Quality of Life in Relation to Length of Intensive Care Unit Stay After Cardiac Surgery

Mohammad Diab, MBChB[a], Rajdeep Bilkhu, MBChB[a], Gopal Soppa, PhD[a], Nadine McGale, PhD[b], Shashivadan P. Hirani, PhD[b], Stanton P. Newman, PhD[b], Marjan Jahangiri, FRCS(CTh) [a]

[a] Department of Cardiothoracic Surgery, St. George's University of London, London, UK

[b] Centre for Health Services Research, School of Health Sciences, City, University of London, London, UK

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Introduction

There is a significant knowledge gap regarding the impact of prolonged intensive care unit (ICU) stay on quality of life (QOL) after cardiac surgery. QOL has been defined as "a person's sense of well-being that stems from satisfaction or dissatisfaction with the areas of life that are important to him/ her."[1]

Advances in diagnostics and therapeutics enable patients to survive and live longer. Consequently, an increasing number of elderly, higher-risk patients are undergoing cardiac surgery. This cohort of patients in the United Kingdom has increased by approximately 5% to 18% in the last 5 years.[2,3] Similar trends have been seen in the United States and elsewhere in Europe.[4,5] These higher-risk and older patients are expected to spend a longer time in the ICU after surgery,[6] and in these patients, QOL is considered a more valuable outcome measure.[7]

There has been considerable debate on the definition of prolonged ICU stay after cardiac surgery, ranging widely from >24 hours to >14 days.[8–10] The incidence of prolonged ICU stay after cardiac surgery varies from 4% to 11%, depending on its definition. Some estimate that up to 36% of patients who undergo cardiac surgery experience a prolonged ICU stay.[11]

A limited number of reviews of QOL after ICU stay have been published.[12] However, there has been no systematic review on the impact of prolonged ICU stay on patients' QOL after cardiac surgery or study of patients undergoing cardiac surgery that assesses QOL according to the requirements described in Table 1.[13] In addition to the paucity of available literature, current research into QOL in cardiac surgery is not standardized. There also remains variability in the number of patients, follow-up times, and the availability of preoperative (baseline) QOL assessment in cardiac surgery.

The aims of this study were to review the literature regarding QOL outcomes in relation to prolonged ICU stay after cardiac surgery and to explore predictors of poor QOL outcomes.

Methods

This systematic review was designed and reported following the PRISMA criteria.[14] All searches were completed on September 17, 2015. A systematic review process of published original research articles was conducted. First, 2 authors (MSD and NM) and a librarian searched SCOPUS to identify the strength and quality of the search. The following electronic databases then were searched independently: MEDLINE (1946-07 August 2015, including articles in review stage), Embase (1974-07 August 2015), the Cochrane Database of Systematic Reviews (2005 to August 2015), Cochrane Central Register of Controlled Trials (2005 to August 2015), and conference abstracts via Google Scholar.

Table 1: Requirements to Increase the Validity of Postoperative Quality-of-Life Studies[13]

Criterion	Explanation
1	Clearly define the number of patients included in the study and the precise surgical intervention (e.g., CABG only v CABG and valve), and explicitly state inclusion and exclusion criteria.
2	Clear description of the number of patients with (1) preoperative and postoperative QOL information and (2) the number of patients with complete QOL information.
3	State whether the study has been performed only on patients with complete data and whether imputation methods have been used to handle the missing data.
4	State the reason for missing preoperative QOL data and a comparison of demographics, comorbidity, cardiac data, and risk stratification of the groups with and without preoperative QOL data.
5	State the reason for missing postoperative data as described in 4.

Abbreviations: CABG, coronary artery bypass graft; QOL, quality of life.

Studies addressing prolonged ICU stay and QOL after adult cardiac surgery were identified. A broad/sensitive search strategy was used: truncated free-text searches within text words were paired with exploded subject heading searches (MeSH and Emtree). Search strategy/search terms used (TERMS IN CAPITALS are subject heading searches, 'exp' ¼ exploded, MeSH terms given, equivalent Emtree headings used in Embase):exp "QUALITY OF LIFE" OR "QUALITYADJUSTED LIFE YEARS"/ (quality of life or qol or QOL or health related Quality of life or HRQOL or Manchester Short Assessment of Quality of Life or SF-36 HEALTH SURVEY or The Short-Form Health Survey or SF-12 HEALTH SURVEY or WHODAS or WHOQOL or "WHODAS 2 0" or WHO-Quality of life-BREF or WHOQOL-BREF or EuroQol or EQ-5D or Nottingham Health Profile or "WHO Disability Assessment Schedule 2 0" or WHO Disability Assessment Schedule or QUALITY-ADJUSTED LIFE YEARS)./AND exp "RESPIRATION ARTIFICAL" OR. exp "CRITICAL ILLNESS" OR. exp "INTENSIVE CARE UNIT"/ (INTENSIVE CARE UNIT or ICU or INTENSIVE THERAPY UNIT or ITU or HIGH DEPENDENCY UNIT or HDU or CRITCAL CARE or Intensive therap* or CRITICAL CARE PATIENTS or Artificial ventilation or Mechanical ventilation) AND exp "THORACIC SURGERY" OR "CARDIAC SURGICAL PROCEDURES" OR "CORONARY ARTERY BYPASS"/ (Heart adj5 surg*). or Cardi* adj5 surg*. or Heart adj5 operation or Cardi* adj5 operation or Beating heart surgery. or Open heart surgery or Cardiopulmonary bypass or Heart bypass or Valve surgery or Aortic valve surgery or Mitral valve surgery or Tricuspid surgery or Valve operation or

Aortic root operation or Aortic root surgery or Valve preserving operation or Cardiothoracic surgery or Coronary artery bypass surgery or CABG.

Using OvidSP, all the identified articles in MEDLINE, Embase, Cochrane Central Register of Controlled Trials, and Cochrane Database of Systematic Reviews were combined using the "and" function to yield the number of citations. These citations were reviewed to identify any other relevant articles. The references of all identified articles also were reviewed to detect relevant information and to identify any additional related articles.

Two reviewers (MSD and RB) performed eligibility assessments independently in an unblinded standardized manner. Abstracts for titles meeting the criteria were reviewed further and agreement reached if they met the inclusion/exclusion criteria. All studies were examined with no restriction on study type. A search of the Cochrane database and PROSPERO showed no relevant systematic reviews on this topic.

Inclusion and Exclusion Criteria

Studies including patients 18 years or older, undergoing all types of cardiac surgery, and who were admitted to ICU after surgery were included. Studies assessing QOL using any QOL scale, including Quality of Well Being Scale, EuroQol (EQ5D), Nottingham Health Profile (NHP), Short Form 36/12 (SF36/SF-12), Sickness Impact Profile, Health Utilities Index, Duke Activity Status Index, WHO Disability Assessment Schedule, or Karnofsky functional status, were included. There is no consensus on the definition of prolonged ICU stay, but it can range from >24 hours to >14 days. Therefore, if already not predefined by an author, any study on QOL after cardiac surgery with length of ICU stay >24 hours[8–10] was included. Only studies for which patients were followed up for at least 3 months post-ICU discharge were included.

Pediatric patients and infants undergoing cardiac surgery were excluded. Patients undergoing cardiac surgery for infective endocarditis or cardiac transplantation and patients undergoing aortic surgery with circulatory arrest also were excluded because the majority of these patients underwent surgery at a time of extremis, preventing accurate preoperative assessment of QOL. Studies for which follow-up was less than 3 months also were excluded; previous studies have noted that 3 months was the minimal recovery time needed in both the physical and mental components of QOL.[15] Studies for which QOL data were not reported and/or data were not provided on request from the authors also were excluded. Articles not published in the English language were excluded.

Data Extraction and Quality Assessment

Two researchers (MSD and RB) were responsible for data extraction with referral to a third researcher if there was ambiguity. Data were entered into Microsoft Excel (Microsoft, Redmond, WA) and included the following: year of publication, author, country of origin, study design, age specific, ICU specific, percent of ICU days greater than 1 day, surgery type, sample size, mean age, percentage of males, patients assessed with QOL tool, length of follow-up, and outcome. Each row represented a unique article.

Of the 1,518 studies captured in the databases, 18 were included. The included articles were assessed methodically for quality, adapting the criteria by Mols et al.[16] This scoring system uses a checklist of 10 items (Table 2). Studies with a score ≥8 were considered to be of high quality, a score in the range of 5 to 7 “moderate quality,” and a score <5 “poor quality.”

Outcomes

QOL after cardiac surgery and its relation to duration of ICU stay was the primary outcome. Secondary outcomes were predictors of poor postoperative QOL.

Table 2: Scoring Criteria for Quality of Eligible Articles (Maximum Score ¼ 10)

Criterion	Explanation
A	Sociodemographic and medical data are described (e.g., age, race)
B	Inclusion and/or exclusion criteria are formulated
C	The process of data collection is described (e.g., interview or self-report)
D	The presence of a comparator (e.g., age-matched population, groups with different treatments or age)
E	Participation and response rate for patient group has to be described as >75%
F	Information is presented about patient/disease characteristics of survivors/non-survivors and/or comparators
G	A standardized or valid QOL questionnaire is used
H	Results are not only described for QOL, but also the physical, psychologic, and social domains
I	Mean, median, standard deviations, or percentages are reported for QOL measures
J	Patients signed an informed consent form before study participation

Abbreviations: QOL, quality of life.

Description of Measurement Instruments

SF-36,[17] Karnofsky Performance Status,[18] EQ-5D,[19] and NHP[20] are measures of health-related QOL commonly used in critical care research. Studies incorporating the New York Heart Association (NYHA) functional class were excluded because NYHA alone is not a validated QOL assessment tool.

The SF-36 questionnaire is validated for QOL assessment in cardiovascular disease. It was introduced in 1990 and was revised in 1996. It consists of 36 questions covering 8 domains (physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional, and mental health), which are summarized as physical and mental component summary scores. The scores range from 0 to 100, with a higher score indicating a better QOL.[17] The SF12 is a shortened version of the SF-36.[17] The Karnofsky performance score originally was designed to assess performance status in cancer patients.[18] It is scored in 10% increments, from normal activity (100%) to death (0%). Therefore, it was designed for purposes other than assessing QOL. Its use in cardiac populations has not been validated; however, it still remains a frequently used tool in assessing functional status (as a marker of QOL), given its simplicity of use. This is despite the increase in the number of novel tools to assess QOL. A number of other assessment tools were used. The Seattle Angina Questionnaire consists of 19 questions measuring domains of coronary artery disease, including physical limitation, frequency of angina, stability of angina, satisfaction of angina treatment, and the effect of angina on QOL.[21] Activities of daily living were assessed in some studies using the Barthel Index, a score commonly used in rehabilitation. The NHP is a 2-part questionnaire assessing a number of domains, including energy, pain, emotional reaction, sleep, social isolation, and physical mobility. Each of these domains is scored out of 100. The second part focuses on the negative impact of poor health on various activities of daily living, such as occupation, housework, and social life.[22] The EQ-5D is a 3-part questionnaire and assesses health in the following 5 domains: mobility, self-care, normal daily activities, pain/discomfort, and anxiety and depression.[19] Although this is a validated assessment tool in QOL, its use in critical care is not as established as is the SF-36.[23] In those with physical illness, the Hospital Anxiety and Depression Scale is a short assessment tool to measure anxiety and depression. Another tool used was the Duke Activity Status Index.[24] This includes 12 questions to assess functional capacity mainly in cardiovascular disease.

Results

A systematic review of the literature identified 1,518 studies. A total of 18 were eligible for review, as shown in Figure 1. Characteristics of all studies are presented in Tables 3 and 4. All studies included were single-center registries. Only 2[4,5] were prospective studies (Table 4). The other 16 studies were retrospective (Table 3).[3,7,9,25–37] The retrospective studies included 1,438 patients. Two studies were prospective and included 100 patients. Of the 18 studies reviewed, 17 were conducted in Europe[3–5,7,25–28,31–37] and 1 in the United States.[9] Given the heterogeneity of the included studies, statistical analysis could not be performed accurately.

Quality of Included Studies

The included studies varied in quality score according to the checklist used (Table 2). The scores ranged between 0 and 10 (Fig 2). The mean quality score was 8.4.

Eight of the eligible studies were allocated a score of 10, 12 studies a score ≥8, and 7 studies ≤7. The lowest score was 4 and was for a conference abstract.[25] Methodologic shortcomings included response rate, a descriptive assessment of QOL results, and lack of information on characteristics of non-responders.

QOL Assessment Tools

Assessment tools ranged from established QOL measures to custom-made questionnaires and objective assessments of independence, including physical functioning and activities of daily living. These are shown in Table 5. The SF-36 and Karnofsky score were the most commonly used tools.

Definitions of Prolonged ICU Stay

The definitions of prolonged ICU stay varied. In 8 studies, the definition of prolonged ICU stay was >5 days.[3,26,27,29,32,33,36,37] The next most common definition was >7 days, reported in 7 studies.[4,9,25,30,31,34,36] Two studies considered ≥2 days in the ICU as prolonged.[5,28] Another study defined prolonged ICU stay as ≥3 days.[7] Mean ICU stay ranged between 2 and 30 days.

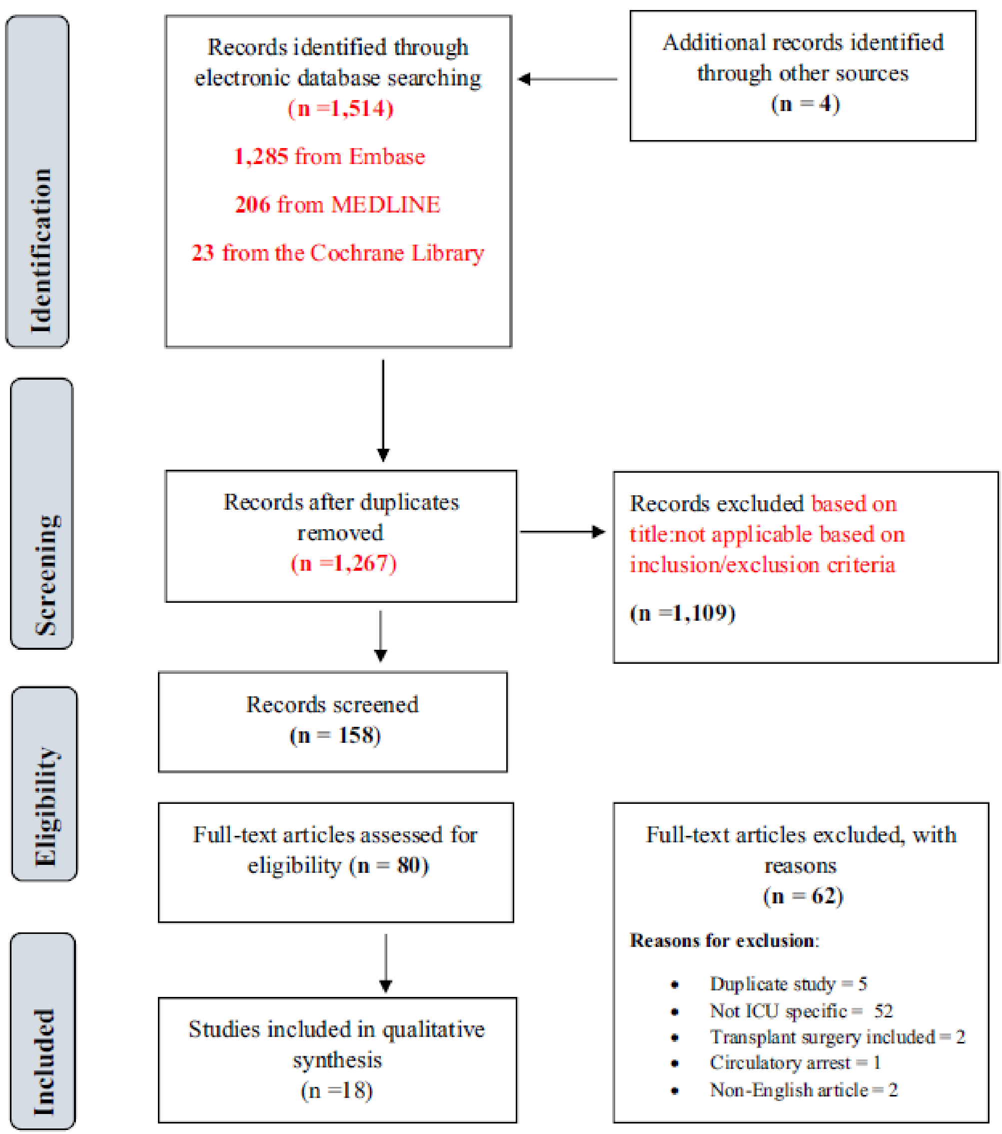

Fig 1. Flow diagram representing phases of article selection for systematic review.

Follow-Up

All studies had a minimum of 3 month's follow-up. Five studies had 1 fixed follow-up point at 12 months.[3,26,27,29,33] Four studies had a follow-up period ranging from 12 to 38 months.[9,34–36] The remaining 8 studies had a follow-up period of more than 5 years[4,5,7,28,30–32,37] and one study up to 10 years.[28] Median follow-up time was 7 months. QOL was assessed at follow-up by mailed survey in 3 studies,[25,33,35] with telephone interview in 5 studies,[3,30,34,36,37] and in-hospital follow-up in 1 study. In 3 studies, follow-up occurred at multiple time points by telephone interview.[8,9,32] In 7 studies there was no clear description of the interview method used.[4,7,26–29,31]

Prospective Studies and Change in QOL Over Time

Two prospective studies were included.[4,5] Gaudino et al[4] examined 121 patients (1.8% of all operated patients) who spent ≥10 days in ICU. The Karnofsky score was used at 1 fixed time point after ICU discharge (12 months). They concluded that patients with prolonged ICU stay had a very poor long-term outcome. However, Sandroed et al[5] studied 43 patients (8% of all operated patients) who stayed in the ICU for more than 1 day by assessing QOL using the SF-36 at 3 time points (6 and 12 months and 5 years). They noted improved QOL after surgery, but the group with prolonged ICU stay improved less than the group with a shorter stay. After 5 years, the ICU group still reported lower SF-36 scores.

Retrospective Studies and Change in QOL Over Time

Sixteen retrospective studies were included.[3,7,9,25–37] The reasons for exclusion are shown in Figure 1. Three studies used multiple QOL tools.[26,28,31] These studies included a total of 3,377 patients, with an age range of 66.1±10.7 to 84.1±3.7 and length of follow-up from 6 months to 10 years. The tools used are shown in Tables 3, 4, and 5.

Two studies[26,32] reported that 78% of survivors had a good functional, physical, and mental outcome. Conversely, Gaudino et al[4] reported a poor outcome in patients after a prolonged ICU stay (>10 days), although this was a prospective study. Hellgren et al[31] found a significant impairment in mobility and the ability to manage daily activities at follow-up in patients with an ICU stay >8 days.

Studies Showing Improvement in QOL

Seven studies[26,29,30,32,35–37] showed an improvement in QOL from baseline. Of these, 4 studies showed mortality was higher in patients with prolonged ICU stay.[27,30,32,36] One study demonstrated statistically significant differences in mortality at 2 years between prolonged and shorter ICU stays but not at 3 years.[35] In addition, these studies reported that good QOL outcomes were achievable in patients with prolonged ICU stay at a high financial cost.

Gersbach et al[29] demonstrated no statistically significant difference in mortality in patients with prolonged ICU stay or in those experiencing a major postoperative event. They suggested that perioperative neurologic insult was the only predictor of poor QOL. In another study, preoperative atrial fibrillation (AF) and prolonged mechanical ventilation were predictive of poor long-term outcomes and increased mortality; however, QOL was not impaired at 5 years' follow-up.[30]

Trouillet et al[37] noted an association with mortality and a higher NYHA classification. Also, NYHA class influenced QOL outcome.

Studies Showing No Improvement/Negative Impact on QOL

Nine studies[3,7,9,25,27,28,31,33,34] showed no improvement or a deterioration in physical and/or mental function. Hellgren et al[31] showed reduced QOL in the domain of physical health in patients requiring prolonged ICU stay after heart valve surgery. Another study showed similar results.[25] Furthermore, these studies noted that physical QOL after prolonged ventilation was significantly reduced compared with short-term ventilation (<10 hours).

The other 7 studies[3,7,9,27,28,33,34] showed similar results, with QOL considerably reduced in the prolonged ICU group, particularly in domains reflecting physical activity. In 8 of 9 studies demonstrating a deterioration in QOL, there was a higher early and late mortality. Jokinen et al[7] also demonstrated reduced QOL after prolonged ICU stay; however, they noted that when comparing this cohort with a normative agematched population, survival and QOL were similar at longterm follow-up. Dunning et al[28] showed impairment in QOL after ICU stays ≥2 days; however, at 10-year follow-up the majority had recovered to an acceptable QOL. Table 6.

Table 3: Retrospective Studies of QOL After Prolonged ICU Stay After Cardiac Surgery

Study	Mean Age (% Male), Surgery	Prolonged ICU Stay Definition, d (Number of Patients Requiring Prolonged Stay; %)	QOL Assessment Tool	Length of Follow-Up (% Follow-Up)	Follow-Up Time Points (Method of Follow-Up)	Comparator	Authors' Conclusions
Isgro et al (2002)[32]	64.9 (66.5%), CABG, valve, and combined	> 5 (232; 4.6%)	BI	6-82 months (90.8%)	6 and 82 months (telephone)	Propensity age-matched population	Excellent physical and psychologic outcome of survivors. Prolonged ICU stay associated with high in-hospital and follow-up mortality.
Jokinen et al (2008)[7]	72.1 ± 2.9 (48.1%), CABG, valve, and combined	3 (104; 13%)	NHP	8.2 years ± 0.7 (75%)	15 months and 8.2 years (face to face)	Propensity age-matched population	ICU stay > 3 days associated with impaired QOL. Survival and QOL similar for octogenarians and age-and sex-matched controls at 8.2 years after cardiac surgery.
Deschka et al (2013)[27]	Group A: 69.0 ± 7.6 Group B: 84.1 ± 3.7 (72.1%), all cardiac surgery	5 (86; 8.1%)	SF-12, BI	1 year (100%)	12 months (face to face)	Matched with patients < 80 years (group A)	QOL did not differ significantly between group A and group B; however, mortality was higher in group B (> 80 years).
Deschka et al (2013)[26]	72.2 ± 9.3 (70.6%), CABG, valve, combined, and aortic	5 (119; 10.9%)	SF-12, BI	1 year (100%)	12 months (face to face)	No	Encouraging physical and psychologic recovery of survivors. Prolonged ICU stay associated with high in-hospital and follow-up mortality.
Gersbach et al (2006)[29]	66.1 ± 10.7 (66%), all cardiac surgery	5 (194; 10.4%)	SF-12, Karnofsky	1 year (98.8%)	12 months (face to face)	Propensity age-matched population, < 5 days ICU stay	QOL at 1 year was improved in 80%, 11.5% felt no change, and 8.5% reported lower QOL. Perioperative neurologic insult was the only predictor of poor QOL. Mortality was low at 1 year.
Grothusen et al (2013)[30]	67.1 ± 10.2 (75.9%), all cardiac surgery	7 (229; 4.3%)	SF-36	5 years (44.1%)	5 years (telephone)	Normative data	QOL not impaired at 5-year follow-up in 49 patients. Preoperative atrial fibrillation and prolonged mechanical ventilation associated with poor long-term outcome and increased mortality.
Soderlind et al (1997)[35]	66 (64%), all cardiac surgery	N/A (study looked at cost of treatment in prolonged ICU stay) (100; 7%)	Self-designed	2 years (91%)	12 and 24 months (mail)	Propensity age-matched population with low cost ICU stay	Good QOL and outcomes at 2 years despite prolonged, expensive ICU stay.
Pappalardo et al (2004)[34]	66 ± 10 (59.4%), all cardiac surgery	7 (148; 3%)	Self-designed	36 ± 12 months (100%)	36 ± 12 months (telephone)	Patients with < 7 days ICU stay	Mild or no limitation in QOL reported by 69%. In-hospital mortality of patients requiring prolonged ICU stay was high.
Soppa et al (2012)[36]	Group A: 70 (64%) Group B: 70 (71%), all cardiac surgery	Group A: 5 (10-53; 2.3%) Group B: > 10 (55; 2.4%)	Karnofsky	13-38 months (100%)	13-38 months at 1 time point only (telephone)	Propensity matched Group A *v* group B	QOL after prolonged ICU stay was satisfactory after 1 year. Patients with prolonged ICU stay after cardiac surgery had high mortality.
Trouillet et al (1996)[37]	60.5 ± 12.2 (62%), all cardiac surgery	> 5 days (not documented)	NHP	70-93 months (97%)	6 years (not specified)	Normative data	Good QOL reported by > 70%. Influenced by age and NYHA classification only. Mortality associated with NYHA classification.

Study	Mean Age (% Male), Surgery	Prolonged ICU Stay Definition, d (Number of Patients Requiring Prolonged Stay; %)	QOL Assessment Tool	Length of Follow-Up (% Follow-Up)	Follow-Up Time Points (Method of Follow-Up)	Comparator	Authors' Conclusions
Hellgren et al (2005)[31]	64 (69%), valve and double valve surgery	8 (225; 5%)	SF36, NHP, and HADS	8 months-5 years (87%)	Not specified (mail)	Propensity matched, ICU stay < 2 days	QOL reduced in patients undergoing heart valve surgery compared with control group. Mortality was higher in the prolonged ICU stay group.
Azhari et al (2012)[25]	67.8 ± 11.5 (71.9%), all cardiac surgery	7 (91; % not documented)	SF-36	Not documented (50%)	12 months (mail)	Same cohort with ICU stay < 1 day	Physical QOL after prolonged ICU stay was significantly reduced compared with ICU stay < 1 day. Mental QOL after prolonged ventilation was equal to patients with < 1 day ICU stay.
Bapat et al (2005)[3]	67.5 (73%), CABG, valve, combined	5 (89; 11%)	SF-36	1 year (100%)	12 months (not specified)	Age-matched uncomplicated recovery control group	QOL significantly reduced in prolonged ICU stay group. High mortality in patients with prolonged ICU stay at 1 year.
Dunning et al (2008)[28]	61 (77.4%), CABG	2 (687; 58.2%)	EQ-5D	10 years (85%)	10 years (not specified)	Propensity match, ICU stay < 1 day	Overall good QOL after CABG. QOL was impaired with ICU stay > 2 days; however, many patients recovered to an acceptable QOL. Poor QOL reported in 14.7% of patients.
Nielsen et al (1997)[33]	64.4 (62.5%), CABG, valve, and combined	5 (96; 1.7%)	NHP	1 year (94%)	12 months (mail)	Propensity match, ICU stay < 1 day	QOL considerably reduced in the ICU group, especially relating to physical activity. Mortality of 50% at 1 year in prolonged ICU stay patients.
Bashour et al (2000)[9]	70 (71.9%), CABG, valve, and combined	10 (142; 5.4%)	Duke Activity Index	16-37 months (80%)	Not specified (not specified)	Patients with ICU < 10 days	Many long-term survivors had a poor QOL. Survivors of prolonged ICU stay died soon after discharge.

Abbreviations: BI, Barthel index; CABG, coronary artery bypass graft; EQ-5D, EuroQol-5D; HADS, Hospital Anxiety and Depression Scale; ICU, intensive care unit stay; NHP, Nottingham Health Profile; NYHA, New York Heart Association; QOL, quality of life; SF-12, Short-Form 12; SF-36, Short-Form 36

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Table 4: Prospective Studies of QOL After Prolonged ICU Stay After Cardiac Surgery

Study	Mean Age (% Male), Surgery	Prolonged ICU Stay Definition, d (Number of Patients Requiring Prolonged Stay; %)	QOL Assessment Tool	Length of Follow-Up, (% Follow-Up)	Follow-Up Time Points (Method of Follow-Up)	Comparator	Authors' Conclusions
Sandroed et al (2014)[5]	Not documented (67%), all cardiac surgery	> 1 (43; 8%)	SF-36	5 years	Baseline, 6 months, 12 months, and 5 years (not specified)	Patients with < 1 day ICU stay	QOL improved after surgery, but to a lesser degree than the prolonged ICU group. This group reported lower QOL compared with the normal group at 5 years. Mortality was higher in the prolonged ICU stay group.
Gaudino et al (2007)[4]	72 ± 9 (66.7%), all cardiac surgery	> 10 (57; 1.8%)	Karnofsky	71 ± 13 months (100%)	6 months and 12 months (face to face)	No	Prolonged ICU stay was associated with poor QOL and outcome.

Abbreviations: ICU: intensive care unit stay; QOL: quality of life; SF-36: Short-Form 36.

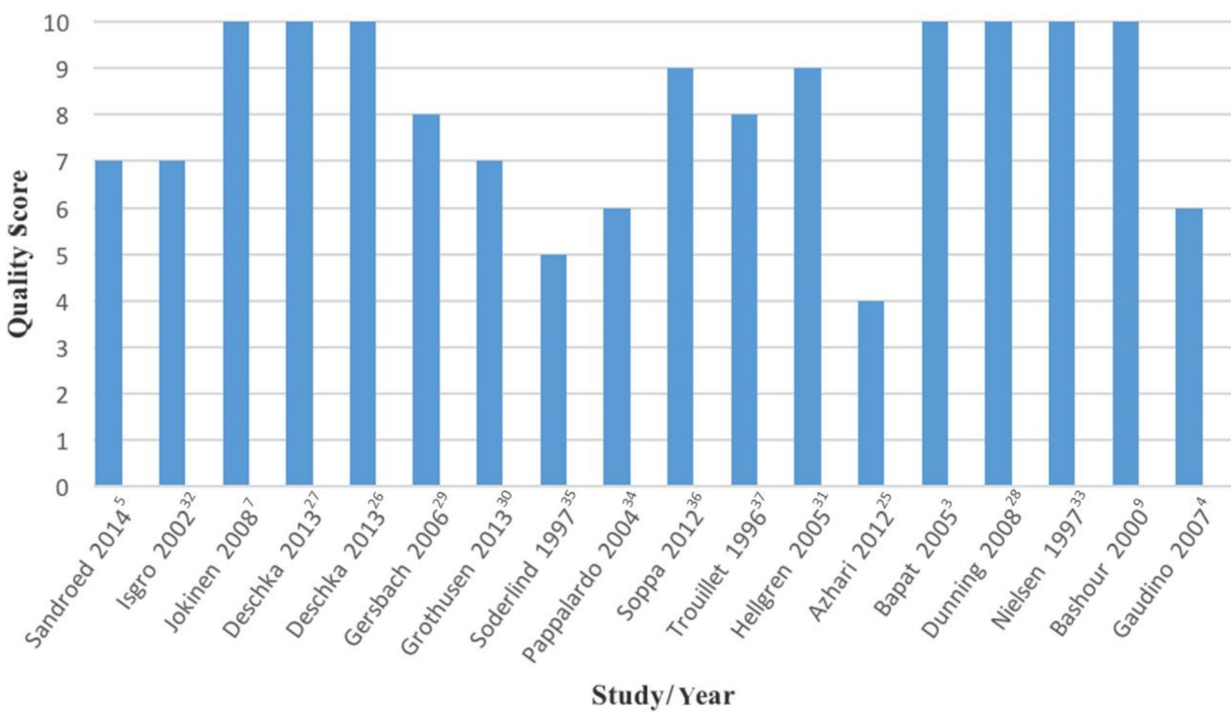

Fig 2. Quality score versus publication.

Risk Factors for Prolonged ICU Stay

Hein et al[11] found that postoperative cardiac failure is an independent risk factor for prolonged ICU stay. Moreover, the urgency, complexity, and duration of cardiopulmonary bypass also were identified as risk factors.[4] Low ejection fraction was identified as a risk factor by several authors.[3,4,38] Organ failure was the main predictor of prolonged ICU stay in 1 study.[11] Five studies examined preoperative risk stratification (European system for cardiac operative risk evaluation [EuroSCORE]),[3,27,30,31,36] and only 1 study related a high EuroSCORE to prolonged ICU stay.[3]

Table 5 : QOL Tools Used in the Examined Articles

QOL Assessment Tool Used	Number of Studies
SF-36	5
Nottingham Health Profile	4
Multiple tools	4
SF-12	3
Karnofsky Performance Status	3
Barthel Index	3
Self-designed questionnaire	2
EQ-5D	1
HADS	1
Duke Activity Status Index	1

Abbreviations: EQ-5D, EuroQol-5D; HADS, Hospital Anxiety and Depression Scale; QOL, quality of life; SF-12, Short-Form 12; SF-36, Short-Form 36.

Discussion

This systematic review provided the first overview on QOL after prolonged ICU stay after cardiac surgery and demonstrated that patients with prolonged ICU stay after cardiac surgery had a slower or poor recovery in QOL in the majority of studies. Furthermore, patients who experienced prolonged ICU stay experienced a greater in-hospital and late mortality. Despite considerable heterogeneity among the included studies, the authors also identified a number of factors that may predict a poor QOL after cardiac surgery.

QOL Outcomes and Assessment Tools

With declining mortality and morbidity after cardiac surgery over the past decade, surgical outcome increasingly is quantified in terms of its impact on patients' functional status and QOL.[39] QOL therefore should be incorporated into cardiac risk stratification scores, which would give patients a better understanding of their postoperative recovery.

This review outlined variable QOL outcomes after prolonged ICU stay. This may be due to 2 factors. First, there was lack of consistency in assessing all domains of QOL. Second, there was no standardization in definitions of prolonged ICU stay, follow-up time points, and clinical endpoints.

There were 8 validated QOL assessment tools and 2 customized questionnaires identified. Of the 2 prospective studies,[4,5] 1 used SF-36 and the other used the Karnofsky score. The latter demonstrated poor Karnofsky scores at follow-up. QOL, as per the World Health Organization definition,[40] consists of a number of domains, one of which is the individual's perception of his or her physical health and level of independence. The Karnofsky score does not take into account other domains, such as psychologic well-being, and therefore alone is not a complete or accurate assessment QOL tool.

To date, no QOL assessment tool has been designed specifically for cardiac surgery, and until this occurs, multiple QOL assessment tools should be used to provide an accurate picture of a patient's QOL, as was done in 4 retrospective studies reviewed for this study.[26,27,29,31]

There are 6 cardiac risk scoring systems that estimate mortality and morbidity.[41] Risk assessment is only an estimate, and many high-risk patients do well, and some low-risk may fare worse. If a proper evaluation of the outcome in patients with complicated cases is to be made, it should include more than surgical mortality and morbidity. One recent study[42] integrated ICU duration into a logistic risk modeling score, the Cardiac Surgery Score (CASUS), and found that integration of length of ICU stay improved mortality prediction significantly. A diverse analysis of the final outcome should include a combination of survival, QOL, functional status, and ICU stay duration.

Table 6 : Quality of Life Domains Assessed in Each Study

Study	Physical	Mental	Nociceptive	Cognitive	Social	Emotional	Vitality	General Health
Isgro et al[32]	√	-	-	-	√	-	-	√
Jokinen et al[7]	√	-	√	-	√	√	√	-
Deschka et al[27]	√	√	√	-	√	√	√	√
Deschka et al[26]	√	√	√	-	√	√	√	√
Gersbach et al[29]	√	√	√	-	√	√	√	√
Grothusen et al[30]	√	√	√	-	√	√	√	√
Soderlind et al[35]	√	√	-	-	√	√	-	-
Pappalardo et al[34]	√	-	√	-	√	√	-	√
Soppa et al[36]	√	-	-	-	√	-	-	-
Trouillet et al[37]	√	-	√	-	√	√	√	-
Hellgren et al[31]	√	√	√	-	√	√	√	√
Azhari et al[25]	√	√	√	-	√	√	√	√
Bapat et al[3]	√	√	√	-	√	√	√	√
Dunning et al[28]	√	√	√	-	√	√	-	√
Nielsen et al[33]	√	-	√	-	√	√	√	-
Bashour et al[9]	√	-	-	-	-	-	-	-
Sandroed et al[5]	√	√	√	-	√	√	√	√
Gaudino et al[4]	√	-	-	-	√	-	-	-

Mechanical Ventilation as a Predictor of QOL Outcome

Prolonged mechanical ventilation is a known factor in influencing postoperative QOL.[11] Scores relating to physical domains in QOL assessment are lower in those with prolonged mechanical ventilation.[25,30] Despite this, the duration of mechanical ventilation has not been incorporated as a variable in the majority of studies assessing postoperative QOL. In addition, the prediction of prolonged mechanical ventilation has not been incorporated into most cardiac surgery risk scoring models. Addition of this vital component could help predict QOL. The definition of prolonged ventilation after surgery, similar to the definitions of prolonged ICU stay, is unclear and should be evaluated and defined.

Preoperative Atrial Fibrillation as a Predictor of Poor Postoperative QOL

One study that examined 229 patients (4.3% of all operated patients) with an ICU stay of >7 days associated preoperative AF with poor long-term QOL outcomes and long-term mortality.[30] Despite this, the Society of Thoracic Surgeons score is the only risk assessment tool incorporating preoperative AF.[43] The association of preoperative AF and poor QOL outcomes may be related to the increased risk of stroke. However, AF also may be an independent risk factor and an overlooked predictor of QOL after surgery.

Perioperative Neurologic Insult as a Major Predictor of Postoperative QOL

Perioperative neurologic insult also was noted to be an important predictor of prolonged ICU stay and poor QOL.[29] Therefore, strategies to prevent neurologic insult should be adopted to prevent this dreaded complication in cardiac surgery, such as avoiding prolonged periods of hypotension in the perioperative period.[44]

Other Predictors of Poor QOL After Cardiac Surgery

Preoperative NYHA classification was noted to be an influencing factor on the rate of recovery and QOL.[4,31,37] However, Dunning et al[28] contradicted this and showed that higher NYHA had no effect on QOL after surgery. Similarly, Hellgren et al[31] found no association among NYHA, prolonged ICU stay, and postoperative QOL. Only 1 reviewed study related other factors, such as age, left ventricular ejection fraction, hypertension, and NYHA, to poor long-term outcome and worse QOL.

De Cocker et al[45] reported 12 predictors of prolonged ICU stay. However, 1 study found no reliable predictor of survival or functional outcomes in cardiac surgical patients requiring prolonged ICU stay.[29] In an attempt to decrease prolonged ICU stay and improve QOL, Hein et al[11] suggested identifying and prophylactically treating causes of postoperative organ failure (such as preoperative insertion of an intra-aortic balloon pump) to decrease prolonged ICU stay and improve QOL.

Study Limitations

Most of the reviewed studies were retrospective and did not allow comparison with preoperative QOL. Second, there has been no clear definition of prolonged ICU stay. As a result, the authors could compare QOL in groups with varying definitions of prolonged ICU stay. In addition, variation in follow-up means there is ambiguity in interpreting postoperative QOL scores. Risk stratification and propensity matching were poor in several studies, making interpretation of a correlation between pre-existing comorbidities with prolonged ICU stay and QOL outcomes difficult. A meta-analysis therefore could not be performed.

Suggestions for Future Research

QOL now is considered to be an important outcome measure.[36] There has been no QOL assessment tool designed specifically for cardiac surgery; therefore, it may be that to accurately assess a patient's QOL, the use of multiple, specific QOL assessment tools is required. Furthermore, development of a specific assessment tool of QOL in cardiac surgery may streamline the process of QOL assessment in these patients. The authors suggest that baseline QOL assessment be required to accurately assess the impact of prolonged ICU stay after cardiac surgery on QOL. Follow-up periods should be defined clearly and patients should be assessed at frequent intervals to allow for identification of specific recovery time points. By doing so, this will provide patients with a better understanding of their postoperative recovery and allow for improved informed consent, particularly in patients in whom QOL likely is to be given more importance than longevity (e.g., in elderly and frail patients). It also would allow for the development of prediction models for postoperative QOL. To achieve this, the implementation of the requirements described in Table 1 in future QOL studies is recommended.

Conclusions

Postoperative QOL after prolonged ICU stay after cardiac surgery varies. The authors have demonstrated that QOL was impaired in prolonged ICU stay after cardiac surgery. Furthermore, mortality was high in this cohort. The authors also have identified that the duration of mechanical ventilation and perioperative neurologic insult were important predictors of poor postoperative QOL. The results of this review may not be generalized mainly due to the heterogeneity in the definition of prolonged ICU stay and timing of follow-ups.

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