SURGICAL RISK ASSESSMENT IS CRUCIAL TO MITIGATE POSTOPERATIVE COMPLICATIONS

A AVALIAÇÃO DO RISCO CIRÚRGICO É CRUCIAL PARA MITIGAR AS COMPLICAÇÕES PÓS-OPERATÓRIAS

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"The conundrum facing all perioperative clinicians when evaluating patients for surgery remains how best to evaluate and quantify the risk of undergoing the anticipated procedure." National Institute for Health and Care Excellence

ABSTRACT

Postoperative complications often determine the failure of a meticulous and adequate surgical intervention. The surgical risk assessment allows the identification of patients who can benefit from a program to optimize their general condition, reducing the risk of postoperative complications. The purpose of this article is to address the main factors associated with increased perioperative risk as well as the most appropriate tools for an objective assessment of surgical risk and to use this information to mitigate postoperative complications.

Keywords: *preoperative risk factors; surgical burden; risk assessment.*

RESUMO

As complicações pós-operatórias determinam, muitas vezes, o insucesso de uma meticulosa e adequada intervenção cirúrgica. A avaliação do risco cirúrgico permite identificar os doentes que podem beneficiar de um programa de otimização do seu estado geral, reduzindo o risco de complicações pós-operatórias. O propósito deste artigo é abordar os principais fatores associados ao aumento do risco perioperatório assim como as ferramentas mais adequadas para uma avaliação objetiva do risco cirúrgico e usar essa informação na mitigação das complicações pós-operatórias.

Palavras-chave: *fatores de risco pré-operatórios; prognóstico cirúrgico; avaliação do risco.*

INTRODUCTION

The rates of morbidity and mortality following surgery remain of great concern. Approximately 40% of in-hospital adverse events are related to operative procedures.[1] Despite the best efforts of surgeons, anaesthesia and perioperative care, surgery is still associated with a significant risk of poor outcome.[2, 3] Postoperative complications (POC) are defined as any deviation from the ideal postoperative course that is not inherent in the procedure and does not comprise a failure to cure.[4] POC occur more often than other types of complications and their consequences are usually more severe. However, nearly half of POC were identified as preventable,[5] so its analysis occupies a prominent place and is an important measure of quality and safety of today's surgical procedures. Objective reporting and comparison of the rates of POC by an institution is essential to deliver a transparent patient care and is a relevant benchmarking criterion.[6] Hence, the aim of this review was to analyse the main factors associated with surgical risk and the existing tools to measure it, with a focus on gastrointestinal surgery.

CLASSIFICATION

In 1992, Clavien et al.,[7] proposed general principles to classify complications after surgery based on a therapy-oriented, four-level severity grading. Twelve years later, Dindo et al., proposed significant revisions of the classification by increasing the number of grades and the weight of life-threatening complications requiring intensive care management. [8] Since then, Clavien-Dindo classification has been tested, assessing the reliability of the classification in several centers over the world.[8, 9] There is, however, an important limitation with this system. The entire postoperative course is defined according to the most severe forms of complications, not considering the possible cumulative contribution of less severe complications.[10] To overcome this limitation and to integrate all complications, new scoring systems have emerged using numerical analogue scales.[11] However, *Clavien-Dindo* classification is still the most used system to classify POC in an objective and reproducible way and is also recommended by several international societies of different surgical specialties.[12]

Postoperative complications and mortality rates

Surgical rates of morbimortality vary widely across hospitals.[13, 14] In gastrointestinal cancer surgery, the incidence of POC has been described, from 33.5 to 51% in esophagectomy.[15, 16] 20 to 40% in gastrectomy,[17, 18] 18 to 35% in colorectal surgery,[19, 20] and 30 to 60% in pancreatectomy.[21] Clinical outcome following major surgery involves interplay between multiple factors, including those associated with patient characteristics (e.g., age, physiological reserve, type and stage of the underlying disease and comorbidities), surgical procedure,[22] hospital volume,[23] technical and structural resources available,[24] but also the diversity of criteria used to describe and classify POC.[25]

The most prevalent POC in gastrointestinal surgery includes pulmonary complications and surgical site infection. Surgical site infection rate is highly variable with an estimated incidence of 9.4%, 14% and 23.2% in high-income, medium-income and low-income countries, respectively, with the highest incidence occurring after contaminated surgery.[26] The severity of these complications embraces mild cases needing local wound care and antibiotics to serious cases with multiple reoperations and a high mortality rate. Nonetheless, it was estimated that 30% of surgical site infections can be prevented with the implementation of pre and intraoperative measures.[27] Postoperative pulmonary complications (PPC) encompass almost any complication affecting the respiratory system after surgery, with an incidence that can range from <1 to 23%,[28] being

more common in the upper abdomen surgery.[29] PPC are an important cause of morbidity and mortality and represents an important financial burden. The 30-day mortality is estimated to be 14-30% in patients who developed PPC, compared with 0.2-3% of patients without PPC.[30] The most frequently described PPC are respiratory failure, pneumonia, atelectasis, bronchospasm, exacerbation of chronic obstructive pulmonary disease (COPD) and pleural effusion. Some authors report that pneumonia is the second most frequent infection among nosocomial infections, with an incidence of 1 to 29% in patients undergoing surgery.[31-36] In addition, pneumonia, along with other PPC (atelectasis and the need of mechanical ventilation), blood transfusion, shock and excessive of perioperative fluids administration, significantly increase the susceptibility for the development of acute respiratory distress syndrome, which represents the main cause of respiratory failure in the postoperative period leading to admission in the intensive care unit.[37-46]

Globally, postoperative **mortality** ranges from 1% to 4% for elective surgery.[47-50] Considering the number of procedures performed worldwide, the postoperative mortality rate translates into approximately 4.2 million deaths, with half of these deaths occurring in low and middle-income countries. These correspond to 7.7% of all deaths worldwide, placing postoperative mortality as the third leading cause of death, just behind ischemic heart disease and stroke.[51] Numerous studies have described important variations in survival following surgery. The underlying reasons for these observations are complex. For many surgical procedures, a hospital volume-outcome relationship exists and can contribute for the disparity.[52-54] However, variations in clinical outcomes after surgery are increasingly used to identify differences in quality of perioperative care that can affect survival.[55] The concept of **failure to rescue** has emerged as an outcome measure that discriminates hospital performance. It is defined by the number of deaths in patients who develop a POC. The reported incidence of failure to rescue is highly heterogeneous and ranges between 8.0 and 16.9% across hospitals in different regions.[56] For instance, in low-income countries, mortality from POC after general elective surgery is twice as high as the global average, although patients are younger and have a lower risk profile.[57]

Preoperative risk factors

The knowledge about risk factors associated with postoperative morbidity and mortality improves clinical decision-making and allows: 1) to act preventively by correcting the modifiable factors; 2) to optimize surgical outcome; 3) to manage resources. These risk factors include variables related to individual characteristics (e.g., age, anatomical variations, physiological reserve, comorbidities, risk factors and geriatric syndromes),[58-63] disease (e.g. location and stage), surgical procedure (knowledge and technical skills, experience of the surgical team, volume of surgeries performed, type and surgical complexity),[64] and to the health system organization (technical resources and structures available).[65]

Age and frailty

A considerable number of articles have been published on POC in elderly patients. Some studies report an increase rate of complications, mainly respiratory.[66, 67] Physiological aging is characterized by a reduction in chest wall compliance and an increase in lung compliance and airway resistance, which increases the ventilatory effort. The decrease in the strength of the respiratory muscles and the reflexes of cough and swallowing, as well as the decrease in the number and the cilia function compromise the clearance of secretions. There is also a decrease in partial pressure of oxygen and an increase in dead space, which causes a reduction in the pulmonary ventilation-perfusion ratio.[68,69]

These factors, associated with some specific conditions associated with the postoperative period, such as immobility and the use of narcotics, promote atelectasis, pulmonary aspiration and postoperative pneumonia.[70] However, elderly patients represent a highly heterogeneous population and although an increase in incidence of POC is expected with increasing age, this is not always observed, fundamentally in the elderly with good performance status and after controlling for other clinical parameters.[71]

Frailty is a term used to define a state of decreased functional reserve and greater vulnerability to aggressive agents such as surgery.[72-74] It is estimated that more than 50% of geriatric cancer patients are classified as fragile or pre-fragile.[75] Multiple frailty screening tools have been developed. Although there is no consensus on the most appropriate tool to assess frailty,[76] the literature is unanimous in considering that patients with a higher preoperative frailty index undergoing surgery, have a higher risk of complications,[72, 77-79] greater functional decline, loss of quality of life,[79] and increased risk of mortality in 30 days to 1 year after surgery.[72, 73] It should be noted that frailty is potentially reversible and can be mitigated preoperatively through pre-habilitation programs, with preliminary evidence showing better operative outcomes in frail surgical patients that have been submitted to these programs.[80]

Smoking

The association between smoking and POC is well established.[81-83] Compared with non-smokers, smokers have an increased risk of respiratory and cardiovascular postoperative complications, impaired wound healing, longer length of stay and higher risk of readmission. Cigarette smoking has been implicated as a major risk factor for PPC. Smoking has an adverse effect on the structure and function of cilia of the tracheobronchial mucosa, decrease mucus hydration and clearance, promoting alveolar collapse and infection of the lower airways.[84] Preoperative smoking cessation, 8 weeks prior to surgery, can reduce frequency and intensity of symptoms and lead to a reduction in the incidence of PPC up to 47%.[85-87]

Alcohol

Similar to tobacco use, there is wide agreement that chronic excessive alcohol consumption increases the risk of poor surgical outcome. Surgical patients with a high level of alcohol consumption have a twofold to threefold increase in postoperative morbidity, the most frequent complications being infections, delayed wound healing, bleeding and cardiopulmonary insufficiency.[88] The rate of POC is increased by about 50% at an intake of more than 2 to 3 alcoholic units /day.[89]

To some extent, abstinence may reverse alcohol-induced pathophysiological processes,[90] and efforts to minimise alcohol consumption prior to elective surgery might diminish complications related to alcohol misuse.[91] A recent systematic review assessed the efficacy of perioperative alcohol cessation interventions for postoperative complications and alcohol consumption. All studies showed a significant reduction in the number of participants who quit drinking alcohol during the intervention period. Intensive alcohol cessation interventions offered for four to eight weeks to participants to achieve complete alcohol cessation before surgery probably reduced the number of postoperative complications.[92]

Comorbidity

Comorbidity has been reported to be a predictor of POC.[93, 94] Diabetic patients have an almost five times higher risk of POC.[95] Hyperglycaemia or elevated values of glycosylated haemoglobin in patients with gastrointestinal cancer are associated

with an increased risk of adverse outcomes, including risk of death, cardiac arrest, surgical site infection and respiratory complications.[96, 97] It also carries an increased risk for long-term, all-cause mortality when compared with those without diabetes. [101] Perioperative glycaemic control is a key aspect of the preoperative approach and is associated with a decrease in infectious complications across a variety of surgical procedures.[98-101]

COPD is an important risk factor for PPC, with a risk greater than 18% in some studies, which varies with severity of the disease.[102-106] Although this is true, when treated and controlled prior to the surgical procedure, patients with COPD have the same incidence of PPC as healthy individuals.[107, 108]

Malnutrition and obesity

Malnutrition and obesity are risk factors for POC. Malnutrition can be present in up to 80% of patients with advanced gastrointestinal cancer, being associated with an increased risk of morbidity and mortality. Patients with severe malignant neoplastic disease and anorexia-cachexia syndrome are characterized by involuntary weight loss, malnutrition, metabolic and immunological changes. Although frequently there is no reduction in the calorie intake, this syndrome is associated with a significant risk POC.[109-112]

Obese patients have important physiological changes resulting in ventilation-perfusion mismatch. They also have decreased lung compliance and impaired chest movements. Moreover, obese patients are more difficult to mobilize during postoperative period, which implies a greater risk of deep venous thrombosis and consequently pulmonary thromboembolism.[113, 114] Integration of nutrition into the overall management of the patient appears to significantly reduce morbidity,[115, 116] and it is a cornerstone perioperative care.

Intraoperative risk factors

General anaesthesia can be associated with the development of respiratory complications. Muscle relaxation necessary for endotracheal intubation can cause bronchial aspiration[117, 118] and need of ventilatory assistance, due to depressing the central nervous system and reduction of the cough reflex, both contributing to increase the risk of PPC.[119]

Prolonged operative duration is an equally important risk factor. A meta-analysis demonstrated an association between prolonged operative time and complications across surgical specialties, approximately doubling with operative time thresholds exceeding two or more hours.[120]

The degree of contamination is usually associated with a higher occurrence of POC in several studies, and patients undergoing contaminated surgery have a higher risk of developing complications, notably surgical site infection.[121] Surgical re-intervention is also a risk factor, since patients are re-exposed to prolonged fasting, surgical stress, general anaesthesia, immunosuppression, immobility, pain and prolonged hospitalization, all of which are known to favour the development of POC.[122]

Type of surgery and location

Several prior investigators have demonstrated increased rates of complications and mortality after emergency surgery. The incidence of respiratory complications in patients undergoing elective procedures is less than that seen in similar urgent procedures, because the first ones were generally optimized for surgery.[123, 124]

Upper abdominal and thoracic surgery is associated with a higher rate of complications. These access routes can reduce vital pulmonary capacity by 50 to 60% and residual functional capacity by 30%. Likewise, reflex inhibition of the phrenic nerve by visceral manipulation or postoperative pain can

induce alveolar collapse that could explain the higher incidence of respiratory complications.[126-128]

Impact of postoperative complications in cancer patient

The occurrence of a major POC severely limits the prognosis of the cancer patient. If, on the one hand, it may delay chemotherapy and reduce its potential benefits, on the other hand, it may prolong the hospital length of stay, reduce patients' quality of life and can precipitate premature death.[128-132] It should also be noted that the occurrence of complications after major surgery proved to be a determinant of long-term survival,[133-135] with a stronger impact than preoperative risk or intraoperative factors.[136-139] There is also evidence that POC can induce a long-lasting suppressive effect on patients' immune systems, making them more susceptible to recurrence.[140-143] An association between POC and patient psychosocial well-being, with high levels of stress and depression, was also demonstrated up to 12 months after surgery.[144]

Preoperative risk stratification tools

Fortunately, for most patients, surgical risk is low. However, there is a subgroup of patients, which despite representing 15-20% of the population undergoing surgery, contributes about 80-90% to postoperative mortality.[145,146] This subgroup frequently includes geriatric patients in need of a major or emergency surgery.[147]

Prevention or mitigation of postoperative morbidity and mortality should include the implementation of a set of perioperative measures or interventions, which begin with the identification of these high-risk patients. Early identification is of crucial importance as it facilitates decision-making about surgical treatment, allows perioperative care individualization and will offer an opportunity to optimize the patient's status.[148-151] Furthermore, risk assessment is essential to compare surgical outcomes among populations of different geographic areas.

The first clinical prediction tool published dates from the 1940s.[148] This tool was developed by Meyer Saklad and evaluated the patient's physical condition by grading them into six classes. This classification was revised in 1961 with the number of classes reduced from six to five, and emergency surgeries were noted by using the prefix 'E'.[152] This score was later adopted by the American Society of Anaesthesiologists and is now known as the **ASA classification**.[149] Although the correlation of ASA classification with perioperative risk has limitations, it does provide a useful, universal and simple assessment tool. Thereafter other tools for predicting morbidity and mortality were developed.

Copeland and collaborators developed a scoring system for patients requiring inpatient surgery, excluding trauma surgery, that also included surgical complexity and is known as the **POSSUM score** (Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity).[151] The authors developed the score to adjust risk to surgical interventions, with the ultimate goal of facilitating audits and allow the comparison of outcomes among different centers.[151] This score was proved to be more accurate in predicting morbidity than mortality[152] and it can over-predict both in patients with low risk profiles. The modified version called **P (Portsmouth) – POSSUM** score seems to be more accurate for predicting mortality.[153-158] However the accuracy in low-risk patients is still low, since it overestimates the risk, making the tool less effective and inadequate to assess the profile of these patients. The 'riskier' the surgical procedure is, the more accurate is the calculated predicted risk.[153, 158-160]

In 2013, the American College of Surgeons National Surgical Quality Improvement Program (**ACS NSQIP**) implemented a free online surgical risk calculator that estimates the chance of an adverse outcome after surgery. The risk calculator includes

20 parameters assessing patient characteristics (e.g., age, ASA class, BMI) and the planned procedure to make logistic model-based predictions for 18 different procedure-specific outcomes within 30 days following surgery.[161] This tool has been shown to exhibit good calibration and discrimination in large-scale investigations. It presents the risk calculations divided into multiple different categories of morbidity and mortality allowing the patient to better understand the risks posed by the proposed intervention.[162] The accuracy of this tool was assessed in a study which concluded that risk calculators with procedure-specific variables might outperform the ACS NSQIP calculator. [161] However it might still be useful to provide sufficient accuracy for general use, applicable in many surgical fields, easily using predictive and generally available information.[161] Unfortunately, this tool requires considerable time to use and has limitations regarding accuracy of risk estimates for higher risk patients.[163] The Surgical Risk Preoperative Assessment System (SURPAS), based on NSQIP data, has the potential to be a useful tool for multiple surgical specialties given its use of only 8 pre-operative variables.[164]

Comparative studies between preoperative risk stratification tools

Currently, there is an overwhelming number of risk tools available but deciding about which one to use is not an easy task. Also, there is no gold standard score, nor even the indication that a certain risk stratification tool should be consistently used in the perioperative setting.[165] Although the use of several tools is mentioned in many works, few are the ones that compare the predicting performance of each other.[166] Some authors report important differences, but the sample size of these studies is often too small for extrapolations.[167-171] Thus, the surgical expert opinion still remains the most used preoperative risk assessment approach in many places, which is obviously biased by the surgeon experience.[172, 173]

The National Institute for Health and Care Excellence (NICE) gathered a committee to review the existing evidence around such tools with the intention to set a recommendation standard in perioperative care. The panel stated that: 1) tools such as POSSUM, P-POSSUM, NSQIP, E-PASS and SRS showed a fair level of accuracy for mortality with median c-statistic of ~85%; 2) all tools were less accurate in predicting morbidity showing a predictive accuracy of ~60-70%; 3) it may be more appropriate to use a surgery-specific risk tool rather than a generic tool.[165]

Contributions to the assessment of the surgical risk in Portugal

The limited accuracy in predicting complications and mortality of the well-known tools such as P-POSSUM, Assess Respiratory Risk in Surgical Patients in Catalonia (ARISCAT), ACS NSQIP, has motivated surgeons in Portugal to study this subject and try to contribute to an improvement of the referred instruments. Thus, Fernandes A et al. studied surgical risk in a cohort of patients with gastrointestinal cancer surgery [174] and Sousa Menezes A et al. [175] in a cohort of patients with head and neck cancer surgery.

In the study of Fernandes A. et al., the ability of the risk scores systems P-POSSUM and ACS-NSQIP to predict morbidity was analysed in a cohort of 341 patients with gastrointestinal cancer. The authors used the Hosmer–Lemeshow test for goodness of fit, comparing the observed with expected complications. P-POSSUM showed a good performance, with an observed and expected complication ratio ranging from 0.76 to 1.23 and an overall good fit ($\chi2 = 2.144$; $p = 0.976$). ACS NSQIP overestimated operative risk in both low and high-risk patients. Overall, it presented a significant lack of fit ($\chi2 = 18.540$; $p = 0.018$). To overcome these limitations the authors developed a new risk score

(MyIPOrisk-score) based on the most predictive variables for surgical morbidity which showed better accuracy to predict complications in the same cohort. The discrimination ability of this new score was significantly higher than each score individually (vs ACS NSQIP p = 0.047; vs P-Possum p = 0.028).[174]

In the study of Sousa Menezes et al, the accuracy of the risk calculators ASA, P-POSSUM, ACS-NSQIP and ARISCAT to predict postoperative complications and mortality was assessed in high-risk patients submitted to head and neck surgery. The authors intended the validation of surgical risk tools to identify patients at risk for perioperative complications and therefore suitable candidates to prehabilitation programmes. In this study, a higher ASA score was positively associated to mortality. P-POSSUM discrimination ability for mortality and morbidity was found to be reasonable and the ACS-NSQIP failed to predict complications and had an acceptable discrimination ability for predicting death. On the other hand, ARISCAT score revealed to be a reliable risk calculator for predicting postoperative respiratory complications. Given the questionable value of the risk scores when evaluated individually, the authors performed a multivariate analysis combining them and designed a new risk tool which better predicted the risk of serious complications. The final model included the scores ACS-NSQIP and ARISCAT according to which the occurrence of serious complications increased significantly with ACS-NSQIP score and ARISCAT score (OR=1.05; 95% CI 1.01–1.10 and OR=1.08; 95% CI 1.02–1.15, respectively).[175]

CONCLUSION

Recent advances in surgery and perioperative care led to a reduction in postoperative mortality, resulting in the expansion of the surgical population. Therefore, an increasing number of surgical procedures began to be carried out in a progressively older and more at-risk population.

An accurate estimation of risks and benefits of the surgical procedure is crucial during preoperative evaluation and allows to discuss with the patient and his family about the appropriateness of the planned surgery and whether it should proceed, should be cancelled, or whether alternative non-surgical options should be considered.

Preoperative risk stratification tools provide a means of objectively evaluating risk and can be used to predict patient tolerance and to assign a tailored treatment approach to the individual patient. The use of a validated risk tool as part of a preoperative assessment, alongside with clinical assessment and judgement, could have the potential to help predict individual patient perioperative needs, informing allocation to an appropriate level of postoperative care.

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