Postoperative pneumonia

Can this important complication be predicted and anticipated?

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Postoperative pneumonia is a major postoperative adverse event and one of the frequent hospital-acquired infections. Postoperative pneumonia is associated with short-term mortality exceeding 10%, long-term decreased survival along with considerable clinical and economic costs. Prevention, early diagnosis and rescue of patients with postoperative pneumonia are important measures needing the support of all healthcare providers across the perioperative period.

Diagnosing pneumonia can be difficult because pneumonia is an infection of the lungs from an array of pathogens with varying clinical, biological marker and imaging manifestations. This is particularly so for postoperative pneumonia with both under-diagnosis and over-diagnosis depending on diagnostic criteria. The Standardized Endpoints in Perioperative Medicine group recommended the US Centers for Disease Control and Prevention (CDC) definition for pneumonia (Table 1), at least for research purposes. This does not, however, make other diagnostic criteria incorrect. Further, the list of alternative diagnoses to acute pneumonia is long and includes: pulmonary oedema, aspiration pneumonitis, pulmonary embolism, exacerbation of chronic obstructive pulmonary disease (COPD); and atelectasis. Therefore, apart from the difficulty of accurately diagnosing pneumonia, these overlapping diagnoses explain, in part, different pneumonia rates in different studies and disagreement between experts.

In the accompanying prediction study entitled ‘Development of a prediction model for postoperative pneumonia’, Russotto et al. used a pragmatic pneumonia definition, the need for treatment with antibiotics for a respiratory infection and at least one of the following criteria: new or changed sputum; new or changed lung opacities on a clinically indicated chest radiograph; temperature more than 38.3°C; and leucocyte count more than $12 \times 10^9/l$. Although this differs from the stricter CDC definition there is likely to be considerable overlap. Further, Russotto et al. found a pneumonia event rate of 2.4% that is similar to earlier investigations with mixed surgical populations: 1.5 and 1.8%. However, Russotto et al. found pneumonia diagnosed at median time of 1 day after surgery while other studies first recorded postoperative pneumonia later. These differences may reflect different pneumonia definitions, be related to other inclusion criteria (elective and nonelective patients), different approaches to data collection, different case mixes with more patients with pre-operative pneumonia identified immediately postoperatively or more patients with intra-operative aspiration.

Several patient-related risk factors for postoperative pneumonia were previously identified: older age; poor nutrition status and pre-operative weight loss; pre-existing dysphagia and swallowing difficulties from neurocognitive or neuromuscular disease; pre-existing comorbidities most often measured with the ASA physical status; immunosuppression including diabetes mellitus or chronic alcohol abuse; pulmonary dysfunction with low pre-existing oxygen saturation related to COPD; pre-existing pneumonia; respiratory muscle wasting and/or smoking history. Frailty may add or...
Transfusions may be associated with postoperative pneumonia. Similar findings were made in a study by Russotto et al. 

**Table 1** US Centers for Disease Control definition of pneumonia

| Criteria | Description |
|----------|-------------|
| (i) New or progressive and persistent infiltrates |
| (ii) Consolidation |
| (iii) Cavitary |
| AND at least one of the following |
| (a) Fever (>38 °C) with no other recognised cause |
| (b) Leucopaenia (white cell count < 4 x 10⁹/l) or leukocytosis (white cell count > 12 x 10⁹/l) |
| (c) For adults >70 year old, altered mental status with no other recognised cause |
| AND at least two of the following |
| (a) New onset of purulent sputum or change in character of sputum, or increased respiratory secretions, or increased suctioning requirements |
| (b) New onset or worsening cough or dyspnœa, or tachypnoea |
| (c) Rales or bronchial breath sounds |
| (d) Worsening gas exchange (hypoxaemia, increased oxygen requirements, increased ventilator demand) |

replace several of these factors, but, like pneumonia itself, there are currently no universally accepted frailty diagnostic criteria.7

Other previous associations with postoperative pneumonia include general anaesthesia without epidural, neuromuscular blocking agents, hyperoxia, naso-gastric tubes, plane positioning with increased aspiration risk of gastric content, fluid administration, acid-suppressive medication and sedation.

Russotto et al. identified five variables independently associated with postoperative pneumonia. Three known pre-operative predictors: functional status, partially/totaly dependent [odds ratio (OR) 2.3], lower pre-operative SpO₂ values breathing room air (OR 1.20) and upper abdominal open surgery (OR 4.0). They also found two intra-operative risk factors: colloid fluid therapy (OR 3.0); and blood transfusion (OR 2.2). Association between postoperative pneumonia, operative site, functional status and transfusion are also consistent with previous findings.8–10

Russotto et al. propose two modifiable predictors of pneumonia: blood transfusion and colloid. However, we cannot currently assume that modifying these factors will improve outcomes. Transfusion and colloid may be risk markers rather than causes of pneumonia.

Possible mechanisms for an association between transfusion and pneumonia include the blood loss (i.e. shock) or the transfusion.8,11 Transfusions may be associated with pneumonia potentially via transfusion-related immune modulation, or transfusion-associated cardiac overload or transfusion-associated acute lung injury.12 Therefore, on the balance of probabilities, measures to decreases transfusions could be considered, including patient-specific transfusion triggers, anaemia treatment before surgery, adapted use of peri-operative anticoagulants and anti-platelet drugs, minimally invasive surgery, and use of tranexamic acid. This is particularly so for patients undergoing elective surgery where there is frequent unwanted practice variation in transfusion medicine. Further, transfusion is associated with significant cost to hospitals.

The finding that intra-operative coloids are associated with postoperative pneumonia is in line with an observational study on postoperative pulmonary complications after noncardiothoracic surgery.5 The biological basis for this finding is not clear but may be related to fluid overload with secondary infected atelectasis; or that colloid requirements are a marker of shock severity. However, many regulatory authorities, including those in Europe, the United States and Australia have recommended restricted use of starch colloids, particularly in sicker patients and those with sepsis. Therefore, in many countries, use of this potentially modifiable risk factor is probably already realised. However, the role of albumin as potential risk or protective factor for pneumonia needs to be clarified because in severe sepsis (often secondary to pneumonia) time to haemodynamic stabilisation was shorter with albumin.13

The data from Russotto et al. were collected in 2011; we cannot exclude that changes in surgical and anaesthesia techniques in recent years alter the proposed prediction model. Before widespread implementation of the proposed prediction model in clinical practice an external validation with more recent data and more recent surgical techniques is warranted.

Early detection and adequate treatment of major post-operative adverse events such as pneumonia, are the primary goal of rescue and a central part of clinically effective and cost effective peri-operative medicine. Although diagnosis of pneumonia is based on clinical, microbiological and radiological criteria, in the postoperative period some classical criteria for pneumonia such as fever, leukocytosis and worsening gas exchange are often present without pneumonia. In most patients with suspected pneumonia empiric antibiotics are started before all CDC criteria are available because delay of appropriate antibiotics is a risk factor for mortality in hospital acquired pneumonia. An unresolved issue is the addition of prednisone in postoperative pneumonia but may be considered if the pneumonia is early after surgery and a community-acquired pneumonia is probable.14

In summary, what are our suggestions for practice and implementation research? The first is to adjust our clinical risk thinking in communications with clinicians, patients and families; including asking the value of the planned surgery. The second is to identify possible preventive strategies for higher risk patients who may benefit. For elective patients a pre-operative ambulatory rehabilitation (prehabilitation) could be started with interventions such as anaemia treatment, protein-rich nutrition, smoking cessation programme and general physical training. Evidence for this approach is a recent randomised controlled trial that demonstrated decreased postoperative pneumonia with targeted pre-operative
teaching from physiotherapists. A further option would be to reduce the severity of the risk factors. However, without adequate clinical trial evidence we cannot estimate the effect of reversing or avoiding risk factors on the outcome postoperative pneumonia. For example, there is no definitive evidence that functional dependence can be reduced but several studies are underway in pre-operative prehabilitation for older frail patients that may answer that question. Third, consider avoiding intra-operative colloids and transfusions. Fourth, adapt postoperative pathways to enhance early detection of pneumonia and adequate treatment (rescue) including planned postoperative intermediate care or high-dependency units.

Russotto et al. may have helped us better predict who is more likely to get postoperative pneumonia. If externally validated, controlled implementation research programs with highly motivated healthcare providers will be warranted with the intention to control and to reduce postoperative pneumonia rate, a major complication.

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