Canadian Journal of Cardiology 33 (2017) 101–109

Review

Prevention of Critical Care Complications in the Coronary Intensive Care Unit: Protocols, Bundles, and Insights From Intensive Care Studies

Sean van Diepen, MD, MSc,[a,b] Wendy I. Sligl, MD, MSc,[c] Jeffrey B. Washam, PharmD,[d] Ian C. Gilchrist, MD,[e] Rakesh C. Arora, MD, PhD,[f] and Jason N. Katz, MD, MHS[g]

[a] *Divisions of Critical Care and Cardiology, University of Alberta, Edmonton, Alberta, Canada*

[b] *Canadian VIGOUR Centre, University of Alberta, Edmonton, Alberta, Canada*

[c] *Divisions of Critical Care Medicine and Infectious Diseases, University of Alberta, Edmonton, Alberta, Canada*

[d] *Duke Heart Center, Duke University Medical Center, Durham, North Carolina, USA*

[e] *Milton S. Hershey Medical Center, Penn State University, Hershey, Pennsylvania, USA*

[f] *Department of Surgery and Cardiac Sciences Program, University of Manitoba, Winnipeg, Manitoba, Canada*

[g] *Divisions of Cardiology and Pulmonary and Critical Care Medicine, University of North Carolina School of Medicine, Chapel Hill, North Carolina, USA*

ABSTRACT

Over the past half century, coronary care units have expanded from specialized ischemia arrhythmia monitoring units into intensive care units (ICUs) for acutely ill and medically complex patients with a primary cardiac diagnosis. Patients admitted to contemporary coronary intensive care units (CICUs) are at risk for common and preventable critical care complications, yet many CICUs have not adopted standard-of-care prevention protocols and practices from general ICUs. In this article, we (1) review evidence-based interventions and care bundles that reduce the incidence of ventilator-associated pneumonia, excess sedation during mechanical ventilation, central line infections, stress ulcers, malnutrition, delirium, and medication errors and (2) recommend pragmatic adaptations for common conditions in critically ill patients with cardiac disease, and (3) provide example order sets and practical CICU protocol implementation strategies.

RÉSUMÉ

Au cours des 50 dernières années, les unités de soins coronariens sont passées d'unités spécialisées en surveillance des arythmies d'origine ischémique en unités des soins intensifs (USI) pour les patients atteints d'une maladie aiguë ou d'une pathologie complexe sur le plan médical dont le diagnostic principal est une maladie cardiaque. Les patients admis aux unités de soins intensifs coronariens (USIC) à la fine pointe de la modernité sont exposés à un risque de complications fréquentes et évitables lors des soins en phase aiguë. Néanmoins, plusieurs USIC n'ont pas adopté les protocoles et les pratiques de prévention selon les normes de soins provenant des USI généraux. Dans cet article, nous 1) avons passé en revue les interventions fondées sur des données probantes et les ensembles de pratiques cliniques exemplaires qui réduisent l'incidence de la pneumonie sous ventilation assistée, la sédation excessive durant la ventilation mécanique, les infections liées à un cathéter central, les ulcères de stress, la malnutrition, le délire et les erreurs de médicaments; 2) recommandons des adaptations pragmatiques aux problèmes courants des patients gravement atteints qui ont une maladie cardiaque; 3) fournissons des ensembles de modèles d'ordonnances et des stratégies pour la mise en place de protocoles pratiques aux USIC.

Coronary intensive care units (CICUs) were conceived as arrhythmia monitoring and treatment units for patients with acute coronary syndromes.[1,2] Over the past 5 decades, CICUs have evolved from a focus on single-system acute cardiac care to intensive care units (ICUs) that commonly care for patients with multisystem disease who increasingly require vasoactive infusions, mechanical ventilation (MV), renal replacement therapy, and mechanical circulatory support.[3,4] This temporal increase in acutely ill patients in the CICU and mechanical therapeutic technologies have potentially increased the risk of critical illness complications, including ventilator-associated pneumonia (VAP), sedation complications, central line infections, stress ulcers, delirium, and medication errors.[5-9] These aforementioned complications are associated with substantially increased in-hospital mortality, morbidity, length

Received for publication May 25, 2016. Accepted June 26, 2016.

Corresponding author: Dr Sean van Diepen, 2C2 Cardiology, Walter MacKenzie Center, University of Alberta Hospital, 8440-11 St, Edmonton, Alberta T6G 2B7, Canada. Tel.: +1-780-407-6948; fax: +1-780-407-7485.
E-mail: sv9@ualberta.ca

See page 106 for disclosure information.

http://dx.doi.org/10.1016/j.cjca.2016.06.011

of stay (LOS), or health care costs (or a combination) and are potentially preventable.[5,8,10-12] Arguably, some of the most important advances in critical care have been the implementation of practices and protocols that reduce the incidence of critical care complications, yet the adherence to these best-care practices among CICUs is neither known nor mandated by cardiovascular guidelines.

A recent statement endorsed by the Canadian Cardiovascular Society advocated for the organizational transformation of CICUs and recommended the use of standardized protocols to reduce preventable critical care complications; however, no literature or published protocols are available to guide implementation in the CICU population.[13] This article reviews contemporary evidence-based practices and "bundles of care" used to prevent common critical care complications that may be less familiar to the cardiovascular community and advocates for the universal implementation of ICU preventive practice standards in critically ill patients admitted to the CICU.

Prevention of VAP

VAP is a subtype of hospital-acquired pneumonia that is specifically defined as pneumonia that develops more than 48-72 hours after endotracheal intubation.[14] The incidence of VAP ranges between 10% and 20% in ventilated patients, with risk factors for VAP including advanced age, male sex, multiorgan failure, chronic disease, nasogastric tube placement, increased gastric pH (resulting from histamine-2 receptor antagonist [H2RA], proton pump inhibitors [PPIs]), previous antibiotic exposure, prolonged MV, cardiothoracic surgery, and the use of paralytic agents.[15-17] The importance of prevention is underscored by observational studies reporting that VAP is associated with a 2-fold increase in mortality, longer LOS, and higher costs compared with patients in whom VAP does not develop.[16] A comprehensive review of the pathogenesis, microbiological features, diagnosis, and treatment of VAP are beyond the scope of this review but are available in clinical practice guidelines.[18]

The simplest potential VAP prevention measure is the avoidance of intubation. Noninvasive ventilation is a safe and effective alternative to MV in appropriately selected patients and may be considered first-line therapy in the treatment of acute decompensated heart failure.[19,20] In patients undergoing MV, the oropharynx can become colonized with aerobic pathogens. Oral mouth care with chlorhexidine decreases the oropharyngeal bacterial burden and has been shown to reduce VAP rates in randomized trials.[21] Oral and digestive tract decontamination with topical and intravenous antimicrobial agents has also been shown to decrease mortality; however, this intervention has not been widely adopted in North America because of concerns regarding the development of antimicrobial resistance.[22]

The selection, positioning, and management of critical care appliances passing through the oropharynx also has a role in VAP prevention. The use of oral endotracheal and gastric tubes reduces the frequency of sinusitis and VAP compared with the use of nasal endotracheal and gastric tubes; hence, oral passage is preferred in most patients undergoing MV.[14,23] Additionally, endotracheal tubes with subglottic secretion drainage prevent microaspiration of oropharyngeal secretions, reduce VAP rates by 55%, and decrease mean MV duration by 1.1 days.[24] Subglottic drainage is recommended for patients likely to require MV for more than 48-72 hours. Clearly, predicting which patients will require prolonged ventilation is a challenge. The ventilator circuit itself can also become colonized with bacteria. The use of heat moisture exchange filters in-line with the ventilator circuit can filter both liquid and aerosolized bacteria and have been shown to reduce VAP.[25] The ventilator circuit, however, should be changed only if visibly soiled or malfunctioning, because more frequent changes do not decrease the incidence of VAP.[26,27] Finally, although tracheostomies may improve patient communication and comfort and reduce sedation requirements, early tracheostomy does not reduce the incidence of VAP.[28]

A patient's interaction with the critical care environment can also prevent the incidence of VAP. Patient positioning to minimize the risk of aspiration with head of bed (HOB) elevations between 30° and 45° has been associated with reduced VAP rates.[29] For patients with femoral sheaths or devices, reverse Trendelenburg positioning or minimal HOB elevations, or both, can still be performed. Adopting protocolized sedation algorithms to assess sedation depth and to maintain light sedation levels can decrease MV time and VAP; specific protocols are discussed in detail in the "Analgesic and Sedation Protocols" section further on. There are other interventions that lack sufficient evidence—limited by low-quality data, study size, or number of studies—to recommend their use for VAP prevention. These include antimicrobial silver-coated endotracheal tubes, probiotics, kinetic beds (which use continuous lateral rotational and oscillation therapy to improve secretion drainage), and prone positioning.

With the large number of evidence-based prevention strategies, the concept of VAP prevention "bundles" has gained popularity, with the goal of improved patient safety and quality care. A limited 4-element VAP bundle (consisting of HOB elevation, oral chlorhexidine, sedation interruption, and a weaning protocol) decreased VAP incidence in a before and after study design.[30] Consequently, the implementation of VAP prevention bundles is now a common practice in many ICUs.

In summary, VAP is common and associated with high morbidity and mortality, and evidence-based prevention strategies are recommended by clinical practice guidelines. Universal adherence to these strategies should be implemented in contemporary CICUs that care for patients receiving MV. A summary of critical care complication outcomes and prevention strategies (Table 1, Fig. 1) along with pragmatic adaptions for the CICU population for each element (Supplemental Table S1) are summarized further on.

Analgesic and Sedation Protocols

Prevention

More than 67% of patients undergoing MV in ICUs experience pain, and up to 71% experience anxiety or agitation.[31,32] Appropriate and timely treatment often requires the use of intermittent or continuous intravenous therapies, which may secondarily lead to a reduced level of consciousness and prolong MV. Although a consensus definition of "excess sedation" among patients requiring MV is lacking, clinical analgesic and sedation protocols that improve patient-centred outcomes have been developed.