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Prevention of Perioperative Complications: “It Takes a Village to Raise a Child"

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Introduction

Despite the increase in patients’ baseline risk, according to the American Society of Anesthesiologists (ASA) score, perioperative mortality has declined over the last 50 years, particularly in developed countries (Bainbridge et al. 2012). Nevertheless, a recent large cohort study in 28

European countries demonstrated that the incidence of in-hospital mortality is relatively high at 4%, which is higher than previously expected (Pearse et al. 2012) as well as postoperative complications i.e. pulmonary and cardiovascular (Canet et al. 2010; Mazo et al. 2014). In an era when the prevalence of elderly and obese patients is likely to increase, perioperative complications in this group become the major concern due to their high risk. The development of postoperative complications is associated with long-term morbidity and financial loss. Financial loss includes not only long-term hospital stays but also the expense of long-term follow-up, repeated admissions and chronic illness support. Multidisciplinary teams including surgeons, medical specialists, and anaesthesiologists could collaborate and plan for perioperative care leading to fewer medical errors and complications (Glance et al. 2014).

Prevention is the Target!

In the entire perioperative care pathway for minimising complications in high-risk patients, cardiovascular and pulmonary complications are the main factors affecting mortality. Cardiac risk factors have been widely recognised, and effective management to reduce perioperative cardiovascular morbidity and mortality has been generally implemented. In recent decades, postoperative pulmonary complications (PPCs) have become a major concern as they are associated with high mortality (Canet et al. 2010).

Unplanned ICU admission is associated with higher mortality rates. Several check lists and scores have been proposed to define the patients at risk for postoperative pulmonary complications (i.e. the postoperative pulmonary complications risk score (ARISCAT), the surgical lung injury prediction (SLIP) score and a score for prediction of postoperative respiratory complications (SPORC), which consist of simplified baseline factors and also objective factors that physicians can assess at the bedside. These scores can identify at-risk patients who require a multidisciplinary team approach and critical care resource allocation. The numbers of critical care beds in each country are heterogeneous, which may reflect the different outcomes. Nevertheless, the social benefit or harm of creating more intensive care unit beds is still debated. An increase in intensive care unit beds may increase harm in terms of unnecessary costs, iatrogenic complications, poor quality of care etc. On the other hand, shortages of intensive care unit beds may lead to delayed admission with potentially an increase in mortality. These link to the concept of a Starling curve for intensive care proposed by Wunsch et al (Wunsch. 2012). Changes in outcome may be related not only to intensive care unit beds but also to various factors i.e. the experience and training of the healthcare professionals as well as available resources at the ICU. Finally, emerging pulmonary risk factors, namely obstructive sleep apnoea, obesity hypoventilation syndrome and pulmonary hypertension, have been proposed. Concerning the increased incidence of PPCs in these groups, we may require further studies to improve the predictive score performance and monitoring technique in these groups (Weingarten et al. 2013).

Individualised Preoperative Monitoring and Care

Haemodynamic Optimisation

Recent meta-analysis has demonstrated that perioperative goal-directed therapy (GDT) reduced mortality in patients with extremely high risks of death (baseline mortality rate more than 20%). The mortality rate reduction was demonstrated in the studies using pulmonary artery catheter, fluid and inotropic drugs rather than fluids alone, and cardiac index and supranormal physiologic resuscitation target as a goal without further increase in cardiac complications i.e. arrhythmia, pulmonary oedema (Arulkumaran et al. 2014). Furthermore, the number of patients developing postoperative complications was reduced in the GDT cohort. These findings show that cardiac output and oxygen delivery targeting resuscitation affect perioperative outcome. Therefore perioperative GDT should be implemented in clinical practice at the right time (early), in the right patients and with the right protocol. However, further studies are warranted to show benefits of GDT in intermediate risk group patients (Cecconi et al. 2013).

Protective Ventilation and Respiratory Monitoring.

The incidence of PPCs varies according to the definition, which can include pneumonia, respiratory infection, atelectasis, pleural effusion, pneumothorax, and bronchospasm, need of non-invasive ventilation or re-intubation. These complications are as common as cardiovascular events, and vary from 2.5% to 5% (de Abreu and Pelosi. 2013). Recent experimental and clinical studies have shown, however, that protective mechanical ventilation might be relevant in non-acute respiratory distress syndrome (ARDS) lungs (Serpa Neto et al. 2012). Protective ventilation (low tidal volume of 6-7 ml/kg predicted body weight, high positive end-expiratory pressure [PEEP] level, between 6 to 10 cmH2O and recruitment manoeuvre) decreases the incidence of perioperative ARDS, pulmonary infection and atelectasis (Hemmes et al. 2013;Sutherasan et al. 2014).

Nevertheless, the recent large RCT, the PROtective Ventilation using HIgh versus LOw PEEP (PROVHILO), in intermediate and high risk abdominal surgery, has demonstrated that there was no difference in the first 5 days postoperative pulmonary complications between patients receiving high level of PEEP (12 cmH2O) and recruitment manoeuvre and low level of PEEP (2 cmH2O) without recruitment. Furthermore, patients in the higher PEEP group developed more frequent intraoperative hypotension and needed more vasoactive drugs compared with the lower PEEP group (The PROVE Network Investigators; for the Clinical Trial Network of the European Society of Anaesthesiology 2014), Therefore we suggest that an intraoperative protective ventilation strategy should include low tidal volume and low level of PEEP without recruitment manoeuvre.

The physicians use less invasive tools. In high risk postoperative abdominal surgery and obesity patients, beside pulse oximetry and end tidal CO2 monitoring, chest wall elastance, transpulmonary pressure and intra-abdominal pressure should be measured. Lung ultrasound, a totally noninvasive tool, can be used to rapidly assess haemodynamic and pulmonary complications in the perioperative period (Cecconi et al. 2013;Sutherasan et al. 2014). In cardiothoracic and abdominal surgery, early postoperative physiotherapy can promote early mobilisation and respiratory muscle training, maintain adequate ventilation and prevention of PPCs (Makhabah et al. 2013). Noninvasive ventilation may prevent and treat postoperative atelectasis and lead to shorter duration of hospital stay in these subgroups, and can be used to treat postoperative respiratory failure (Jaber et al. 2010).

Biomarkers for Perioperative Management

Because postoperative adverse events are known to be the most important predictors of long-term mortality, it is necessary to improve preoperative identification of patients that may present greater risk of postoperative complications. Importantly, an improvement in such identification also allows more efficient use of healthcare resources. Traditionally, studies have been focused on identifying higher risk patients, those presenting potential cardiovascular complications (Barnett and Moonesinghe. 2011). However, beyond this important category, there are also other groups of patients with with other potential complications, such as emesis, chronic pain, drug interactions or cognitive dysfunction, who may benefit from optimised perioperative protocols. In this context, biomarkers may represent a valuable tool, improving the prediction of short- and long-term outcomes.

Preoperative Biomarkers

The measurement of cardiac dysfunction plasma biomarkers such as B-type natriuretic peptide (BNP) or its precursor (N-terminal fragment (NT-proBNP)), has allowed a very significant improvement in cardiac failure management. BNP-guided therapy reduces all-cause mortality in patients with chronic heart failure (Porapakkham et al. 2010). Within non-cardiac surgery, meta-analyses have shown that elevated preoperative levels of BNP or NT-proBNP represent a powerful and independent predictor of cardiovascular events in the first 30 days after non-cardiac surgery(Karthikeyan et al. 2009). Despite this remarkable value of BNP, is also important to take into account variability depending on the measurement assay, which may make it difficult to establish comparisons.

High sensitivity C reactive protein (hs-CRP) is a general biomarker of inflammation that offers important information regarding development and outcome of cardiovascular pathology. Beyond this, several studies have shown that higher preoperative hs-CRP levels are independently associated with perioperative complications both in cardiac and non-cardiac surgery (Ackland et al. 2007;Cappabianca et al. 2006). Nevertheless, it seems that when added to the Framingham Risk Score, CRP levels do not provide relevant additional information (Shah et al. 2009).

Postoperative Biomarkers

Several studies have demonstrated that elevated troponin levels are associated with mortality after major vascular surgery (Bursi et al. 2005). In a recent meta-analysis Levy et al. reported that increased postoperative troponin measurement is an strong independent predictor of mortality at one year, and therefore may help physicians to risk stratify patients after noncardiac surgery(Levy et al. 2011). In addition, levels of heart-type fatty acid binding protein (Muehlschlegel et al. 2010) and cardiac imaging strategies (Jerosch-Herold and Kwong. 2008) have also shown promising utility. Thromboelastography performed immediately after surgery has been associated with postoperative thrombotic complications, including myocardial infarction, in a diverse group of surgical patients (McCrath et al. 2005).

Acute kidney injury is also a very important determinant of the outcome of surgical patients. Besides creatinine or urea, other biomarkers may offer interesting information about renal function in the early postoperative period. These include kidney injury molecule-1, cystatin C, neutrophil gelatinase-associated lipocalin, liver-type fatty acid binding protein as well as RIFLE score (Edwards et al. 2011;Waikar et al. 2008).

Neurological adverse events, such as stroke, delirium or cognitive dysfunction, are also frequent, and lead to prolonged intensive care unit stay and increased mortality. Markers of neurological damage such as S100B protein or neuronal specific enolase (NSE) have been studied in the postoperative period. Serum levels of S100B 24 hours after cardiac surgery have been useful to identify adverse neurologic outcomes (Georgiadis et al. 2000). Increased S100B in patients with a stroke following cardiac surgery correlated with the size of infarcted brain tissue and also showed an association with an increased risk of postoperative mortality (Jonsson et al. 2001). Furthermore, NSE and S100B concentrations 6 to 30 hours after cardiac surgery contributed significantly to a predictive model of the neuropsychological outcome (Herrmann et al. 2000). However, it should also be noticed that some studies have found conflicting results regarding the relationship between NSE levels and neurological outcome in several non-cardiac surgical procedures (Cata et al. 2011) (reviewed by Cata et al. 2011).

Summary

Haemodynamic and respiratory monitoring are essential in the perioperative period to minimise complications, particularly in high-risk patients, by early treatment and early allocated point-of-care. Studies investigating biomarkers require consistent characterisation of postoperative outcomes and adequate data collection of clinical phenotypes. A deeper knowledge of physiopathology will allow the identification of novel useful biomarkers that may help to stratify risk and improve patient's outcome by refining clinical management in the perioperative period. There is an African proverb, **"It takes a village to raise a child", which means that the work of raising a child cannot be done alone; rather, an entire community must participate to some extent in the task.** The collaboration between surgeons, anesthesiologists and medical specialists may lead to improved outcome in surgical patients.

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