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Post-operative pulmonary complications: Understanding definitions and risk assessment

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Post-operative pulmonary complications (PPCs) can have severe consequences and their incidence is high. In recent years, PPCs have been the subject of numerous studies and articles, which have provided a great deal of information that is beneficial but that can cause confusion on a practical level. This review focusses on three main points: (1) the definitions of PPCs, which are heterogeneous and often vary from one report to another, despite emerging consensus; (2) the risk as reflected in the pool of PPC predictors, with each study identifying some but leaving us with a myriad of combinations; and (3) the many PPC prediction scores proposed, each with its strengths and limitations. We attempt to clarify the practical and research implications of the current situation.

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Introduction

Post-operative pulmonary complications (PPCs) are a major problem because of their high incidence and potential severe consequences. PPCs develop in an estimated 5–8% of general surgical populations, and the associated mortality ranges from 8–24% [1,2]. Detecting patients at risk is an important goal for anaesthesiologists, who must focus especially on these patients, devising strategies for prevention during surgery and afterwards.

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In the last 15 years, many studies [1,3–13] have analysed PPC risk factors and used models to create clinical scores that can quickly predict high risk. Results have differed considerably from study to study, however, because of variation in populations of interest, inclusion and exclusion criteria, candidate variables, outcome definitions and study designs. The vast and heterogeneous information produced by this research is not easy to process and can unfortunately lead to confusion.

In this review, we describe the PPC definitions used to date and emerging ones, discuss evidence for the main PPC risk factors, and analyse the PPC prediction scores designed for clinical use thus far.

Definitions of PPCs

There are many PPCs, each defined in various ways. Studies of PPC risk have sometimes used specific outcomes, such as pneumonia, acute respiratory distress syndrome (ARDS) or post-operative respiratory failure (PRF). Some outcomes have well-established definitions, while others do not. For example, the diagnosis of post-operative pneumonia has long been guided by the definition of the US Centers for Disease Control and Prevention [14], and ARDS can be diagnosed according to the recent Berlin definition [15]. In contrast, the story of PRF is different. PRF has been variously identified by surrogates, such as the need for mechanical ventilation, prolonged ventilation or unexpected reintubation [5,7–9,11], and it has also been equated with ARDS [16]. We have argued elsewhere that the most accurate and clinically useful definition of PRF is hypoxaemia of new onset (appearing in the first few post-operative days) with or without hypercapnia [3,16], following West's well-established textbook [17] and in keeping with new recommendations [18]. Hypoxaemia is objective (based on a measurement), precise (as a diagnosis of gas exchange impairment) and clinically useful (revealing a clinical problem that may not have led to other symptoms yet). It is probably more sensitive than surrogate definitions of PPC risk, such as post-operative intubation, since a patient can be treated with non-invasive ventilation (NIV) without intubation. In addition, it is more specific, since a surrogate event such as post-operative intubation could be related to non-respiratory complications such as stroke or cardiac arrest.

In the interest of reaching a consensus on diagnostic criteria, a combined task force of the European Society of Anaesthesiology (ESA) and the European Society of Intensive Care Medicine (ESICM) recently proposed standardised definitions of outcome measures [18]. Table 1 shows their proposals for PPC definitions, which we think should be applied in future studies.

Many researchers have defined composite PPC outcomes [1,12], a debated approach in which several complications, any of which contributes to a diagnosis of PPC for the researchers' purpose, are grouped together in clinically defensible ways. One result is that the rate of events is usefully increased for risk analysers, thus increasing power. Clinicians who ultimately use the resulting risk scales are also benefited, as it is probably easier in most clinical conditions to apply a score that groups all foreseeable PPCs than to apply multiple scores for several specific complications (ARDS, pneumonia, post-operative intubation, etc.) The point of preoperative risk assessment is to induce vigilance by warning the anaesthetist of the strong possibility of some threat. A high score for a PPC composite will accomplish that goal quickly. Once the predictors of composite risk have been identified, further research on specific outcomes for some clinical contexts can be useful because the pathophysiology and time course of single PPCs are different.

Risk for developing PPCs

In studies on PPC risk that started to appear about 15 years ago, around 50 risk factors have been identified and discussed in reviews [16,19,20]. The weights of these factors are assigned variously in different studies, such that many potential combinations of them might be inferred. We agree with the approach of most authors to direct attention towards predictors that can be identified in the preoperative period, when patients and clinical teams have time and resources to devote to attenuating risk [21]. The sooner predictors are identified, the more likely they are to be modifiable.

The present review focusses on the main predictors, according to their weight in risk models, the evidence that supports them, and their apparent modifiability. We also discuss the hypothetical mechanisms that might explain why these variables have emerged as predictors. Although risk analysis

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