ARTICLE

Improving the quality of care of the critically ill patient: Implementing the central venous line care bundle in the ICU

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Intravascular (IV) access in the care of the critically ill patient is an intervention that is both life-saving and life-threatening under certain circumstances. Critically ill patients frequently require the administration of intravenous fluids, blood products, medication, nutritional replacement therapy as well as monitoring of the intravascular volume.

Such invasive interventions, together with the critically ill patient's impaired immune system as a result of multiple and complex medications, co-morbid illnesses, prolonged intensive care unit (ICU) admission and multiple intravascular line insertions, make such patients at risk of developing catheter-related bloodstream infections (CRBSIs). According to the Centers for Disease Control (CDC) in the USA, 80 000 central venous catheter (CVC)-associated bloodstream infections (BSIs) occur in American ICUs each year based on an average rate of 5.3 CVC-associated BSIs per 1 000 catheter days in ICU.

In an attempt to provide guidance in the prevention of CRBSIs, evidence-based clinical practice guidelines have been developed by various groups such as the CDC working group in the USA and the Infection Control Committee of the National Health Systems Trust in the UK. These guidelines provide clinical practice recommendations based on extensive research in this area. A further initiative in reducing CRBSIs has been the development of care bundles, specifically the central line bundle, by the Institute for Healthcare Improvement (IHI) in the USA. The IHI describes a care bundle as a specific improvement tool with clear parameters, involving a small number of elements that are all based on level 1 evidence which must be adhered to for every patient irrespectively, to improve patient outcomes. The central line bundle as defined by the IHI is 'a group of evidence-based interventions for patients with intravascular central line catheters that, when implemented together, result in better outcomes than when implemented individually'.The care bundle approach provides access to resources to initiate the recommendations of the 5 Million Lives Campaign programme, which is a national effort to reduce preventable deaths in US hospitals. Tools such as central venous line insertion checklists and daily worksheets are freely available from the IHI website to facilitate the practical implementation of the necessary changes. This strategy provides a programme that requires a disciplined team effort and has the potential to provide sustainable improvement in the quality of patient care. Such a programme could be co-ordinated by a clinical nurse specialist in collaboration with the medical director of the critical care unit or department, the microbiology department and hospital management. The benefit to both the quality of patient care and the reduction in costs to the patient and health care provider may be substantial, making a strong case for utilising these guidelines in the South African health care setting, both in the public and private sectors.

Catheter-related bloodstream infections (CRBSIs)

CRBSIs are described as follows by Pronovost *et al.*,[1] according to the National Nosocomial Infections Surveillance (NNIS) System definitions (2004 data) (Table I).

The incidence of CRBSIs remains a problem in all spectra of critical care practice.[1-3] The CDC found that the incidence of CRBSIs varies considerably by type of intravascular catheter, frequency of intravascular catheter manipulation, and patient-related factors.

Table I.	Definitions of catheter-related blood stream infections (CRBSIs)[1]

1. Presence of a recognised pathogen cultured from one or more blood cultures (B/Cs)

AND

Organism cultured from blood not related to infection at another site

OR

2. Presence of at least one of the following:

- Fever (temperature >38°C), chills, hypotension

AND

- Signs and symptoms and positive results not related to infection at another site

AND

Presence of at least one of the following:

- Common skin contaminant cultured from 2 or more B/Cs drawn on separate occasions
- Common skin contaminant cultured from at least one B/C in a sample from a patient with an IV catheter
- Positive antigen test on blood

In an extensive literature review by Mermel,[4] and the NNIS System report of the CDC,[2] the majority of serious CRBSIs (90%) were associated with central intravascular catheters (CVCs), especially in the ICU patient population. Such significant infections, including CRBSIs, result in increased mortality and morbidity, prolonged ICU and/or hospital stay, potential further complications (such as renal failure, respiratory failure or septic shock), thus requiring an increased cost to patient and health care provider.[5-8] Current data in a recent systematic review by Maki *et al*.[9] indicate that the problem remains a serious challenge in present-day critical care management. A study by Koh *et al*.[10] recommends that intra-arterial catheters should be accorded the same degree of care in preventing CRBSIs as central intravascular lines, as they found similar colonisation and infection rates with the use of both catheters. It is therefore in the interest of both the patient and the health care institution to employ relevant measures that can reduce these infections and their sequelae by using these evidence-based clinical practice guidelines.

Care bundle approach

A further initiative in reducing CRBSIs has been the development of care bundles,[11] specifically the central line bundle, by the IHI.[12] Fulbrook and Mooney[13] define care bundles as 'groups of evidence-based practice interventions'. The theory behind care bundles is that the grouping together of the interventions in a single protocol, and the consistent application of recommended practices by the whole critical care team, should improve patient outcome. The key to successful implementation lies in the combined efforts of the clinical team in conjunction with the hospital management team that must provide the support and infrastructure to facilitate the quality improvement initiative.

The incidence and cost of these health care-associated infections have been recognised as real problems in health care services in both the USA and the UK. Mermel[4] stated in 2000 that the cost (1994 data) of caring for patients with CRBSIs in the USA ranged from $60 million to $460 million per annum. Maki and colleagues[9] in 2006 publicised that 'Intravascular devices (IVDs) are now the single most important cause of health care-associated BSI (blood stream infection), with an estimated 250 000 to 500 000 IVD-related (intravascular device) BSIs occurring each year throughout the USA. Furthermore such infections were associated with increased hospital length of stay, from 10 to 20 days, and excess health care costs, ranging from $4 000 to $56 000 per infection.'[9] Shannon *et al*.[14] conducted a 3-year cost analysis study on CRBSIs in a medical ICU and a coronary care unit (CCU) in a USA hospital from 2002 to 2005. The study revealed a total loss of operations of $1 449 306 in the 54 cases analysed, noting that the costs of the CRBSIs and the associated complications averaged 43% of the total cost of care. Shannon *et al*. state further that 'the elimination of these preventable infections constitutes not only an opportunity to improve patient outcomes, but also a significant financial opportunity'.[14] In the UK health care-associated infections cost the NHS approximately £1 billion per annum (2005 data).[15] The incidence of CRBSIs in South Africa is unknown.

Central venous line bundle

The key components of the central line bundle are:

1. hand hygiene
2. maximal barrier precautions upon insertion
3. chlorhexidine skin antisepsis
4. optimal intravascular catheter site selection, with the subclavian vein as the preferred site for non-tunnelled intravascular catheters
5. daily review of line necessity with prompt removal of unnecessary lines.

The specific details and evidence base for each of the components or elements are described in the CDC clinical practice guidelines for the prevention of intravascular catheter-related infections.[2]

For each of the components or elements the IHI website provides tools in the form of 'How to Guides',[16] checklists and daily goals worksheets that facilitate the practical implementation of the required changes. It is noteworthy that Vincent[17] argues that checklists are used widely outside of hospitals, and that the highly technical and rapidly changing environment of the ICU can be compared with the aviation cockpit – a place where checklists are accepted as a routine

part of ensuring safety. Vincent promotes the practice of combining daily bedside rounds with the use of a checklist such as the FAST HUG concept, which is used collaboratively with the multidisciplinary team at the bedside.[17] Hospitals are encouraged to empower nurses to enforce the bundle through the use of such checklists to promote adherence to evidence-based guidelines.[15] The potential benefit of this basic strategy could be significant reductions in CRBSIs in the ICU.[18]

Central venous line care guidelines

Specific details related to each component of the bundle are described in the CDC guidelines for the prevention of catheter-related infections.[2] Recommendations are provided regarding general precautions, insertion of lines, dressings, line care, different types of catheters and related devices, supported by a grading of the available evidence upon which the recommendations are based. Much of the underpinning work for these guidelines was based on the extensive work performed by Mermel and co-workers[19] in 2001 while developing guidelines for the management of IV catheter-related infections. Within the Southern African context, Mer[20] published guidelines with specific recommendations for local conditions that are in line with the CDC guidelines.

The IHI in the USA has produced resources aimed at facilitating the implementation of the bundle components such as the 'Getting started kit' and 'How-to guide' to prevent central venous line infections.[21] The kit details the background of the problem and describes the 5 components of the central line care bundle. It outlines the implementation strategy and provides checklists, daily goals worksheets, intervention-level measures such as the number of CRBSIs per 1 000 catheter days, as well as tips, fact sheets and addresses frequently asked questions.[21]

Advantages/benefits

Review of the *CDC Clinical Practice Guidelines* for the prevention of intravascular catheter-related infections reveals a comprehensive set of guidelines that clarify concepts and definitions and provides detail regarding the relevant epidemiology and pathogenesis, addresses each aspect of central venous line insertion and management, and then provides evidence-based recommendations for practice.[2] A further advantage is the provision of a quick summary of these recommendations for the practitioner at the bedside. The benefit to both quality of patient care and reduction in costs to both patient and health care provider is potentially substantial.

Disadvantages

The Campaign Programme requires a team effort from both medical and nursing staff, in collaboration with management staff, and presents many a challenge including medical dominance as described by Coombs.[22] A new strategy is often met with resistance and unless the team is committed to the initiative, it could prove difficult to implement or demonstrate benefit. The programme ideally requires that baseline measurements of the particular problem are measured, e.g. the incidence of CRBSIs in a particular hospital or ICU over a specific time period. Ongoing measurements of the rate of infections are required, and ultimately the extent of the problem after the interventions have been introduced for a designated time period must be measured. This process requires a sophisticated data collection system and a dedicated team, which is not freely available to all ICUs in South Africa. The disadvantage of the audit process required by the IHI campaign is that it is labour intensive as this process is instrumental in its successful implementation.

Implementation

Curtis *et al*.[23] developed a step-wise 'how-to' guide for the interdisciplinary team on how to initiate a quality improvement programme (Table II).

Table II. Step-wise 'how-to' guide

Initiation of a programme[23]

1. Identify local motivation, support teamwork and develop strong leadership.
2. Prioritise potential projects and choose the first target.
3. Operationalise the measures, build support for the project, and develop a business plan.
4. Perform an environmental scan to better understand the problem, potential barriers, opportunities, and resources for the project.
5. Create a data collection system that accurately measures baseline performance and future improvements.
6. Create a data reporting system that allows clinicians and others to understand the problem.
7. Introduce effective strategies to change clinical behaviour.

Evaluating and maintaining the programme

1. Determine whether the target is changing with periodic data collection.
2. Modify behaviour change strategies to improve or sustain improvements.
3. Focus on interdisciplinary collaboration.
4. Develop and sustain support from hospital leadership.

Bhutta *et al*.[3] found that a step-wise introduction of evidence-based interventions is effective in reducing

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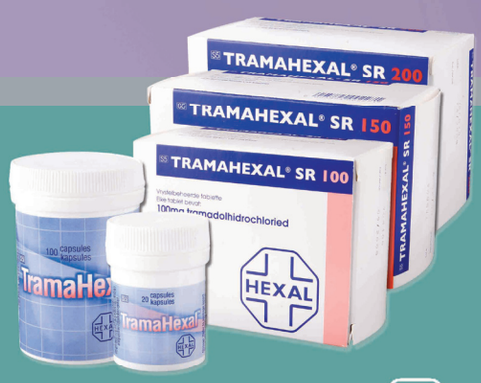

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intravascular catheter-associated blood stream infection. Their strategy included the following steps:

1. A multidisciplinary team required to identify the problem, viz. CRBSIs.
2. The setting up of a data collection system to measure baseline performance, i.e. establish prevalence of such infections, as well as ongoing improvement via (suitable) surveillance.
3. A data reporting system that allows all stakeholders to understand the extent of the problem and gauge the effects of changes in practice.
4. The introduction of effective evidence-based strategies to combat the problem.
5. The provision of intensive and sustained education of all staff members for continued success in reducing CRBSIs.

Wenzel and Edmond[24] note that, given the prevalence of intravascular catheter-related infections and the basis of current data on pathogenesis, prevention strategies have become a major issue in the quality of care in the USA. They too advocate a team-based prevention strategy focusing on quality, encouraging team-based professionalism, using evidence-based systems, and caring behaviour that consistently leads to safety and comfort of patients. The authors refer specifically to the success achieved by Pronovost and colleagues,[1] who conducted an interventional study in 2006 which achieved a 66% reduction in CRBSIs in 103 ICUs. The structure of the intervention involved daily commitment to a culture of safety, ongoing surveillance by trained infection-control personnel, and a supportive central education programme – the same key elements proposed by Bhutta *et al*.[3] The processes of the intervention involved the 5 components of the central venous line bundle as listed above.

In the September 2006 editorial of the *Mayo Clinic Proceedings*, Snyder[25] refers to the systematic review by Maki *et al*.[9] in the same edition regarding the risk of catheter- and intravascular device-related infections. He proposes that the prevention of these infections is a quality-of-care mandate for institutions and physicians and outlines the components of the strategy as follows:

1. Targeted, evidence-based insertion practices that use maximal barrier protection, topical chlorhexidine for skin disinfection before intravascular catheter insertion, avoidance of femoral route insertion when possible, and post-insertion skin disinfection procedures and removal of intravascular catheters when they are no longer necessary (i.e. the central venous line bundle).
2. Promotion and certification of an education programme that addresses intravascular catheter-associated bloodstream infections (i.e. the supporting education programme).
3. Implementation of a tool to quantify adherence to practice (e.g. the checklist).
4. Use of intravascular catheter insertion kits with standardised contents to enable a competent health professional to perform the procedures and adhere to accepted techniques (i.e. the equipment and consumables provided by hospital management).
5. Measurement of infection rates (i.e. the data collection system).

Snyder states that 'these procedures, along with the appropriate training, are becoming standard practice at many institutions because of the emphasis by state agencies as well as payers and third-party quality-of-care monitoring agencies such as The Leapfrog Group'.[25]

Conclusion

Despite the development of these procedures originating from the USA, there is a strong case for utilising their work and applying the principles in the South African health care setting. The IHI has pledged its support to institutions that wish to participate in the campaign and has extended this invitation to countries outside of the USA. The incidence of CRBSIs in the South African setting is unknown given the lack of a national data collecting system.

This strategy has the potential to reduce serious, even life-threatening, infections in the critically ill patient. In resource-strapped health care settings such as in South Africa, it makes sense to get the basics right consistently. The cost of hand-washing solutions is phenomenally less than the use of repeated intravenous anti-microbial therapy and increased hospital stays. The recommendations arising from this review are at the very least that the incidence of CRBSIs in South African hospitals is measured and serious consideration be given to adopting the IHI quality improvement strategy of implementing the care bundle approach to improving the quality of patient care.

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