further worsen to moderate cognitive impairments for up to 6 months after the operation took place (Newman, Kirchner, Phillips-Bute, Gaver, Grocott & Jones 2001). Post-operative care following open-heart surgery is a complex and multifaceted process that underlines management of chronic postsurgical pain (CPSP) (Clark, Conway, Poulsen, Keech, Tirimacco & Tideman 2015; Kalso, Mennander & Tasmuth 2001); prevention of the surgery site infection (Forrester, Cai, Zeigler & Weiser 2017); prevention of sepsis (Plaekke, De Man, Coenen, Jorens, De Winter & Hubens 2019); exercising (Westerdahl & Möller 2010); wound healing (La Pier 2007); poor functional recovery (McGillion, Duceppe, Allan et al. 2018); as well as overcoming psychological issues such as anxiety, depression, and post-traumatic stress (Fredericks, Lapum & Lo 2012). All these are associated with morbidity, prolonged length of hospital stay, and thereby, economic burden on the health care systems (LaPar, Crosby, Rich, Fonner, Kron, Ailawadi & Speir 2013).

From a historic point of view, increasing demands and health care system changes resulted in the development of the concept of advanced nursing practice since 1960 in the US and 1980s in the UK (Daly & Carnwell 2003). Nowadays, nursing is a dynamic and fast developing discipline that aims to provide the best health care service to the patients. It is undeniable that nurse-led care has a significant role in the provision of a beneficial contribution to healthcare services, and as a result, an improvement on the patients' quality of life (Laurant, van der Biezen, Wijers, Watananirun, Kontopantelis & van Vught 2018). Moreover, a body of research shows that the delivery of nurse-led primary health care service could result in better clinical outcomes and psychological satisfaction for patients (ibid.). Therefore, advanced nurse-led programs in cardiac post-surgery rehabilitation have become one of the most prospective and promising health care policy strategies worldwide (ibid.).

World Health Organization (WHO) has also made its recommendations on the expansion of the role of nurses in primary health care service globally (WHO 2012). Nonetheless, some research shows that several patient-nurse barriers exist that interfere with the clinical outcomes, in particular, an overwhelming workload as well as paperwork, working under pressure, challenging nursing tasks, shortage of highly skilful nurses, frequent patient admissions, imposed long shifts, working under stress, continuous care of infectious patients with surgical complications thereby reducing the quality of medical service (Shafipour, Mohammad & Ahmadi 2014). Therefore, this systematic review aims to evaluate whether there are clinical outcomes associated with advanced nurse-led interventions after open-heart surgery using standard sternotomy.

2 Theoretical basis

2.1 Cardiac rehabilitation programs

According to WHO, the definition of rehabilitation of cardiac patients is “...as the sum of the activities needed to provide the optimal physical, mental and social pre-conditions for regaining a normal function in society.” (WHO 1969). In addition to that, cardiac rehabilitation represents an integrative strategy that underlines optimal medical, physiological, psychological, social, and vocational care that will promote successful recovery after the acute cardiac event (Fridlund 2002). At the time being, patients in the post-surgery period are prescribed sternal precautions that restrict the use of their upper limbs and trunks for 4–6 weeks in order to minimize movement between the sternal edges (Price, Gordon, Bird & Benson 2016) and thereby promote osteosynthesis (Cahalin, Lapier & Shaw 2011). Nonetheless, some real-time ultrasound studies showed that upper limbs and trunk movements are associated with micromotion of less than 2 mm of the sternal edges, suggesting that strict post-operative movement restrictions might not be the absolute requirement for the patients (Balachandran 2015). Nonetheless, upper limb movements are part of post-operative standard physiotherapy treatment, therefore, there are many clinical issues for health professionals as well as the patients (Katijjahbe et al. 2017). On the other hand, recent meta-analysis showed that physical activity was associated

with the metrics of steps per day (1423, 95% CI 757.07 to 2089.43, $p < 0.0001$), and the proportion of patients categorized as physically active (relative risk 1.55, 95% CI 1.19 to 2.02, $p = 0.001$) increased after the introduction of physical interventions programs (Dibben, Dalal, Taylor, Doherty, Tang, & Hillsdon 2018).

Nonetheless, post-surgery cardiac rehabilitation and advanced intervention is an important phase for a full functional recovery (Adams, Pullum, Stafford, Hanners, Hartman & Strauss 2008; Falcoz, Chocron, Stoica, Kaili, Puyraveau & Mercier 2003; Morone, Weiner, Belnap, Karp, Mazumdar & Houck 2010). Cardiac rehabilitation programs are mainly aimed at the prevention of clinical complications, thereby leading to enhanced functional recovery and patients' well-being (Fridlund 2002). Although, a recent systematic review showed that there is not enough evidence of statistically significant intervention effects on the psychological component of wellbeing such as post-surgery anxiety, depression and emotional components of health-related quality of life (HRQoL) of the patients (Phillips 2014).

2.2 The role of the nurse in the cardiac rehabilitation programs

Without a doubt, nurses play important roles in the cardiac rehabilitation programs, such as container (i.e. a listener and an active receiver), counsellor for patients and their families, educator, and others (Fridlund 2000). In particular, the nurse can do educational work and thereby educate the patients and spouses on diet, exercise, health education, social support, as well as give psychological support to deal with stress management, anxiety, and depression (Fridlund 2000). Moreover, nurses require proper evaluation tools in clinical practice as well as being self-critical and serve as a good role model in order to enhance the rehabilitation process (Fridlund 2000). Moreover, in terms of the nurse-led interventions, there can be subdivision into hospital and further home-based rehabilitation programs (Overend, Anderson, Jackson, Lucy, Prendergast & Sinclair 2010). Nonetheless, recent systematic studies showed that only a few researches have been done on the differences of centre and home-based rehabilitation (Jolly, Taylor, Lip & Stevens 2006), although, both types of rehabilitation showed similar results (Anderson, Sharp, Norton, Dalal, Dean, Jolly, Cowie, Zawada & Taylor 2017).

Basically, intervention can help the patients and their families not only to establish minimally required knowledge for self-managed post-surgery rehabilitating care but also to understand the psychological importance of family support for a successful recovery (Fridlund 2002). Nurse-led interventions can be medical, educational, and psychological (Davies, Taylor, Beswick, Wise, Moxham & Rees 2010). Some data showed that educational nurse-led interventions were associated with significant improvements in physiological risk parameters such as the level of triglycerides, low density lipoproteins, in particular, the reduction of TG, TC and LDL at both three months ($p < 0,01$, $p < 0,001$) and six months ($p < 0,05$, $p < 0, 001$) (Jiang, Sit & Wong 2007). Moreover, there can be telephone-based nurse coaching sessions following discharge by monthly supportive care check-in phone calls. The nursing medical staff constantly interacts with the patient either at hospital or at home, using telephone on a standardized curriculum and guidebook (Wells, Stockdill, Dionne-Odom et al. 2018). Research Cochrane review showed that there were significant benefits of cardiac rehabilitation programs associated with reduced cardiovascular mortality and hospital readmissions, in addition to improved quality of life (Anderson, Thompson & Oldridge 2016).

3 Research question/objective

The central question to be resolved in this research is “What are the effects of home-based nursing-led programs on the quality of life of the patients following the surgery?”.

The objective of this systematic review is to investigate the effectiveness of home-based nurse-led interventions following open-heart surgery using standard sternotomy.

4 Methods/search strategy

A systematic review, of any available existing literature describing the efficacy of nurse-led interventions after open-heart surgery, was performed. A two-step search strategy was performed in the review. An initial limited search was performed in the most commonly used databases that contain high number of publications. Search in

the CINAHL, PubMed, Scopus and ClinicalTrials.gov databases was undertaken followed by an analysis of the text words contained in the title and abstract and of the index terms used to describe those articles. A second search using all identified keywords and index terms was performed across all included databases. The key terms used for searching the CINAHL, PubMed, Scopus, ClinicalTrials.gov databases were: “nursing-led interventions”, “sternotomy”, “cardiac rehabilitation”, “short-term survival”, “surgery outcomes”, “quality of life” either alone or in combination; moreover, reference search for relevant studies (searched 10.04.2019) and reference lists of all included studies were checked. (For detailed info, see Appendix 1). This search was rerun, and the strategy was revised, limited to publication years between 2005 and 2019, for CINAHL, PubMed, ClinicalTrials.gov and Scopus, in May 2019 in order to obtain the newest published studies (searched 09.06.2019). (For further details, see Table 1, Figure 1). Moreover, the reference lists of all identified reports and articles were searched for any related studies and reviews. Search strategy and number of search results for every keyword and keyword combination can be found in Appendix 1.

4.1 Inclusion Criteria

Any randomized clinical and controlled studies published between 2005 and 2019 were analyzed, moreover, studies published only in English were analyzed. Cohort studies were considered to be eligible, provided that data from the comparison group was available. After initial search, titles and abstracts were analyzed for eligibility.

This review included studies with participants aged 18 years and over following open-heart surgery and cardiac artery bypass grafting.

Publications analyzing interventions like sternotomy/open heart surgery and cardiac artery bypass surgery (CABG) using standard sternotomy were included in the study.

Randomized Clinical Trials (RCTs) were considered if the comparators were usual/standard care or other forms of Cardiac Rehabilitation (CR).

Studies with the following outcomes were considered to be eligible:

a) Health-related quality of life: assessed using validated disease specific or generic instruments such as the Disease Health-Related Quality of Life Questionnaire or the 36-Item Short Form Health Survey (SF-36).

b) Rehospitalization frequency: overall number of cardiac-related hospital re-admissions following surgery in the follow-period.

Only RCT that investigated the effect of nurse-led home-based cardiac rehabilitation interventions following open-heart surgery were eligible. Nurse-led care programs were considered, regardless to the frequency, intensity, and duration of the rehabilitation program. Trials that were not particularly home-based, nurse-led or their results were not specific to open-heart surgery were excluded.

4.2 Exclusion criteria

Case-reports and case-series were excluded because of high potential to bias in the study design, as well as non-nurse led programs. (See Appendix 3).

4.3 Quality assessment

Quality assessment of above-mentioned databases was performed by primary and secondary reviewer using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Systematic Reviews and Research Synthesis (The Joanna Briggs Institute, 2017). Paper quality was assessed by JBI checklist where each reviewer assessed and scored each paper using “Yes”, “No”, “Unclear” and “Not applicable” scale.

4.4 Data synthesis

No meta-analysis was performed because of heterogeneity of the outcome data. A total of 635 studies were found using a list of words mentioned above. No data was found through analyzing references of identified reports.

Total number of studies found in databases and number of studies considered to be eligible in this research can be found in Table 1.

Table 1. Number of studies found and considered to be eligible

Number of studies found	Number of studies considered to be eligible
n = 635	n = 3

Flowchart of inclusion and exclusion criteria based on systematic search is demonstrated below (Figure 1).

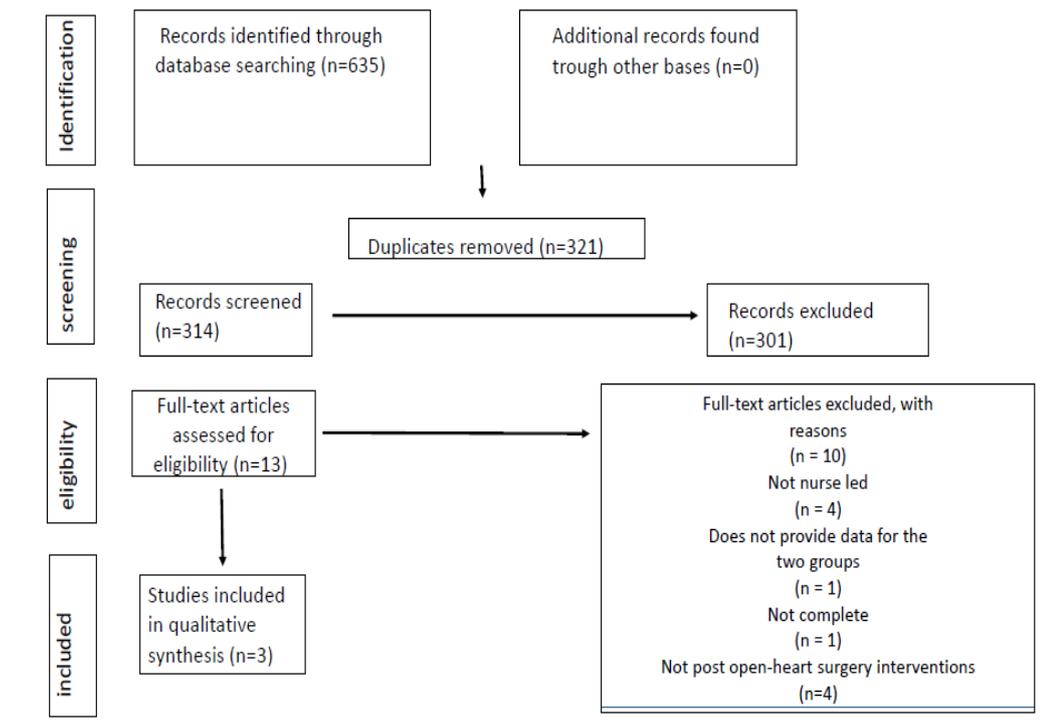


Figure 1. PRISMA flowchart through the phases of systematic search

5 Results

The search results identified 635 potential studies to be considered in the systematic review. A total of 321 studies were excluded as they were considered to be duplicates. Review titles and abstracts were also excluded. There remained 13 articles to be assessed, resulting in 10 studies being excluded due to not fulfilling the inclusion criteria. (See Figure 1). Four studies out of these 10 were excluded as they were led by physiotherapists/clinicians, i.e. not nurse-led ones, 1 was not complete, 4 studies evaluated the nurse-led interventions not after open-heart surgery, and the last one did not provide data for the two groups. The remaining methodological quality assessment was carried out on the remaining three trials and all were included in the systematic review. A detailed outline of the search and study

selection process is presented in Appendix 1. The studies that were included and excluded are presented in Appendices 2 and 3 (See Appendices 1, 2, and 3).

5.1 Nurse-led programs and the quality of life of the patients

It should be noted that there were only sparse studies available that assessed the quality of life of the patients associated with nurse-led intervention programs for cardiac rehabilitation programs.

Two studies assessed HRQoL and nurse-led programs. Based on the requirements for the assessment of methodological quality, these two studies scored 23 out of 24. Both studies were randomized, although the outcomes were not stated in a detailed way. In the first study, there were 185 participants aged ≥ 18 –80 years who underwent CABG electively (Lie, Arnesen, Sandvik, Hamilton & Bunch 2009). The studies were of low to moderate quality, but they were included for the analysis. The interventions were different compared to each other, namely nursing-led interventions, in particular, a home-based interventions program, and a nurse-led individualized exercise plan. In the second study, authors failed to find association between quality of life and type of intervention (Macken, Yates, Meza, Norman, Barnason & Pozehl 2014). (See Table 2).

5.2 Psychoeducation as part of nurse-led interventions

Only one out of three studies evaluated the role of psycho-educative intervention, in particular, structured information on possible medical complications and psychological support. Study outcomes showed that there were differences to a statistically significant level in the quality of life of the participants. In particular, patients under nursing-led interventions ($n=93$) showed lower scores for role physical (60.7 ± 42.3 vs. 67.7 ± 12.6 , $P = 0.03$), and role emotional (70.4 ± 39.9 vs. 79.4 ± 8.1 , $P = 0.003$); although they indicated higher scores for bodily pain (77.8 ± 23.7 vs 71.2 ± 3.9 , $P = 0.001$) (Lie et al. 2009).

5.3 The evaluation of home-based nursing-led interventions program care

Only one out of three studies assessed the overall HRQoL (Salavati, Falahinia, Vardanjani et al. 2016). More specific data was assessed in the two other studies, in particular, physical functioning, the incidence of angina, treatment satisfaction, disease perception, mental function, and marital quality (Lie et al. 2009; Macken et al. 2014). Although, these two studies showed a significantly higher HRQoL among those who received home-based CR (154.93 ± 4.6) compared to those who received usual care (134.20 ± 8.2) (MD $3.08 \pm 95\%$ CI, 2.32, 3.84). Mean scores also differed to a statistical significance between the results of the study group who received home-based nurse-led program care and those who did not; 25 versus 22 in physical limitations, 62 versus 58 in emotional function, and 60 versus 52 in social function, respectively, $P < 0.05$. Moreover, there was no association found between marital status and quality of life (Macken et al. 2014).

5.4 Hospital readmissions

No studies were found that evaluated either the effectiveness of nurse-led rehabilitation programs or home-based interventions with psycho-educative methods following open-heart surgery using standard sternotomy on the rate of readmissions to the hospital.

Table 2. Narrative view of the papers included into the systematic review

Participants	Intervention	Comparison	Outcome	The title of the study
34 patients After CABG mean age: 33–77	Study group (n = 17) Nurse-led individualized exercise plans three days/week for 6–12 weeks, group education classes, PaTH intervention: both patients and partners received the individualized treatment plan, counseling as well special educational sessions Control group (n = 17) Standard usual care: at	MSF-36 (Physical Functioning subscale), depression (Patient Health Questionnaire), and marital adjustment 7-item Dyadic Adjustment Scale (DAS-7) [Hunsley, Best,	There were no statistically significant differences in HRQoL between the groups	Macken, L.C., Yates, B.C., Meza, J., Norman, J., Barnason, S., Pozehl, B. 2014. Health-related Quality of Life Outcomes in Coronary Artery Bypass Surgery Patients and Partners. <i>Journal of Cardiopulmonary Rehabilitation</i>

	the community hospital allowed spouses/family members to participate in the exercising sessions	Lefebvre & Vito 2001]		Prevention;34(2), p.130–137.
185 patients after CABG mean age: 62	Control group (n = 92) who were under standard usual care - short talks with medical staff Study group (n = 93) Nursing-led care included: two 1-hour home visits in 2 to 4 weeks following the operation. Psychoeducation contained structured information on possible medical complications and psychological support	SAQ, Seattle Angina Questionnaire; MSF-36, Medical Outcomes Study Questionnaire Short Form 36 Health Survey;	Patients under nursing-led interventions showed lower scores for role physical (60.7 ± 42.3 vs 67.7 ± 12.6 , $P = 0.03$), and role emotional (70.4 ± 39.9 vs 79.4 ± 8.1 , $P = 0.003$); although they indicated higher scores for bodily pain (77.8 ± 23.7 vs 71.2 ± 3.9 , $P \setminus 0.001$)	Lie, I., Arnesen, H., Sandvik, L., Hamilton, G., Bunch, E.H. 2009. Healthrelated quality of life after coronary artery bypass grafting. The impact of a randomised controlled home-based intervention program. <i>Quality of Life Research</i>,18(2), 201–207.
110 patients after CABG Age: from 30 to 70		27-item MacNew Heart Disease HRQoL	There were differences to a statistically significant level between the groups, in particular, there were significant improvements in physical limitations Emotional and social functioning (Group 1: 67.86 ± 7.5 Group 2: 64.76 ± 8.4 PjNS; HRQoL 2 months follow-up Group 1: 134.20 ± 8.2 Group 2: 154.93 ± 4.6 $P < 0.05$) There was a significant	Salavati, M., Falahinia, G., Vardanjani, A.E., Rafiei, H., Moosavi, S., Torkamani, M. 2016. Comparison Between Effects of Home Based Cardiac Rehabilitation Programs Versus Usual Care on the Patients' Health Related Quality of Life After Coronary Artery Bypass Graft. <i>Global Journal of Health Sciences</i>,;8(4), 196.

			improvement in the group under nursing-led programs (154.93 ± 4.6 vs 134.20 ± 8.2, P< 0.05).	
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6 Discussion

The results of the systematic review, although with a certain degree of ambiguity, indicate that indeed, there exists an association between nurse-led post-cardiac artery bypass grafting care: Two out of the three studies found statistical significance in quality of life between the intervention and control groups. Furthermore, there seems to be both positive and negative effects of such nurse-led programs. On the one hand, two studies coincided in revealing emotional enhancement in the intervention group, and each of them separately provided evidence for higher self-assessed physical and social wellbeing. On the other hand, one study demonstrated a stronger feeling of pain in the nurse-led post-operative patients.

Therefore, answering the research question “What are the effects of home-based nursing-led programs on the quality of life of the patients following cardiac artery bypass grafting?”, the present study concludes that such rehabilitation programs are beneficial for the emotional, physical, and social well-being of the patients and are detrimental with regard to pain management.

As pointed out in the introduction, post-surgery recovery bears both physical and emotional stress, and it is, therefore, crucial to identify best-practice strategies to cope with these negative consequences. The end goal is to increase the quality of life of the patients. The current research has identified that nurse-led programs may positively influence patients’ recovery process by advantageously impacting their emotional, physical, and social experiences.

Being a systematic review, the present study cannot, unfortunately, compare its findings to previously published literature as all the studies on the topic have already been included into the research as the basis for the analysis. In other words, the present findings are derived from the research already available.

There are a number of limitations to the study. First, there is a general lack of research on the assessment of effectiveness of nurse-led post-heart surgery programs; as a result, only three relevant articles were identified. Second, all the studies included used self-reported assessments of the patients' well-being and quality of life, and these are subjective to each participant's perception. Third, other important factors such as social support, comorbidities, or mental health history that may influence a person's perception of quality of life have not been studied in detail to provide a clearer picture of whether it was the type of post-surgery care that affected their quality of life. Finally, given the heterogeneity of the findings of the identified studies and their scarce number, no meta-analysis could be performed, which means that a numeric degree of certainty of the accuracy and validity of the results cannot be established. Therefore, the present study utilizes the most appropriate method and provides a qualitative rather than quantitative review of the published literature. Once more nurse-led intervention effectiveness studies are published, a deeper qualitative and quantitative analysis can be performed.

7 Conclusion

The findings of the present systematic review may be useful for patients planning to or undergoing post-open-heart operation care, their families, and cardiac surgeons in deciding which post-operative care to follow or recommend. Thus, translating the findings into practice, all these stakeholders may bear in mind that when opting for home-based nurse-led post-surgery care, better outcomes with regard to emotional, physical, and social quality of life may be achieved. The findings are also important for the nurses who provide such care in showing that pain has been shown to be higher in the intervention group, indicating that more effort should be put into pain management when looking after the patients. Moreover, the findings are of importance to researchers in the fields of cardiac surgery, nursing care, determinants of quality of life, program evaluation, etc. Not only has the systematic review produced a unified summary of the published interventions and contributed to the body of knowledge on the topic, but it has also provided a basis for future studies. Specifically, it is recommended that more epidemiological studies on post-operative home-based nurse-led care, that would include other important biological and social

cofactors and reflect both short- and long-term outcomes, be performed and published, allowing for a possibility to produce a meta-analysis in the future. It is then suggested to examine more deeply how exactly and through what mechanisms nurse-led programs affect patients' perceptions of quality of life to obtain a complete picture.

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Appendices

Appendix 1. Searching strategy

CINAHL via EBSCOhost

Search: June 2019 (Search modes: Boolean/Phrase)

Search	Keyword	Results
S1	(MH "Nursing interventions"+)	16,474
S2	Sternotomy	1,061
S3	Sternotomy and nursing	41
S4	Nursing care and sternotomy	24
S5	(MH "Quality of Life.")	78,601
S6	Health-related Quality of Life	13,264
S7	(MH "Readmission")	7938
S8	Nurse-led interventions	
S9	Rehospitalization	1203
S10	nursing interventions or nursing care or nursing support or best practice	130,719
S11	"(nursing interventions or nursing care or nursing support or best practice) AND cardiac rehabilitation	219
S12	nursing interventions or nursing care or nursing support or best practice) AND cardiac rehabilitation AND surgery	34
S13	Limiters: randomized clinical trials "(nursing interventions or nursing care or nursing support or best practice) AND cardiac rehabilitation Randomized Controlled Trials	4

ClinicalTrials.gov

Last search: May 2019

Search ID	Keyword	Results
#1	Open heart surgery	533
#2	Limit to Open heart surgery older than 18 years	111
#3	Coronary artery disease AND bypass graft	334
#4	Sternotomy	72
#5	Limit to Completed studies with results, adult aged_18	35
#6	Nursing intervention after sternotomy	0

Scopus

Last search: April 2019

Search	Keyword	Results
#1	TITLE-ABS-KEY ("Coronary Artery Bypass Graft")	63,733
#2	TITLE-ABS-KEY ("Rehabilitation") OR TITLE-ABS-KEY ("Rehabilitation Nursing")	289,819
#3	TITLE-ABS-KEY ("Nurse-led Cardiac Rehabilitation")	2
#4	TITLE-ABS-KEY ("health related quality of life ") OR TITLE-ABSKEY("HRQoL")	38,519
#5	#1 OR #2 OR #4	7502

Pubmed

Last searched: June 2019

Search	Keyword	Results
#1	Open heart surgery	17,791
#2	((randomized clinical trials on nursing interventions) AND "clinical trial") AND "clinical trial"	2874
#3	"Clinical Trials" AND "nursing interventions"- English Full Text Link Out to Libraries and Clinical studies	83
#4	((randomized clinical trials on nursing interventions) AND "sternotomy"[Filter]) AND "rehabilitation"[Filter]	63
#5	((randomized clinical trials on nursing interventions) AND "post-surgery"[Filter]) AND "rehabilitation"[Filter]	806
#6	Limited to clinical trials on "nursing interventions" [Filter]	145
#7	(("advanced nursing care" AND "open-heart surgery"[Filter]) AND "rehabilitation"[Filter])	29
#8	Nursing[Title] AND Interventions[Title] AND Improve[Title] AND Cardiac[Title] AND Rehabilitation[Title]	
#9	((randomized clinical trials on "quality of life") AND "post-surgery"[Filter]) AND "rehabilitation"[Filter]	17
#10	((randomized clinical trials on nurse-led) AND "post-surgery care"[Filter]) AND "outcomes"[Filter]	12

Appendix 2. Randomized clinical studies included into the systematic review

Macken, L.C., Yates, B.C, Meza, J., Norman, J., Barnason, S., Pozehl, B. 2014. Health-related Quality of Life Outcomes in Coronary Artery Bypass Surgery Patients and Partners. *Journal of Cardiopulmonary Rehabilitation Prevention*,34(2),130–137.

Lie, I., Arnesen, H., Sandvik, L., Hamilton, G., Bunch, E.H. 2009. Healthrelated quality of life after coronary artery bypass grafting. The impact of a randomised controlled home-based intervention program. *Quality of Life Research*,18(2),201–207.

Salavati, M., Falahinia, G., Vardanjani, A.E., Rafiei, H., Moosavi, S., Torkamani, M. 2016. Comparison Between Effects of Home Based Cardiac Rehabilitation Programs Versus Usual Care on the Patients' Health Related Quality of Life After Coronary Artery Bypass Graft. *Glob J Health Sc*,8(4),196.

Appendix 3. Reasons for exclusion of papers

Hirschhorn A.D., Richards D., Mungovan S.F., Morris N.R., Adams L. 2008. Supervised moderate intensity exercise improves distance walked at hospital discharge following coronary artery bypass graft surgery—a randomized controlled trial. *Heart, Lung and Circulation*,17(2), 129–138.- **not nurse-led**

Seki E., Watanabe Y., Sunayama S., Iwama Y., Shimada K., Kawakami K. 2003. Effects of phase III cardiac rehabilitation programs on health-related quality of life in elderly patients with coronary artery disease. *Circulation journal*, 67(1), 73–77.- **not nurse-led**

Ennis S., Lobley G., Worrall S., Powell R., Kimani P.K., Khan A.J., Banerjee P., Barker T., McGregor G. 2018. Early initiation of post-sternotomy cardiac rehabilitation exercise training (SCAR): study protocol for a randomised controlled trial and economic evaluation. *BMJ Open*, 8(3),e019748. doi: 10.1136/bmjopen-2017-019748.- **not nurse-led**

Busch J.C., Lillou D., Wittig G., Bartsch P., Willemsen D., Oldridge N. 2012. Resistance and balance training improves functional capacity in very old participants attending cardiac rehabilitation after coronary bypass surgery. *Journal of the American Geriatrics Society*, 60(12), 2270–2276.- **not nurse-led**

Gortner S.R., Gilliss C.L., Shinn J.A., Sparacino P.A., Rankin S., Leavitt M., Price M., Hudes M. 1988. Improving recovery following cardiac surgery: a randomized clinical trial. *J Adv Nurs*,13(5), 649-661.- **too out of date to be considered**

Kikkenborg B., Støier L., Moons P., Zwisler A.D., Winkel P., Pedersen P. 2015. Emotions and health: findings from a randomized clinical trial on psychoeducational nursing to patients with implantable cardioverter defibrillator. *J Cardiovasc Nurs.* ,30(3), 197-204. doi: 10.1097/JCN.000000000000132.- **not open-heart surgery/ sternotomy (the method of device implantation is subcutaneous intervention)**

Cossette S., Frasure-Smith N., Dupuis J., Juneau M, Guertin MC. 2012. Randomized controlled trial of tailored nursing interventions to improve cardiac rehabilitation enrollment. *Nurs Res.* ,61(2), 111-120. doi: 10.1097/NNR.0b013e318240dc6b.- **interventions were after short-hospital stays, not after the open-heart surgery**

Grossman J.A. 2016. Cardiac Rehabilitation Enrollment and the Impact of Systematic Nursing Interventions for Postmyocardial Infarction and Stent Patients. *Clin Nurs Res.* ,25(4),378-90. doi: 10.1177/1054773815620777. Epub 2015 Dec 9. – **percutaneous cardiac interventions, not the open heart surgery**

Jiang X,, Sit J,W., Wong T.K. 2007. A nurse-led cardiac rehabilitation programme improves health behaviours and cardiac physiological risk parameters: evidence from Chengdu, China. *Journal of Clinical Nursing.* 16(10),1886-1897.- **not the open heart surgery**

Carroll D.L., Rankin S.H., Cooper B.A. 2007. The effects of a collaborative peer advisor/advanced practice nurse intervention: cardiac rehabilitation participation and rehospitalization in older adults after a cardiac event. *Journal of Cardiovascular Nursing.*22(4),313–319- **no available data for two groups**

Smith K.M., Arthur H.M., McKelvie R.S., Kodis J. 2004. Differences in sustainability of exercise and health-related quality of life outcomes following home or hospital-based cardiac rehabilitation. *European Journal of Cardiovascular Prevention & Rehabilitation.* 11(4),313–319. – **the status is not complete, recruiting**