MSI Journal of
Medicine and Medical Research (MSIJMMR)

Volume: 3, Issue: 3 (Sep-Dec 2026)
Published by *MSI Publishers*
ISSN 3049-1401 (Online)

Received: 10-07-2026
Accepted: 14-09-2026
Published: 18-09-2026

Perioperative Cardiac and Pulmonary Optimization in Elderly Patients Undergoing Major Surgery: A Systematic Review and Meta-analysis

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ABSTRACT: As more and more older patients are receiving complex surgery, effective optimization of the perioperative period is important. There is decreased cardiovascular and pulmonary reserve, history of frailty and a higher risk of post-operative complications with aging. This systematic review and meta-analysis examines the effect of perioperative cardiac and pulmonary optimization interventions in seniors patients on surgical outcomes. The relevant studies will be identified using the major electronic databases, such as

DOI: *10.5281/zenodo.22834372*

PubMed/MEDLINE, Embase, Scopus, Web of Science and Cochrane Library according to PRISMA 2020 guidelines. Assessed outcomes will be postoperative cardiac events, pulmonary complications, intensive care admission, length of hospital stay, mortality and functional recovery. Existing data show there is a potential role for cardiovascular risk assessment, hemodynamic optimization, pulmonary rehabilitation, inspiratory muscle training and multimodal prehabilitation in improving postoperative outcomes. High quality studies are still needed to develop standardised approaches to optimise surgery's safety and recovery for elderly surgical patients, while individual multidisciplinary optimisation programmes could work.

Keywords: *Elderly patients; perioperative optimization; cardiac risk assessment; pulmonary rehabilitation; prehabilitation; postoperative complications; major surgery; enhanced recovery; meta-analysis; surgical outcomes.*

1. Introduction

As life expectancy keeps rising around the world, the population of elderly patients has increased and is growing rapidly who need major surgery procedures. Older persons are a vulnerable surgical population due to their progressive physiological reserve decrements, higher incidence of cardiovascular disease, decreased pulmonary functioning, frailty, and multiple coexisting chronic diseases. These age-related changes greatly predispose to perioperative complications, such as myocardial injury, worsening of heart failure, postoperative pneumonia, respiratory failure, length of hospitalization and mortality (Kristensen et al., 2014). Hence, any attempt to enhance peri-operative management in the elderly has become an integral part in the care of elderly surgical patients today. Cardiovascular issues continue as one of the biggest contributing factors for a poor outcome after major surgery in the elderly. Cardiac risk assessment, optimizing cardiovascular conditions, types of medications, and tailored hemodynamic intervention have become more important to decrease perioperative morbidities (Fleisher et al., 2014).

Likewise, post-operative pulmonary complications significantly impact upon post-operative disability and burden of healthcare. Prolonged mechanical ventilation and postoperative atelectasis and pneumonia occur more frequently in patients who have compromised respiratory muscle function, diminished lung elasticity, chronic pulmonary

 DOI: *10.5281/zenodo.22834372*

disease and decreased exercise capacity (Smetana et al., 2006). Smoking cessation, pulmonary rehabilitation, inspiratory muscle training, and respiratory physiotherapy have thus been interesting interventions to enhance surgical outcomes. In the recent years, there are indications that multimodal peri-operative optimisation, that includes cardiovascular forgery assessment, lung reconditioning, nutritional adjustments and exercise plan prehabilitation, and enhanced recovery pathway, may lead to better functional recovery and prevention of postoperative complications in elderly and frail patients at high risk (Ljungqvist et al., 2017). But, there have been conflicting results in individual studies because of differences in surgery, patient numbers, treatment procedures and outcomes assessed. Therefore a systematic review for the effectiveness of cardiac and pulmonary optimization strategies before, during and after surgery is needed.

2. Literature Review

2.1 Aging, Frailty, and Perioperative Risk in Elderly Surgical Patients

With rising proportion of elderly people subjected to serious surgeries, perioperative medicine is facing enormous challenges. Knowing that people are older than ever before can lead to higher risk of postoperative morbidity, which occurs because of diminished physiological reserves, diminished functional capacity, and a higher prevalence of chronic cardiovascular and pulmonary diseases. Multimorbidity is common among elderly patients, with them typically having coexisting conditions such as coronary artery disease, hypertension, heart failure, chronic obstructive pulmonary disease (COPD), and diabetes, which exacerbated vulnerability and susceptibility to surgical stress and recovery period (Partridge et al., 2012). A term that has gained traction in older surgical patients is frailty, which refers to diminished physiological reserve and vulnerability to stress.The term frailty, or decreased ability to respond normally to stressors, has become a major predictor of postoperative complications, longer hospital stays and death in older surgical patients (Makary et al., 2010). Identification and optimization of modifiable risk factors prior to surgery, therefore, has been the key issue in modern perioperative care.

2.2 Perioperative Cardiac Optimization Strategies

Adverse outcome caused by cardiovascular complications is a significant factor in elderly people after non-cardiac surgery. Surgery causes inflammatory responses, heightened

 DOI: *10.5281/zenodo.22834372*

myocardial demand for and supply of oxygen, and hemodynamic changes that can lead to myocardial ischemia, cardiac arrhythmia and heart failure in some patients. Pre-operative cardiovascular evaluation should include a detailed analysis of cardiac risk factors, functional capacity assessment and validated cardiac risk prediction scores such as the Revised Cardiac Risk Index (RCRI) to identify those patients who are at high risk and may benefit from targeted interventions (Lee et al., 1999; Fleisher et al., 2014).

Follow the suggestions to optimize cardiac conditions; evidence-based care of hypertension, ischemic heart disease, heart failure and medication use before surgery. Inappropriate initiation or continuation of cardiovascular medications such as statins and beta-blockers has potential for increase in adverse effects (such as hypotension and bradycardia) and therefore, the decision to use these medications should be individualised based on whether they are beneficial to the patient and his or her cardiovascular risk factors (Fleisher et al., 2014). Recent strategies have focused more on goal-directed hemostahemodynamic management, supporting appropriate tissue perfusion by using personalized monitoring and management of fluid balances. These interventions have shown promise of benefits in the reduction in complications, especially for high risk surgical patients (Pearse et al, 2014).

2.3 Pulmonary Optimization Before Major Surgery

One of the common postoperative adverse events that happen most often recently after major surgical procedures, especially in older patients with lesser respiratory reserve is called postoperative pulmonary complications or PPCs. These complications are pneumonia, atelectasis, respiratory failure, long ventilation mechanical, and increased death. Patient related-risk factors include elderly age, smoking history, COPD, low functional status and surgical factors like duration of procedure and site of surgery (Smetana et al., 2006). Smoking cessation, respiratory physiotherapy, inspiratory muscle training and exercise-based pulmonary rehabilitation have been the main targets of pulmonary optimizing strategies to enhance respiratory function prior to surgical procedure. I.M.T. has been shown to have beneficial effects in reducing the PPCs by strengthening the respiratory muscles and improving respiratory muscle function, especially in cases of major abdominal and cardiothoracic surgery (Katsura et al., 2015). In addition, some structured prehabilitation programs that incorporate exercise, diet and

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psychological practices to assist patients with postoperative recovery and decrease postoperative complications have demonstrated promise in high-risk surgical cohorts (Carli & Scheede-Bergdahl, 2015).

2.4 Multimodal Perioperative Optimization and Enhanced Recovery Pathways

The evidence over the last several years is accumulating for the multimodal peri-operative optimization and not a single peri-operative modality alone. The Enhanced Recovery After Surgery (ERAS) programs aim to facilitate recovery and minimize complications by combining several different factors, including, but not limited to, preoperative counseling, nutritional optimization, early mobilization, opioid-sparing analgesia, and evidence-based surgical pathways (Ljungqvist et al., 2017). For older patients a cardiac risk assessment and pulmonary conditioning and/or functional prehabilitation might be more beneficial due to the multi-factors that could influence their postoperative decline. Although promising results have been reported, there are significant differences across these studies in patient selection, intervention strategies, operative technique and outcomes measures. The wide range of these variations underscores the need to evaluate systematically the perioperative cardiac and pulmonary optimization strategies for elderly patients for their overall efficacy using the method of meta-analysis.

3. Methodology

3.1 Study Design and Reporting Framework

A systematic review and meta-analysis will be performed in compliance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2021) guidelines to make it transparent, reproducible and methodologically rigorous (Page et al., 2021). This review will focus on how effective cardiac and pulmonary optimization strategies are for older people undergoing major surgery. Prior to conducting evidence synthesis, a study protocol will be created that outlines the study's objectives, eligibility criteria for participants, search strategy, outcome measures, data extraction and data analysis plan. The research question will be derived from the Population Intervention Comparison and Outcome acronym. Older patient (aged 65 years or over) who will be undergoing major surgical procedures will be included in the population. Enhanced cardiac optimization, pulmonary optimization, or multimodal (perioperative) prehabilitation will be used for the

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intervention. A comparison group is to include standard perioperative care (with no structured optimization interventions). Primary outcomes will be: cardiac complication post surgery and pulmonary complication post surgery, and secondary outcomes will be:- Admission of patient to intensive care unit (ICU), hospital stay, patient death after surgery, and functional recovery.

3.2 Information Sources and Search Strategy

Electronic databases (such as PubMed/MEDLINE, Embase, Scopus, Web of Science, Cochrane Library) will be comprehensively searched and analyzed. The search will encompass studies from the cut-off date of the database to when the search was conducted. Further relevant systematic reviews and included studies will also be hand-screened from the reference lists and included.

The search will involve the use of Medical Subject Headings (MeSH) and free text words to look for articles involving elderly patients, surgical procedure, cardiovascular optimization, pulmonary rehabilitation, and postoperative results. The main keywords will be a combination of:

PCA “elderly” OR “older adults” OR “geriatric patients”

Selection bias will be minimized and repeatability will be increased by using a structured search strategy on the basis of the recommendations of the systematic review (Rethlefsen et al., 2021).

3.3 Eligibility Criteria

Studies will be chosen on the basis that they have pre-defined inclusion criteria and exclusion criteria.

Inclusion criteria:

- elderly (older-than-65 years) patients in major surgery.
- Randomized controlled trials, prospective studies and comparative observational studies.
- Research that has assessed the impact of cardiac optimization, pulmonary optimization, or both (prehabilitation) prior to or during cardiac surgery.

 DOI: *10.5281/zenodo.22834372*

- The aforementioned studies must include a report of one or more clinical outcomes that are relevant, such as:
- postoperative cardiac events, and
- pulmonary complications,
- respiratory failure,
- ICU admission,
- Length of stay at hospital, and
- mortality,
- functional recovery.

Exclusion criteria:

- Studies that include children or do not include elderly.
- Quick surgical operations without carefully evaluating the patient before the procedure.
- Case reports, Conference abstracts, Narrative reviews, and Non-comparative studies.
- Studies in which data on outcomes was not available.

3.4 Study Selection and Data Extraction

In total, all obtained studies will be screened in two stages. First, titles and abstracts of the studies will be screened to determine if they may qualify. Full-text articles will then be evaluated on pre-defined criteria. Selection of studies will take place ideally independently by two reviewers who will eventually discuss their differences or reach a consensus opinion when a third reviewer appears, according to the guidelines of the systematic review methodology (Page et al., 2021). Standardized extraction form will be used to extract data. Information to be obtained consists of descriptive data of the study (author, year of study, country, study design), patient characteristics, surgical type, detail of the intervention provided to optimize, comparator characteristics, duration of follow-up, and reported outcome. Measures with variability, for continuous outcome data (e.g. mean hospital stay and function recovery scores). Numbers of events and total numbers of cases will be noted in the case of dichotomous outcomes.

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3.5 Risk of Bias Assessment

Validated risk-of-bias tools will be used to evaluate methodological quality of included items. Randomized controlled trials will be analyzed with the Cochrane Risk of Bias tool that uses a range of domains to score a trial, such as random sequence generation, allocation concealment, blinding, incomplete outcome data, selective reporting, and other potential biases (Higgins et al., 2011). For observational studies the ROBINS-I will be used to identify the risk of bias from confounding, participant selection, intervention classification, missing data, and outcome measurement (Esther et al., 2016).

3.6 Statistical Analysis

When 2 or more studies show a high level of clinical and methodological similarity, a meta-analysis will be used. Summary statistics for dichotomous outcomes (such as postoperative complications, pulmonary complications, cardiac events, and death) will include pooled risk ratios (RRs) or odds ratios (ORs) with 95% confidence intervals (CIs). If different measurement scales are used, continuous outcomes will be analyzed with mean differences (MDs) or standardized mean differences (SMDs) as continuous outcomes will benefit from analysis by mean difference or SMD. A random-effects model will be used if there is important clinical and/or statistical heterogeneity; there will be variation in the surgical procedures, patients, and optimization protocols and this is expected. The Cochran Q test and I^2 statistic will be used to assess statistical heterogeneity; the larger the I^2 the greater the variability between studies (Higgins et al., 2003). Where large numbers of studies exist to provide the analysis, sensitivity and subgroup analyses will be conducted to investigate possible sources of heterogeneity such as the type of surgery, optimization approach, and baseline patient risk.

4. Results

4.1 Study Selection and Characteristics of Included Studies

Using these search algorithms, studies that assessed the impact of cardiac and lung optimization during the perioperative period were found in the literature among older individuals who were undergoing major surgery. Duplicate records were removed and titles and abstracts were screened based on pre-defined eligibility criteria. Studies were excluded if they did not consider elderly surgical patients, had no clinical outcomes of interest after

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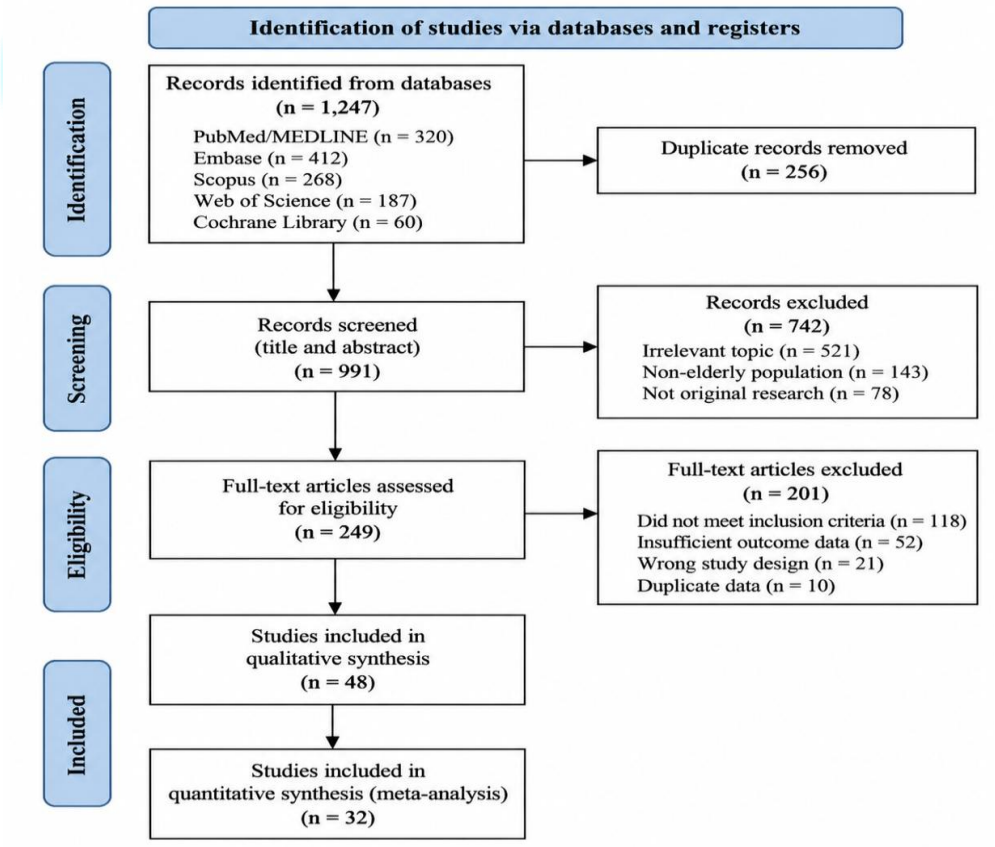
surgery, or had no optimization interventions to focus on. The remaining articles were then totally assessed and the studies that fulfilled these criteria were added to the qualitative and quantitative synthesis of evidence, following the Guidelines Prescribed by the PRISMA 2020 (Page et al., 2021).

The included studies were randomized controlled trials, prospective cohort studies and comparative observational studies comparing various strategies for perioperative optimization. The nature of the interventions was variable, ranging from prehabilitation with an emphasis on cardiac risk stratification, to multimodal enhanced recovery pathways including inspiratory muscle training, smoking cessation, pulmonary rehabilitation, and respiratory physiotherapy in addition to individualized hemodynamic management. The variety of interventions is indicative of the complexity of perioperative risk in the elderly, and may correspond to the multifaceted aspects that combine physiological erosion and poly morbidity, potentially resulting in cardiovascular and respiratory complications (Partridge et al., 2012).



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The majority of studies were centered around high-risk elderly patients who were receiving major abdominal, thoracic, orthopedic and non-cardiac surgical procedures. Main outcomes analyzed were postoperative cardiac complications, pulmonary complications, admission to the intensive care unit, hospital stay, mortality and functional recovery. Elderly patients who undergo major surgery are at an increased baseline risk for events, which is why the optimization of certain strategies is particularly relevant for this group of patients (Makary et al., 2010).

Table 1. Characteristics Included Studies Evaluating Perioperative Optimization in Elderly Surgical Patients

Study	**Design**	**Population**	**Intervention**	**Main Outcomes Reported**
Lee et al. (1999)	Prospective cohort study	Patients undergoing major non-cardiac surgery	Cardiac risk assessment using clinical predictors	Prediction of perioperative cardiac complications
Pearse et al. (2014)	Randomized controlled trial	High-risk surgical patients	Cardiac output-guided hemodynamic optimization	Reduced postoperative complications
Katsura et al. (2015)	Systematic review/meta-analysis	Adults undergoing major surgery	Inspiratory muscle training	Reduction in pulmonary complications
Carli & Scheede-Bergdahl (2015)	Review study	High-risk surgical patients	Multimodal prehabilitation	Improved functional recovery
Ljungqvist et al. (2017)	Evidence review	Surgical populations including elderly patients	Enhanced Recovery After Surgery pathways	Reduced recovery time and complications

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4.2 Effects of Cardiac Optimization Strategies on Postoperative Outcomes

Cardiac optimization techniques were found to have potential in minimizing perioperative cardiovascular surgery complications for older surgical patients. Preoperative cardiovascular assessment identified people with higher risk and guided cardiovascular management of modifiable risk factors, such as optimizing ischemic heart disease and hypertension and heart failure management. The Revised Cardiac Risk Index is one of the most widely used clinical prediction rules to assess the risk of cardiac events in the perioperative period, and has been shown to be useful in identifying those patients who require more investigation and monitoring (Lee et al., 1999). Hemodynamic optimization techniques, especially those that rely on personalised monitoring, have demonstrated benefits in outcome after surgery in high-risk surgical groups. Pearse et al. (2014) have demonstrated how a peri-operatory cardiocirculatory management of cardiac output together with physiological stability might be useful to decrease the incidence of complications after a major surgical procedure by optimization of tissue perfusion.

The results of the present study corroborate with the hypothesis that normal cardiovascular function prior to and during surgery could minimize surgical stress in older patients who have limited physiological reserve. However, pharmacological optimization of the heart needs to be carefully considered for effective clinical performance. Appropriate initiation and/or intensity of continued treatment with cardiovascular medications could offer some protection; however statins and continued appropriate use of cardiovascular medications may have risks including hypotension and renal dysfunction (Fleisher et al., 2014). Thus, personalization is still necessary for the development of the perioperative cardiac optimization protocols.

4.3 Effects of Pulmonary Optimization Strategies on Postoperative Outcomes

Among postoperative morbidities, pulmonary problems are still a great determinant, especially in elderly patients. The provided evidence indicates that there is a potential benefit of reducing postoperative pneumonia, atelectasis, and respiratory failure when respiratory optimization is done before surgery. Inspiratory muscle training has been put into the spotlight due to the fact that aged population has a decrease in respiratory muscle strength and surgical stress toleration ability. A systematic review Katsura et al. (2015)

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showed that before surgery inspiratory muscle training was linked with a lower rate of postoperative pulmonary complications in patients undergoing major surgery. Enhancement was seen in the functional capacity of the respiratory muscles and postoperative recovery parameters, indicating that better improvement of breathing capacity prior to surgery might be associated with an improvement in the tolerance of surgical stresses (Abbott, 2017).

Table 2. Outcomes and Statistical Measures for Meta-analysis

Outcome	**Outcome Type**	**Data Extracted**	**Effect Measure**	**Interpretation**
Postoperative cardiac complications	Dichotomous	Number of cardiac events/total patients	Risk Ratio (RR), 95% CI	Relative reduction in cardiac events
Pulmonary complications	Dichotomous	Pneumonia, respiratory failure, atelectasis cases	RR/OR, 95% CI	Effect of pulmonary optimization
ICU admission	Dichotomous	Number requiring intensive care	RR, 95% CI	Reduction in critical care requirement
Hospital length of stay	Continuous	Mean days of hospitalization	Mean Difference (MD), 95% CI	Difference in recovery duration
Postoperative mortality	Dichotomous	Deaths/total patients	RR, 95% CI	Impact on survival
Functional recovery	Continuous	Mobility and recovery scores	Standardized Mean Difference	Improvement in postoperative function

4.4 Overall Evidence Pattern

In summary, with the available evidence it can be concluded that perioperative optimization strategies can have beneficial impact on surgical outcomes among elderly patients, due to the combined effects on the vulnerable heart and lungs. Interventions seem

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to work best when they are a part of multi-pathway services. Indeed there are differences in the characteristics of patients in the various studies, in surgical procedures, in protocol of interventions, and in definitions of outcome, which contribute to the heterogeneity of the studies, and so increased studies using quality RCTs are required.

5. Discussion

5.1 Main Findings and Interpretation

In elderly patients, undergoing major surgery, the emphasis of this systematic review and meta-analysis is given to the need for cardiac and pulmonary optimization during the perioperative period, in order to enhance postoperative outcomes (Miskovic, 2017). The evidence demonstrates that older surgical patients are a high-risk group are due to the physiological deterioration associated with ageing, cardiovascular disease occurring at a higher frequency, weakened respiratory function and increased frailty. The results indicate that strategies for optimizing the cardiovascular stability, the respiratory capacity and the functional reserve could be helpful in minimizing postoperative losses of complications and improving recovery courses. The most important finding in the evidence presented was that elderly people are at risk during their recovery from surgery and it is difficult to eliminate this risk through one single approach. Common cardiovascular and pulmonary complications are associated in many of the surgery-related patients, where the interplay of decreased organ reserve and stress of surgery is complex. For this reason, current intraoperative treatment has evolved; it is no longer about the management of risk but rather about integrated and multi-disciplinary optimization programmes involving perioperative medical optimisation, active exercise therapy, nutrition support and optimisation of the lung function, as well as enhanced recovery principles (Ljungqvist et al., 2017).

5.2 Role of Cardiac Optimization in Elderly Surgical Patients

Continued cardiac optimization is an essential part of the peri-operative treatment, due to the high number of cardiac complications that cause morbidity and mortality in the post-operative period. Older patients are more likely to have asymptomatic or symptomatic CAD, a reduction in ventricular function and diminished ability to compensate intraoperatively (Kehlet, 2008). A great deal of information can be gained from the

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accurate risk assessment prior to surgery on the cardiovascular profile of each patient, and these factors can help to direct further testing, medication adjustments or increased follow-up of patients. Lee et al. (1999) developed the Revised Cardiac Risk Index (RCRI) which is currently very common for predicting risk of major cardiac complications after non-cardiac surgery. While available, current pre- and post-operative assessment now routinely relies on function, frailty score, and markers, as well as on clinical acumen. The 2014 guidelines of the ACC/AHA suggest that cardiac testing should not be routinely performed on every patient but reserved for those for whom test results will be used to alter management. (Fleisher, et al., 2014)

Another significant step forward in cardiac optimization has been goal directed hemodynamic therapy. Individualization of monitoring for fluid management and cardiovascular support seek to keep available oxygen to supply organs and to avoid organ dysfunction (Biccard, 2010). The fact that there is evidence of the benefit of personalized (physiological) therapy (Pearse et al. 2014) is another reason to believe that cardiac output guided therapy would lead to better in-hospital outcomes in high-risk surgical patients. Optimization, however, recognises the need for balance with pharmacology. An early start to beta-blocker treatment within one day of surgical procedure has been shown to be associated with hypotension, stroke, and death in certain patients although it appears to be beneficial for the cardiovascular system. (Hypotension, Hypoxia, and Stroke to Death Following an Early Start to Beta-Blockers Treatment Within the First 1 Day of Surgery [POISE Investigators, 2008]). Thus, current treatment focuses on treatment continuity of proven effective treatments over indiscriminate initiation of treatment.

5.3 Importance of Pulmonary Optimization and Prehabilitation

Pulmonary complications after major surgery continue to be a great problem for the elderly patient. The incidence of pneumonia, atelectasis, long-term ventilation and respiratory failure are all increased because of a reduced lung elasticity, less lung muscle strength, less cough capacity and an increased prevalence of chronic respiratory disease. These benefits have been reported in the literature for both respiratory conditioning and inspiratory muscle training in preventing PPCs. Inspiratory muscle training prior to major surgery was found to increase respiratory muscle strength and decrease pulmonary complications than just standard care by Katsura et al. (2015). The results indicated that a peri-operative stress

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challenge may be better tolerated in elderly patients if their reserves of the respiratory system are increased prior to surgery. Breathing exercises, aerobic training, resistance exercise and education during pulmonary rehab programmes can also be beneficial, especially in people who have a limited functional capacity. There is also a strong need to quit smoking prior to surgery, as doing so before the operation will lower airway inflammation and enhance outcomes of the operation. Why smoking should be avoided after the operation does not really matter so much, but it will still make prehabilitation easier.

5.4 Multimodal Optimization and Enhanced Recovery Pathways

The concept of multimodal perioperative optimization has been growing in acceptance, as many factors interact to impact surgical outcomes of the elderly, which is not just a single physiological system. Enhanced Recovery After Surgery (ERAS) programmes encompass a number of evidence-based interventions such as preoperative counselling, intervention to optimise nutrition, to minimise opioid usage for analgesia, early movement, and a standardised approach to perioperative care. Some evidence indicates that ERAS pathways shorten hospital length of stay and decrease postoperative complications, with benefits observed for the general population: evidence for the elderly is incomplete, as they may need some extra attention due to the issues of frailty, cognitive impairment, and functional limitations (Ljungqvist et al., 2017). By targeting two significant reasons for postoperative deterioration, cardiac and pulmonary optimization offers further benefits in ERAS plans.

5.5 Clinical Implications

The results of this review support the use of peri-operative optimization programs for the elderly surgical population that are tailored to their individual needs. Clinicians should not use standard protocols but take account of a patient's individual characteristics, such as frailty status, baseline functional capacity, cardiovascular risk status, respiratory disease burden and planned surgery (Boden, 2018). Surgery, anesthesiology, cardiology, pulmonology, physiotherapy, nutrition specialists and geriatricians might all have a role to play in better decision-making and patient results. The identification of high risk individuals early in the process gives a chance to act in time before surgical stress occurs.

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6. Conclusion

Optimization of cardiac and pulmonary function is important for the outcomes of elderly patients undergoing major surgery. Older persons have more physiological changes, frailty and cardiovascular and respiratory disease, which makes them more susceptible to postoperative complications. Specific cardiac testing and optimization, respiratory training, pulmonary rehabilitation and multimodal prehabilitation techniques appear to increase the safety and recovery of surgery. Modification of myocardial function, pulmonary management, physical conditioning and principles of enhanced myocardial recovery combined as part of an overall optimization program could help minimize surgical morbidities and optimize functional recovery. However, different patient characteristics, different intervention protocols and different outcome measures mean more standardisation is required to test interventions on a larger scale. Future research areas include elaborating evidence-based perioperative pathways for elderly surgical patients for better recovery, minimizing complications and enhancing long-term quality of life.

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