The importance of telehealth in the implementation of best practice in paediatric burn management by non-burn specialist clinicians

Tania McWilliams

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The importance of telehealth in the implementation of best practice in paediatric burn management by non-burn specialist clinicians

This thesis is presented for the degree of

Doctor of Philosophy

Tania McWilliams

Edith Cowan University
School of Nursing and Midwifery
2020
DECLARATION

Declaration: I certify that this thesis does not, to the best of my knowledge and belief:

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ABSTRACT

Introduction: Burns are a leading cause of injury worldwide, yet the initial assessment and management of patients following burn injury is often performed by non-burn specialist clinicians. Using the Gilbert Behaviour Engineering Model as a framework, strategies were introduced to support these clinicians. A better understanding was needed, however, of the effectiveness of these strategies, and the experiences of clinicians who provide this initial care.

Aims: This study aims to contribute new knowledge related to paediatric burn care through the evaluation of a state-wide burns telehealth program in Western Australia; specifically, develop a deeper and more relevant understanding of a state-wide burns infection control bundle; and elaborate upon existing knowledge of factors that influence clinical practice in acute burn management.

Method: A sequential explanatory mixed methods design was used. Phase 1 used quantitative data to explore the state-wide burns telehealth clinical and education program as well as the effectiveness of the state-wide burns infection control bundle. Phase 2 used qualitative data to explore factors that influence clinician practice in acute burn management.

Results: The burns telehealth clinical program activity increased between 2005/6 and 2012/13. By providing real-time advice to non-burn specialist clinicians, unnecessary inpatient length of stay, transfers and admissions were reduced. The burns telehealth education program delivered to non-burn specialist clinicians demonstrated increased knowledge in most aspects of acute burn care following attendance at the education sessions. Building on these strategies, the implementation of a state-wide burns infection control bundle was effective in reducing burn wound infection and sepsis rates to zero, but was not able to demonstrate the same effectiveness in reducing upper respiratory or urinary tract infections in this population. Following integration of these strategies within the state-wide model of care, an exploration of factors which influence the clinical practice of the non-burn specialist clinicians providing this initial care demonstrated a number of common themes, in particular, that telehealth services support these clinicians, but IT issues remain a barrier.

Conclusion: The integration of state-wide clinical and educational paediatric burn telehealth services enabled the introduction of a state-wide infection control bundle which has resulted in increased non-burn specialist clinician knowledge and access to real-time advice which has reduced unnecessary transfers and admissions, while also reducing the risk of infection for those burns patients who do require transfer and admission. Clinicians providing this initial care reported that this telehealth service was a major support in their care of paediatric patients following burn injury, demonstrating its importance now and in the future.
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Thank you to all my family and friends who have supported me throughout my studies.

To Professor Di Twigg, who consistently guided, taught and supported me throughout my studies and kept me on track, thank you for being such a wonderful supervisor and mentor.

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To Margaret Giles, who assisted with the data analysis concepts for the paper, “Telehealth for paediatric burn patients in rural areas: a retrospective audit of activity and cost savings.”

Thank you to all the staff who participated in this thesis, your contribution to patient care and insight into patient care in WA is invaluable.
DEDICATION

This work is dedicated to my Father, Jacobus Thomas Boot, who always encouraged me to work hard and would have loved to have known the findings of this study and to have seen this thesis finished. RIP, I miss you.
**LIST OF PUBLICATIONS**

This thesis is presented to meet the requirements of a thesis with publication. The five papers in the thesis include three that have been accepted for publication in high ranking peer-reviewed journals and two which are currently under review in high ranking peer-reviewed journals. The papers are listed below in the order they appear in the thesis:

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<th>Phase 2: Qualitative</th>
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<td>McWilliams, T., Twigg, D., Hendricks, J., &amp; Wood, F. Factors influencing the implementation of best practice in paediatric burns management. <em>Draft</em>.</td>
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STATEMENT OF CONTRIBUTION OF OTHERS

This thesis is my own composition, all sources have been acknowledged and my contribution has been clearly identified and supported as at least 50% by my co-authors. All co-authors have given permission for me to include the publications in the thesis.

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Dr Joyce Hendricks (Supervisor)
2/2020

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2/2020

To Whom It May Concern.
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- literature search
- literature assessment
- interpretation of data
- drafting of literature review
- revisions of literature review

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- Research design
- Data collection
- Data analysis
- Drafting of paper
- Revisions of paper

to the paper, “Telehealth for paediatric burn patients in rural areas: a retrospective audit of activity and cost savings.”

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To Whom It May Concern.
I, Tania Lorena McWilliams, contributed:

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- Research design
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- Research design
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<th>Description</th>
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<tr>
<td>ANTT</td>
<td>Aseptic Non-Touch Technique</td>
</tr>
<tr>
<td>ANZBA</td>
<td>Australian New Zealand Burn Association</td>
</tr>
<tr>
<td>AUD</td>
<td>Australian dollars</td>
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<tr>
<td>BEM</td>
<td>Behaviour Engineering Model</td>
</tr>
<tr>
<td>CNC</td>
<td>Clinical nurse consultant</td>
</tr>
<tr>
<td>COREQ</td>
<td>Consolidated Criteria for Reporting Qualitative</td>
</tr>
<tr>
<td>GEKO</td>
<td>Governance Evidence Knowledge Outcomes</td>
</tr>
<tr>
<td>HAI</td>
<td>Healthcare associated infections</td>
</tr>
<tr>
<td>HEPA</td>
<td>High-efficiency particulate air</td>
</tr>
<tr>
<td>IPC</td>
<td>Infection prevention control</td>
</tr>
<tr>
<td>IP</td>
<td>Internet protocol</td>
</tr>
<tr>
<td>M.I.C.E.</td>
<td>Mobile Image Communication Exchange</td>
</tr>
<tr>
<td>MRSA</td>
<td>Methicillin resistant Staphylococcus aureus</td>
</tr>
<tr>
<td>NHMRC</td>
<td>National Health and Medical Research Council</td>
</tr>
<tr>
<td>NSQHS</td>
<td>National Safety and Quality Health Service</td>
</tr>
<tr>
<td>PCH</td>
<td>Perth Children’s Hospital</td>
</tr>
<tr>
<td>PMH</td>
<td>Princess Margaret Hospital for Children</td>
</tr>
<tr>
<td>STROBE</td>
<td>Strengthening the Reporting of Observational Studies in Epidemiology</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>TBSA</td>
<td>Total body surface area</td>
</tr>
<tr>
<td>UMRN</td>
<td>Unique medical record number</td>
</tr>
<tr>
<td>WA</td>
<td>Western Australia</td>
</tr>
<tr>
<td>Webpas</td>
<td>Web Patient Administration System</td>
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<tr>
<td>WHO</td>
<td>World Health Organisation</td>
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</table>
CHAPTER 1: INTRODUCTION

Introduction

Burns are a leading cause of injury worldwide. Children who sustain severe burns in Western Australia (WA) are admitted to Perth Children’s Hospital (PCH), formerly Princess Margaret Hospital for Children (PMH), for inpatient management. Many others receive their treatment as outpatients or via the state-wide burns telehealth service. The initial assessment and management received by patients with burn injuries in WA often occurs in their local health care facility by clinicians with various levels of burn management knowledge and experience. These clinicians include mainly general practitioners, emergency department clinicians and remote area nurses. The acute care provided by these non-burn specialist clinicians has a significant impact on patient outcomes, and therefore should comply with best practice recommendations; every intervention from the point of injury will influence the scar worn for life. However, research into factors influencing the transfer of knowledge to the clinical practice of treating patients following burn injury remains scarce.

Background

It has been estimated that 180,000 burn-related deaths occur each year worldwide and 11 million people require medical attention following burn injury (World Health Organisation [WHO], 2020). In Australia it is estimated that approximately 1% of the population will sustain a burn annually, of which 10% will need hospital admission for the injury, and 10% of these admitted patients will have a life-threatening burn (Wasiak et al., 2009; Greenwood et al., 2007). Between 2000 and 2012, 10,712 people were admitted to WA hospitals following a burn injury. Sixty-one percent of those admissions occurred in Perth hospitals and the remaining 39% occurred in rural and remote hospitals (Randall et al., 2017). In the study by Randall et al. (2017) males and people from lower socio-economic backgrounds were more likely to sustain a burn injury requiring admission, and the majority of these burns occurred in the home. Eighty-nine percent of burn injuries admitted to hospital during 2000-2012 in WA were less than 20% of total body surface area (TBSA), 53.3% were partial thickness burns, 29.8% were due to scald and 28.3% were due to flame (Randall et al., 2017). During the same period 3,191 children aged 0 to 15 years were admitted to WA hospitals following a burn injury; the highest paediatric admission rates were in the 0- to 4-year-old patient group (Randall et al., 2017). A number of studies have found that children, particularly those aged under 5 years, are at greatest risk of sustaining a burn injury (Duke et al., 2012; D’Souza, Nelson, & McKenzie, 2009; Wasiak et al., 2009). Although admission rates for paediatric patients with burn injuries in WA are reported to be slowly declining (Duke et al, 2012, Randall et al., 2017), outpatient clinic presentations continue to increase (WEBPAS data). The trend of increasing referral of patients with smaller burn injuries and the common practice of earlier discharge of inpatients to outpatient management reported in Smolle et al.’s (2017) worldwide review may account for this increasing non-admitted activity in WA. These burn injuries may have both immediate- and long-term physical and psychosocial effects for patients and families, while also requiring significant healthcare resources and funding for their treatment (Pellatt, Williams, Wright, &
Young, 2010; Willebrand et al., 2011). The burden of burn injury to the individual, the community and the health system is therefore significant and optimal care for these patients is vital.

In WA non-burn specialist clinicians often attend to the acute pre-transfer management of patients with burn injuries prior to admission and administer the initial care (Rea, Kuthubutheen, Fowler, & Wood, 2005). Providing optimal initial burn care reduces morbidity and, in larger injuries, mortality. This care ultimately influences a patient’s cosmetic and functional scar outcome. This can affect a child’s appearance and ability to perform simple physical tasks in the future (Khorasani & Mansouri, 2010; Kim, Martin, & Holland, 2012; Naumeri, Ahmad, Malik, & Sarwar, 2018).

Western Australia encompasses one third of the nation’s land mass and has a population of almost 2.6 million people. The healthcare needs of Western Australians are met by the WA Department of Health, Aboriginal Medical Service, general practitioners and various other public and private health care organisations. The PMH Total Care Burns Unit was the state’s only paediatric burn unit at the time this study was undertaken (prior to its closure in June 2018 and the opening of PCH), was located in the capital city Perth and provided a state-wide burn service. Annually, over 300 inpatients and 4000 outpatients received acute, rehabilitative and reconstructive burn care by the PMH Total Care Burns Unit (Web Patient Administration System [Wepbas] data, 2019). Patients referred to the PMH Total Care Burns Unit were initially assessed and treated either by the PMH Emergency Department, or other hospitals, health services, nursing posts or general practitioners from the metropolitan, rural or remote areas of WA.

Since 2005, the Western Australian paediatric burn unit has provided a state-wide clinical advice through the delivery of a telehealth service. Utilisation of the telehealth service has steadily increased as it has become imbedded in the model of care for paediatric patients following burn injury. The service provides acute and long-term patient review and advice conducted by the burns team in collaboration with referring clinicians. Due to the increased risk of morbidity and mortality for patients with burn injuries who do not receive appropriate initial management, the evaluation of the burns telehealth service has significant clinical implications both locally and internationally.

Prior to this study there were gaps in the literature regarding many aspects of initial care provision for patients with burn injuries by non-burn specialist clinicians. There was a paucity of evidence to determine whether providing education via synchronous telehealth to non-burn clinicians would result in an increase in knowledge, better care or cost savings. Building on the telehealth service and incorporating the telehealth clinical advice and education programs, an infection control bundle was developed and evaluated with the intention of reducing the rate of healthcare associated infections for paediatric patients following burn injury.

This study explores the introduction and evolution of the WA state paediatric burns telehealth service which provides advice for non-burn specialist clinicians. This service is vital to
enabling real-time clinical advice for optimal care and ongoing clinician education, with the aim of avoiding unnecessary patient transfers and reducing inpatient length of stay. A better understanding is needed of the factors that influence clinician transfer of knowledge from such education and advice, and ultimately, which factors actually influence the implementation of best practice when providing care for paediatric patients following burn injury in WA. This is important as it enables identification of the factors the clinicians themselves report. This study, therefore, contributes new knowledge that is vital to the optimal care of paediatric patients who have sustained burn injuries prior to their transfer to a burn unit.

**Aims of study**

The aims of this study are to

1. develop new knowledge related to burn care management though an evaluation of a state-wide paediatric burns telehealth program,
2. develop a deeper and more relevant understanding of a state-wide burns infection control bundle, and
3. elaborate upon existing knowledge of factors that influence clinical practices in acute paediatric burn management.

**Purpose of the study**

The purpose of this study is to explore factors that influence paediatric burn care in WA by non burns clinicians.

**Significance of the study**

The significance of this study is the identification of factors influencing the transfer of knowledge into clinical practice by clinicians following their participation in a telehealth program to improve the quality of care provided to patients. The identification of these factors and their effectiveness will enable the implementation of strategies to improve the quality of frontline management of paediatric patients following burn injury.

**Research questions**

This study investigates acute paediatric burn management in WA through an exploration of influencing factors and compliance with best practice. This is evaluated by addressing the following research questions:

1. How effective was the state-wide telehealth education program in transferring knowledge of best clinical practice?
2. How effective was the state-wide infection control bundle in changing practice related the use of best practice?
3. What factors influence frontline clinician compliance with best practice acute paediatric burn management in WA?

<table>
<thead>
<tr>
<th>Overall Study Research Questions</th>
<th>Individual Project Research Questions</th>
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<tr>
<td>Phase One</td>
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<tr>
<td>How effective were the state-wide telehealth clinical and education programs in transferring knowledge of best clinical practice?</td>
<td>Can clinical advice delivered via a state-wide burns telehealth program reduce unnecessary patient transfers and inpatient bed days over an 8-year period (2005–2013)? Does clinical advice delivered via a state-wide burns telehealth program result in cost savings? What are the learning needs of multidisciplinary non-burn specialist clinicians in WA regarding the assessment and management of paediatric burn injured patients? Does the implementation of a state-wide education program delivered via videoconference increase clinician knowledge of burns assessment and management?</td>
</tr>
<tr>
<td>How effective was the state-wide telehealth program infection control bundles in changing practice related the use of best practice?</td>
<td>Does the implementation of a state-wide infection control bundle reduce healthcare associated infections in paediatric burn injured patients in WA?</td>
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<td>Phase Two</td>
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<tr>
<td>What factors influence frontline clinician compliance with best practice acute paediatric burn management in WA?</td>
<td>What factors influence pre-admission clinician compliance with best practice acute paediatric burn management in WA? What are the environmental factors which influence compliance with best practice acute paediatric burn management in WA? What are the individual factors which influence compliance with best practice acute paediatric burn management in WA?</td>
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Research design

A sequential explanatory mixed methods approach was used for this study. This was used because understanding the complexity of knowledge transfer requires pragmatism to glean knowledge related to patient outcomes, clinician experience and understanding, and ways to address shortfalls in practice (O’Cathain, Murphy, & Nicholl, 2010). A mixed methods approach also adds multiple perspectives, while strengthening rigour and understanding. This method facilitated investigation of the effectiveness of strategies employed to promote the use of best practice using quantitative methods, while also exploring factors influencing the implementation of best practice from the perspective of the clinicians using qualitative methods. This will be further explored in Chapter 3, Methods.

Theoretical framework

In order to comprehensively guide and assess the factors influencing knowledge transfer and the subsequent implementation of best practice in the initial assessment and management of paediatric patients with burn injuries, a sound theoretical framework was required. A framework which allowed for the identification and analysis of multiple factors which can influence a clinician’s transfer of theoretical knowledge into clinical practice, and therefore
provided competent care for patients, was therefore needed. The Behaviour Engineering Model (BEM) developed by Thomas Gilbert (2013) provided the theoretical framework for this study. The BEM enabled the systematic identification and analysis of factors which build and promote competence, as well as factors which are potential barriers to competence in the provision of initial burn care (Gilbert, 2013; Chevalier, 2003). The model facilitated the exploration of factors that influence clinician performance and therefore the transfer of knowledge into clinical practice (Gilbert, 2013). The model was also used to identify and analyse staff perception of performance enhancers (knowledge translation) and barriers (Weinberger, 1998). Although other models exist, the BEM was chosen due to its ability to identify multiple factors internal and external to the clinician which impact on their knowledge translating into clinical practice in such a complex system of operation in the real world. As a result, the BEM is effective in identifying any problems as well as potential solutions when investigating the factors clinical which influence clinical care.

The BEM has been previously used in the corporate environment and healthcare settings (Chae & Park, 2019; Kyle-Needs & Lindbeck, 2011) to assess staff perceptions of performance influencing factors (Ripley, 2003). The BEM categorises six factors that are necessary for performance —individual factors such as knowledge, capacity and motives and environmental factors such as data, instruments and incentives—all of which influence a clinician’s performance (Gilbert, 2013). Together, Gilbert (2013) asserts, these six factors create a system which results in either competence or incompetence.

<table>
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<th>Information</th>
<th>Response</th>
<th>Motivation</th>
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<td><strong>Environmental Factors</strong></td>
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<td>Factors Influencing Best Practice in Burn Management (Phase 2)</td>
<td>Factors Influencing Best Practice in Burn Management (Phase 2)</td>
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<td>Burns Infection Control Bundle (Phase 1)</td>
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<td>Factors Influencing Best Practice in Burn Management (Phase 2)</td>
<td>Factors Influencing Best Practice in Burn Management (Phase 2)</td>
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<td>Burns Infection Control Bundle (Phase 1)</td>
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<td></td>
<td>Factors Influencing Best Practice in Burn Management (Phase 2)</td>
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*Table 1. Use of the Behaviour Engineering Model to guide phases of the study (Gilbert, 2013).*

Environmental factors include data (information), instruments (response) and incentives (motivation) (Gilbert, 2013). These factors reflect environmental supports or barriers for clinicians, which impact their ability to provide optimal care. Data include clear guidelines and
feedback regarding performance for staff (Gilbert, 2013; Binder, 1998). In this study, this means the availability of initial burn assessment and management guidelines, plus feedback relating to the appropriateness of clinical practice and consequent patient care. Instruments include tools and resources available to perform the expected work (Gilbert, 2013; Binder, 1998). In this study, this means the availability of the necessary equipment to provide best practice clinical care. For example, airway equipment, the Lund and Browder chart, intravenous fluids and lines, indwelling catheters, Acticoat\textsuperscript{TM} dressings and the availability of expert resources for advice. Incentives include the available monetary and non-monetary incentives for staff as well as performance-based career opportunities (Gilbert, 2013; Binder, 1998). In this study, this includes local healthcare facility performance incentives such as bonuses or ‘employee of the month’ and promotional opportunities.

Individual factors include knowledge (information), capacity (response) and motives (motivation) (Gilbert, 2013). These factors reflect individual clinician supports or barriers which impact their ability to provide optimal care. Knowledge includes an individual’s knowledge and skills derived from both education and non-training interventions (Gilbert, 2013; Binder, 1998). In this context, this refers to clinician knowledge of best practice in burn assessment and management and their skill in providing that care. Capacity denotes the hiring of appropriate staff whose abilities enable them to perform their role (Gilbert, 2013; Binder, 1998). In this study, this refers to the appropriate recruitment, selection, rostering and availability of clinicians with approved qualifications and the necessary abilities to perform tasks. Motives include people’s attitudes and preferences regarding the type of work and the work environment, and their willingness to work for the incentives available (Gilbert, 2013; Binder, 1998). This refers to a clinician’s attitude and preferences regarding the assessment and management of a child who has sustained a burn injury, and their willingness to participate in that patient’s care. Although the BEM looks at multiple individual and environmental factors, a limitation of the model is that other factors may be affecting a clinician which this model does not capture. Individuals and environments are both incredibly complex and multifaceted, and therefore it is difficult to ever capture all influencing factors in a clinician’s practice.

When the factors above are considered together the potential influences on the provision of best practice during the initial management of paediatric burn injuries can be identified. Clinical competence and the delivery of best practice by clinicians is complex and multifactorial (Khomeiran, Yekta, Kigere, & Ahmadi, 2006). Even when clinicians possess knowledge, their transfer of that knowledge into clinical practice is influenced by many factors, and the importance of the context in which they practice is a common theme in the literature (Pentland et al., 2011). By identifying the factors which facilitate or present barriers to optimal performance in the initial management of patients with burn injuries, strategies can be expanded and developed to support clinicians. This theoretical model provided a comprehensive framework for both developing and evaluating strategies used in this study as it facilitated the targeting of factors that influence best practice and the assessment of these factors. The evaluation of these strategies and further exploration of influencing factors forms the scope of this study.
Conflict of interest

During the period in which this study was conducted, the researcher was also the PCH Total Care Burns Unit Clinical Nurse Consultant. This meant that the clinician implementing the changes was also evaluating them. This may have potentially influenced potential participant decisions to participate in any phase of the research, or could have influenced their responses. Due to this clinical-research overlap, there was a potential conflict of interest regarding the possible disclosure by clinicians during interview of unsafe clinical practices which this role would usually deal with directly. During the research period, any actual suboptimal care provided by referring clinicians was to be addressed confidentially by the director of the WA Burn Service with the referring clinician directly within one week of admission. This process thereby ensured continued clinical governance over patient care, kept research separate from clinical care, whilst removing the conflict of interest for the researcher. Intervention by the director of the WA Burn Service was not required.
Chapter summary

Burns are a frequent and serious cause of injury internationally. The initial acute assessment and management of burn injuries in WA is often performed by non-burn clinicians with varying levels of knowledge and experience. Research into many aspects of the provision of this care and the factors that influence it is scarce. This study, therefore, aims to increase knowledge regarding burn care management through the evaluation of a state-wide burns telehealth service and a state-wide burns infection control bundle and explore the factors which influence acute burn management in WA. The purpose of the study is to explore factors which influence burn care by non-burn specialist clinicians across the state, to enable the implementation of strategies to improve this care. Three main research questions guided investigation of the effectiveness of the state-wide telehealth program, the state-wide education program and the factors which influence frontline clinician compliance with best practice in acute paediatric burn management in WA. A sequential explanatory mixed methods approach was used to address these questions and the Gilbert BEM was used as a theoretical framework to identify factors which influence burn care.

Thesis structure

This thesis does not follow a traditional format and is reported as a thesis with publication. Chapter 1 provides the study rationale and background. It also presents the researcher’s position. The following chapters are underpinned by papers peer reviewed for publication. Three papers are published in peer reviewed journals and two are currently under peer review. These five papers are woven together through three overarching chapters (Introduction, Discussion and Conclusion), such that the thesis as a whole forms a cohesive account of the research undertaken.

Chapter 3 focuses on the methods used in this study and Chapter 4 presents the results of the study, both Phase 1 and Phase 2. These phases explore the telehealth service (both clinic advice and education services); the integration of the telehealth service and infection control to implement a state-wide burns infection control bundle; and, finally, the factors that influence the implementation of best practice in acute paediatric burn care in WA. Chapter 5 presents an overall discussion and conclusion of the thesis, including limitations and implications for future research, education, policy and practice.

Chapter to follow

Chapter 2 presents an analysis of the literature on factors influencing the implementation of best practice. A scoping literature review process was used to identify current knowledge.
CHAPTER 2: FACTORS INFLUENCING BEST PRACTICE IN BURN CARE: A SCOPING REVIEW

Introduction

Chapter 2 provides a scoping review of the literature on factors influencing the transfer of knowledge into clinical practice. The review was conducted to identify current knowledge about factors influencing the implementation of best practice in burn care. Due to a paucity of literature on this topic and the gap in the literature that prompted this thesis, the scope of the literature review was broadened. The search strategy is outlined using a structured 12-step approach as per Kable, Pich, and Maslin-Prothero (2012), which guided the comprehensive search and documentation of the literature (Figure 1). The revised aim was to critically appraise the literature regarding the factors which influence the implementation of best practice in clinical healthcare practice more generally. This chapter highlights that, to date, there is no literature on the factors that influence the implementation of best practice in the initial management of paediatric patients following burn injury. The chapter also highlights that in other areas, despite the contextual nature of factors influencing the transfer of knowledge into clinical practice, common themes do emerge across various clinical areas. These common influencing factors include individual factors, organisational factors, education and training, polices, plus resources. The identification of common influencing factors combined with the lack of literature addressing this issue in burn care, demonstrates the need for research in this area. This literature review therefore highlights the importance of this research in filling this gap in the current literature on burn care. The results are presented in the following paper.
“Factors influencing best practice in burn care: a scoping literature review”


Abstract
Background: The implementation of best practice improves patient outcomes, yet an ongoing gap exists between research and clinical practice. The transfer of knowledge into practice and the factors which influence this is therefore vital for improving patient care.
Aim: Critically appraise the available literature regarding factors which influence the implementation of best practice.
Method: A scoping literature review utilising a 12-step approach was used to search and critically review the relevant literature.
Results: Following broadening of the original aim, six articles were retained and critiqued. Five themes emerged from the literature as factors which influence the implementation of best practice, namely individual factors, organisational factors, education and training, policies plus resources.
Conclusion: Literature regarding factors which influence the implementation of best practice is sparse, yet common themes emerged. There is a gap in the evidence regarding these factors in the acute management of burns and further research in this area is needed.

Introduction
Optimal acute burn care reduces morbidity and mortality (Khorasani & Mansouri, 2010; Kim, Martin, & Holland, 2012; Naumeri, Ahmad, Malik, & Sarwaz, 2018). The implementation of best practice in the care of burns from the patient’s initial presentation following injury and throughout their patient journey is therefore the goal. In addition to the initial life and limb saving measures when caring for a patient with a burn injury, treatment also aims to salvage tissue within the burn itself and prevent conversion to a deeper injury. Jackson’s (1953) seminal burn wound model demonstrates the importance of both initial and ongoing treatment in salvaging the “zone of stasis” to prevent conversion of the burn to a large and/or deep injury. First aid, oedema management, appropriate fluid administration, prevention of infection, appropriate wound management and control of comorbidities are some of the most important factors in preventing further tissue destruction (Dries, 2009; Jackson, 1953; Lanier, McClain, Lin, Singer, & Clark, 2011).

It is therefore apparent that the care provided for patients following burn injury in their acute management is vital to their outcome, yet is provided in a variety of clinical settings. Consequently, the factors which influence the care of the burn injured patient along this journey will vary according to the clinician providing it and the environment in which they practice. In order to facilitate best practice for patients following burn injury, it is important to understand
the factors which can influence their care and what assists or prevents the implementation of best practice.

**Background**

The implementation of best practice has been demonstrated to improve patient outcomes (Khorasani & Mansouri, 2010; Kim et al, 2012; Naumeri et al, 2018). Despite this, it is widely reported that an ongoing gap exists between evidence of best practice generated through research and clinical practice in many areas, including burn care (Ketelaar, Russell, & Gorter, 2008; Singh, 2015; Yue, Fan, & Peng, 2018). The transfer of best practice into clinical practice by clinicians is multi-factorial. The factors which can influence the implementation of best practice are individual, organisational and environmental. Some factors act as a barrier to the implementation of best practice, whilst others facilitate its implementation and can differ depending on the specialty and the environment of practice. By investigating these factors, we can understand why the implementation of best practice occurs in some areas, but not others, and strategies can be proposed to improve the uptake of best practice in clinical areas in order to improve patient care.

Knowledge transfer is a key component in the implementation of best practice, in order to close the gap between evidence and clinical practice (Lang, Wyer, & Haynes, 2007). Clinician knowledge of best practice in the treatment of a patient may or may not translate into clinical practice, a phenomenon which is widely reported in the literature (Ketelaar et al., 2008; Singh, 2015; Yue et al, 2018). The transfer of knowledge of high-level research evidence into clinical practice is known as knowledge translation (Lang et al, 2007). A lack of knowledge translation can result in patients not receiving optimal care which is supported by recent research findings (Lang et al, 2007). Many studies investigate various strategies to improve the implementation of best practice, but understanding the barriers and facilitators for knowledge translation into clinical practice is important (Aita, Richer, & Heon, 2007; Ketelaar et al., 2008). By understanding the factors which influence the implementation of best practice within a particular environment and patient group, we are able to devise strategies which support facilitating factors and assist in overcoming barriers (Menzies, Duz, & Kinch, 2015; Ketelaar et al., 2008; Lang et al., 2007). This concept is therefore vital to ensuring optimal burn care for our patients. A review of the available literature surrounding this topic is therefore vital in order to build on current knowledge.

**Aim**

The aim of this review was to critically appraise the available literature regarding the factors that influence the implementation of best practice in burn care. Due to the lack of literature specific to burn care, the aim was revised to critically appraise the available literature regarding the factors which influence the implementation of best practice in clinical practice.

**Methods**
The review followed a structured 12-step approach as outlined by Kable, Pich, and Maslin-Prothero (2012). This search strategy ensured a comprehensive, thorough search of all available literature followed by a critical review of the relevant literature. The literature was searched using the databases of CINAHL, Proquest, Medline, Emcare and Embase. All reference lists of relevant literature were hand searched for other potentially relevant studies.

**Inclusion criteria**

The following inclusion criteria were initially applied to the search for articles:

- full text
- English language
- published January 2003 – April 2019
- original research studies or discussion articles about factors which influence the implementation of best practice in burn care.

Articles were excluded if they were either focused on other clinical conditions, written in a language other than English, or not primary data sources such as previous literature reviews, systematic reviews, discussion articles, letters or commentaries.

Seven search terms were used to search the databases:

- burns AND best practice
- burns AND knowledge transfer
- burns AND clinical practice
- burns AND education
- burns AND factors influencing
- burns AND telehealth
- burns AND telemedicine.

Unfortunately, following review of 1,576 articles listed, none were identified as meeting the inclusion criteria; all were excluded after reviewing their abstract and title. Due to this paucity of research in the area of burns, the literature search was widened and repeated to encompass areas of clinical practice other than burn injury which investigated factors influencing the transfer of knowledge into practice.

The following inclusion criteria were applied to the widened search for articles:

- full text
- English language
- published January 2003 – April 2019
- original research studies or discussion articles about factors which influence the implementation of best practice in clinical practice.

Articles were excluded if they were either written in a language other than English or not primary data sources such as previous literature reviews, systematic reviews, discussion
Articles, letters or commentaries. Articles investigating student transfer of knowledge into practice were also excluded, as we wished to explore the factors experienced by qualified clinicians. Two search terms were used to search the databases: knowledge transfer AND clinical practice.

This strategy resulted in improved results compared to the previous searches. Following identification of 5,986 potential articles, 5,974 were excluded based on their title and abstract, 12 were retained for full text evaluation. Six articles did not meet the inclusion criteria, as they were not original research studies or discussion articles about factors which influence the implementation of best practice in clinical practice. Six were identified as meeting the inclusion criteria and included in this review and critique.

![Flow chart of literature screening](image)

**Figure 1: Flow chart of literature screening**

**Assessment of articles**

The papers were assessed using two recognised approaches for the types of studies identified in this review. Qualitative papers were assessed using the Consolidated Criteria for Reporting Qualitative Studies (COREQ) 32-item checklist. Quantitative papers were assessed using Strengthening the Reporting of Observational Studies in Epidemiology Statement Guideline (STROBE) for reporting observational studies (Table 1).

<table>
<thead>
<tr>
<th>Quality of articles</th>
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<tbody>
<tr>
<td>Checklist</td>
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<tr>
<td>High</td>
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<tr>
<td>Medium</td>
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<td>Low</td>
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Table 1: Criteria used to assess methodological quality of articles

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<tr>
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<th>COREQ</th>
<th>STROBE</th>
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<tr>
<td>21-32</td>
<td>11-20</td>
<td>0-10</td>
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<td>15-22</td>
<td>8-14</td>
<td>0-7</td>
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</table>

Each paper’s quality was assessed according to the criteria and methodologies outlined by the respective approaches. Each paper was then allocated a score based on the criteria and classified as either high, medium or low quality (Table 1). Four of the papers reviewed used qualitative methods and two used quantitative methods.

Results

The results of the literature review are summarised in Table 2. There were five elements that emerged in the literature as common factors influencing the implementation of best practice in clinical practice amongst clinicians: individual factors, organisational factors, education and training, policies and resources.

Individual Factors

Knowledge transfer is associated with increased number of years of nursing experience (Davies, Wong, & Laschinger, 2011). Personal interest, self-confidence and professional nature were also highlighted as factors which facilitate the transfer of knowledge from education into clinical practice (Nayeri & Khosravi, 2013). The influence of culture, families and research utilisation overload were highlighted by Moloney (2013). Ploeg, Davies, Edwards, Gifford, and Miller (2007) noted that positive staff attitudes and beliefs facilitated implementation of guidelines, but negative staff attitudes presented barriers to their success.

Organisational Factors

Organisational structure and atmosphere were identified as factors which influenced the transfer of knowledge from education into practice (Nayeri & Khosravi, 2013). This was echoed by Davies, Wong, and Laschinger (2011), who found that structural empowerment, contribution and informal power were also associated with increased knowledge transfer. The combination of structural empowerment and leader member exchange was also supportive of knowledge transfer (Davies et al., 2011). Interestingly, organisational factors were identified as potential barriers amongst renal nurses in Australia (Moloney, 2013). Likewise, Ploeg, Davies, Edwards, Gifford, and Miller (2007) found that limiting integration of guidelines into organisational structures or processes, as well as organisational and system level changes were potential barriers to their implementation. Rycroft-Malone et al. (2004) also observed that the relevance and fit of evidence to practice and organisational issues affected its implementation into clinical practice. Multi-professional focus, professional relationships, collaboration and the importance of a lead to drive the implementation of evidence-based practice in clinical areas were all identified as important factors in its success (Rycroft-Malone et al., 2004). Collaboration, teamwork, the identification of champions and support from leaders were also identified as supporting factors in the findings of Ploeg et al. (2007). Ploeg et al. (2007) also found that support from professional organisations and collaborations with other organisations and networks facilitated the implementation of clinical guidelines. Opportunities to put
education into practice and the structure of the education programs themselves were also highlighted as factors which influence transfer of knowledge into clinical areas (Nayeri & Khosravi, 2013).

**Education and training**

Education and training in research methods was identified as a facilitator if implementing evidence-based practice, whilst inadequate resources and training were identified as barriers to implementing evidence-based practice (Duncombe, 2018). This is reflective of Moloney’s (2013) findings which highlighted information access, knowledge, learning and complexity as potential barriers to the implementation of research findings into clinical practice. Ploeg et al. (2007) also found that the use of group interactions such as education sessions facilitated the implementation of evidence-based guidelines.

**Policies**

The nature and the role of the evidence itself was identified as a factor in implementing it into clinical practice (Rycroft-Malone et al., 2004). Evidence based organisational policies and procedures were also identified as a facilitator to implementing evidence-based practice (Duncombe, 2018). Rycroft-Malone et al. (2004) also noted the influence of policies in implementing evidence-based practice.

**Resources**

Lack of time, workloads and patient care were identified as potential barriers to the use of research findings in clinical practice (Moloney, 2013). Rycroft-Malone et al. (2004) had similar findings, with time, staff shortages, staff expectations, financial constraints and lack of equipment all identified as barriers to successfully implementing evidence-based practice. Similarly, Ploeg et al. (2007) identified resource and time constraints as barriers to implementing guidelines.

<table>
<thead>
<tr>
<th>Author, year, country</th>
<th>Study design</th>
<th>Sampling and sites</th>
<th>Data collection</th>
<th>Data analysis</th>
<th>Comments/key findings</th>
<th>Limitations</th>
<th>Quality appraisal</th>
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<tbody>
<tr>
<td>Davies et al. (2011)</td>
<td>Secondary analysis of data previously collected in a non-experimental, predictive mailed survey of nurses to examine the relationships among structural empowerment, leader-member exchange</td>
<td>Random sample of 234 Registered Nurses working in Ontario urban tertiary care hospitals</td>
<td>Mailed survey using three standardised self-report instruments: Conditions of Work Effectiveness Questionnaire, the LMX-MDM (multidimensional Measure) and the Personal Knowledge</td>
<td>Statistical analysis used SPSS (Statistical Package for Social Sciences). Descriptive statistics were performed on all the variables. The hypothesis was tested using hierarchical multiple</td>
<td>Increased number of years nursing experience was associated with knowledge transfer. Structural empowerment was another predictor of knowledge transfer. Contribution and informal power were also associated with knowledge transfer.</td>
<td>Potential response bias. Bias from self-report tools. LMX-MDM may not capture leader behaviour most related to knowledge transfer. Only represents one point in time. Urban setting only.</td>
<td>STROBE 22/22</td>
</tr>
<tr>
<td>Study</td>
<td>Methodology</td>
<td>Participants</td>
<td>Data Analysis</td>
<td>Findings/Conclusions</td>
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<tr>
<td>Duncombe (2017) Bahamas</td>
<td>Descriptive comparative study to examine the perceived barriers and facilitators to implementing evidence-based practice amongst nurses working in psychiatric, geriatric, hospital and community settings.</td>
<td>A stratified random sample of 100 government employed nurses in the Bahamas who participated in the study.</td>
<td>Self-administered questionnaire s. 5-point Likert-like scales examining nurses’ perceptions of barriers and facilitators of evidence-based practice.</td>
<td>Identified barriers included inadequate resources and inadequate training. Facilitators included research method training and evidence based organisational policies and protocols. Further study needed regarding connection between leader behaviours and personal knowledge use.</td>
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<tr>
<td>Nayeri &amp; Khosravi (2013) Iran</td>
<td>Qualitative approach with conventional content analysis to assess the factors that affect the knowledge transfer from continuing professional education programs to clinical practice.</td>
<td>Thirty-four Nurses with at least two years of work experience currently working in hospitals affiliated with Tehran University of Medical Sciences, social security hospitals and private hospitals.</td>
<td>Individual, open question interviews were used. Conventional qualitative data analysis approach was used based on a constant comparative analysis approach.</td>
<td>The main themes which emerged included: Personal interest and self-confidence, organisational structure and atmosphere, professional nature, opportunity to put the education into practice and design of educational programs. Cannot be replicated in larger population with certainty due to qualitative content analysis.</td>
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<td>Moloney (2013) Australia</td>
<td>Phenomenological study to investigate what factors influence the employment of research utilisation by Queensland renal Nurses.</td>
<td>48 renal Nurses from throughout Queensland Australia who responded to an expression of interest sent to renal units. Homogenous sample.</td>
<td>Individual face to face semi structured homogenous focus groups. Comenced with identical questions and subsequent questions were determined by the responses. Key elements identified in the literature. Verbal recordings were transcribed and categorised. Thematic analysis was 3 staged: line by line coding, descriptive themes then analytical themes.</td>
<td>Barriers identified included time, knowledge, workload, care, organisation factors, information access, learning and complexity. New themes identified included: cultural influence, family influence and research utilisation overload. Reflective of view of this small subset of renal Nurses. The views of the participants may be different to those Nurses who declined involvement in the study.</td>
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<tr>
<td>Study</td>
<td>Design</td>
<td>Country</td>
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<td>Data Collection</td>
<td>Data Analysis</td>
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<td>Rycroft-Malone et al. (2004) United Kingdom</td>
<td>Two phase design to identify: What factors do practitioners identify as the most important in enabling implementation of evidence into practice? What are the factors practitioners identify that mediate the implementation of evidence into practice? Do the concepts of evidence, context and facilitation constitute the key elements of a framework for getting evidence into practice?</td>
<td>United Kingdom</td>
<td>Two focus groups: Phase 1 - 12 participants divided into two focus groups for role 1-5 years (n=7) and role 2-7 years (n=5). Phase 2 - selection of two sites: Site 1 was a transplant unit, Site 2 was an orthopaedic unit.</td>
<td>Phase 1 data was collected through researcher moderated focus groups using a semi-structured interview guide which lasted 60-90 minutes, tape recorded and transcribed verbatim. Phase 2 data was collected from nurses working within the units through semi-structured interviews, which took approximately one hour, were recorded and transcribed verbatim.</td>
<td>All data was analysed using content analysis, with data broken down and categorised into themes, using the QSR Nudist package.</td>
<td>The main themes which emerged from the data were: The nature and role of evidence, Relevance to and fit with practice, and organisational issues, plus policies Multi-professional focus, relationships and collaboration. Importance of a lead to drive the implementation. Resources were a potential barrier, namely time, staff shortages, staff expectations, finances and lack of equipment.</td>
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<tr>
<td>Ploeg et al. (2007) Canada</td>
<td>Before and after study with both qualitative and quantitative data components to study the process and outcome of guideline implementation, including qualitative data related to facilitators and barriers associated with guideline implementation.</td>
<td>Canada</td>
<td>Seven guidelines were implemented over 22 sites throughout Ontario Canada including hospitals, long-term care agencies and community care organisations. Criterion sampling used and included:</td>
<td>Semi-structured audio taped phone interviews at completion of guideline implementation. Participants asked about their perceptions of the guidelines, barriers and facilitators. Tapes were transcribed verbatim. Data was analysed using the Boyatzis 1998 coding and thematic analysis approach.</td>
<td>Individual, organisational and environmental level factors identified. Facilitators included: learning about guidelines through group interaction such as education sessions, positive staff attitude/beliefs, leadership support, champions, teamwork/collaboration, professional association support, inter-</td>
<td>Unable to determine differences in perceptions by various direct care providers. Little information on similarities and differences in facilitators/barriers across different care settings/guidelines. Limited to this healthcare system.</td>
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the CRN (n=8), nurses & other healthcare providers (n=58) and administrators/managers (n=59) from these sites. A total of 125 participants.

organisational collaboration and networks. Barriers included: negative staff attitudes/beliefs, limited integration of guideline recommendations into organisational structures and processes, time and resource constraints, organisational and system level change.

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<th>Table 2: Analysis of literature retrieved</th>
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**Discussion**

The literature included in this review identified a variety of individual and organisational factors which influence clinician transfer of knowledge into practice, and therefore the implementation of best practice into clinical care. Clinician experience, confidence, interest and positive attitude enhanced knowledge transfer into clinical practice, whilst negativity and overload were barriers (Davies et al., 2011; Moloney, 2013; Ploeg, Davies, Edwards, Gifford, & Miller, 2007; Nayeri & Khosravi, 2013). Various organisational factors identified that provide barriers and support. Organisational structure was one common theme; the diversity of organisational factors identified perhaps reflects the diverse environments and contexts in which the studies were conducted (Davies et al., 2011; Moloney, 2013; Nayeri & Khosravi, 2013; Ploeg et al., 2007; Rycroft-Malone et al., 2004). Education was identified as an important support to the transfer of knowledge into clinical practice; three studies identify this factor as important (Duncombe, 2017; Moloney, 2013; Ploeg et al., 2007). Also supportive were policies; two studies identified organisational policies as important to the successful implementation of evidence-based care (Duncombe, 2018; Rycroft-Malone et al, 2004). Resource issues, such as lack of time and heavy workloads, were identified by three studies as significant barriers to the implementation of best practice (Moloney, 2013; Ploeg et al., 2007; Rycroft-Malone et al., 2004).

The literature, therefore, highlighted that knowledge transfer needed to implement best practice is complex and unique to the context in which the transfer occurs. Some common themes were revealed, but also some diversity in factors identified. This highlights an overall limitation of these studies, that the factors identified in each study reflect the unique environmental factors of practice in a particular context. This limits the generalisability of findings, especially in view of the small number of studies meeting the criteria for inclusion in this review and the relatively small sample sizes in the studies. A further limitation is the potential response bias in the studies, as there is a potential that clinicians with an interest in knowledge transfer and the
implementation of best practice may be more likely to participate in such a study than those with no interest.

Another limitation is the lack of exploration of factors affecting the implementation of best practice in burns. Only one study (Yue et al., 2018) has explored the factors influencing the implementation of best practice in this clinical area, but it explored the ability of burns nurses to search for and analyse the research literature, rather than factors which influence the transfer of this knowledge of the literature into clinical practice. Thus, there is a gap in the literature that concerns the factors that influence knowledge transfer to implement best practice in the management of burn injured patients. The need for research in this area is apparent, as the care patients receive following burn injuries, especially in the initial phase, affects their outcome. Future research should focus on exploring factors which influence the implementation of best practice for clinicians who provide the acute management of burn injured patients.

Conclusion

In conclusion, literature addressing the factors that influence knowledge transfer that results in the implementation of best practice is sparse. The few studies available demonstrate that knowledge transfer factors are diverse, but common themes such as personal characteristics, organisational structure, education, policy and resources emerge as influential. There is currently no literature regarding the factors affecting the ability of clinicians treating patients following burn injury to transfer knowledge into practice; this is an area of important future research for the burn community.

References


**Chapter summary**

With a paucity of literature in the area of burn care, a broad scoping review of factors influencing the implementation of best practice in clinical practice was conducted. The six
articles included in the scoping review were assessed to be of high-quality following review by the two recognised approaches of COREQ and STROBE. Despite the variety of clinical settings, five common themes emerged from the literature as factors influencing the transfer of knowledge into clinical practice: individual factors, organisational factors, education & training, policy and resources (Davies, Wong, & Laschinger, 2011; Duncombe, 2018; Nayeri & Khosreravi, 2013; Moloney, 2013; Ploeg et al., 2007; Rycroft-Malone et al., 2004). The review of the current literature identified common themes influencing knowledge transfer in healthcare, but highlighted the gap in knowledge regarding this topic in the area of burns. The gap in current knowledge identified in this review demonstrates the need for into the factors that influence the implementation of best practice in burn care.

**Chapter to follow**

Chapter 3 introduces the methodology used in this study. A sequential explanatory mixed methods approach was used to address the overall aim of the study, namely, to explore the factors that influence burn care in WA. Three quantitative studies in Phase 1 explored the effectiveness of a state-wide burns telehealth advice program, a state-wide telehealth education program, then a state-wide infection control bundle. In Phase 2 a qualitative study used interviews to further explore the factors which influence best practice in burn care in WA. The methodology used for all studies will be described.
CHAPTER 3: METHODS

Introduction

The study used a sequential explanatory mixed methods approach to address the aims of the study. An overview of the approach used is provided and its advantages and limitations are addressed. Each individual project within this study used a unique design in order to answer specific research questions. Phase 1, the quantitative analysis phase, began with a retrospective audit used to assess the burns telehealth clinical program. A two-phase design in the next study used a clinician survey to assess learning needs, followed by pre-post tests to assess the effectiveness of the burns telehealth education program. An interrupted time series was used to assess effectiveness of the state-wide burns infection control bundle in reducing healthcare associated infections in patients following burn injuries. Phase 2 collected qualitative data using semi-structured interviews of clinicians to identify factors that influence the implementation of best practice in burn management.

Research Design

Methodology

Mixed methods are credited with enabling researchers to obtain a better understanding of “complex human phenomena,” thereby making it useful in healthcare when studying clinician decision-making, behaviour and clinical practice (Doyle, Brady, & Byrne, 2016). Cresswell and Plano-Clark (2006) state that it is the combination of both qualitative and quantitative methods that gives mixed methods a greater understanding of complex issues than using either method be themselves. The qualitative data builds on and contextualises the quantitative data, enhances the results and assists in the creation of new knowledge (Creswell, 2014; Creswell, Plano-Clark, Gutmann, & Hanson, 2003; Mason, 2006; Stange, 2006; Taylor & Trumbell, 2005).

Understanding the complexity of knowledge transfer requires a pragmatic approach to glean knowledge related to patient outcomes, clinician experience and understanding, and the ways to address shortfalls in practice (O’Cathain et al., 2010). An advantage of the sequential explanatory mixed methods approach is that it is straightforward and allows the researcher to explore the results obtained in the quantitative phase by further exploring the concepts in the qualitative phase (Ivankova, Cresswell & Stick, 2006). By using a mixed method approach, it adds multiple perspectives, while strengthening rigour and understanding by using an integrated, in-depth approach to the research questions. This method facilitated investigation of the effectiveness of strategies employed to promote the use of best practice using quantitative methods, while also exploring factors influencing the implementation of best practice from the perspective of the clinicians, using qualitative methods.

An explanatory sequential mixed methods approach has been used in various healthcare related studies. Shahhosseini and Hamzehgardeshi (2015) used this approach in their exploration of
the facilitators and barriers to nurses’ participation in continuing education programs, by first using a cross-sectional survey followed by semi-structured in-depth interviews. Carr (2008) used the same approach to obtain a clearer understanding of post-operative pain management, in particular, the factors involved in inadequate pain management.

Despite its advantages, there are some challenges with this approach. Cresswell (2014) states that using both quantitative and qualitative research together minimises the limitations of each approach. However, due to the long timeframe of these approaches, the same sample may not be available for both the quantitative and qualitative phases of the study (Doyle et al, 2016); this was an issue faced in this study with an ever-changing healthcare workforce.

The sequential explanatory mixed methods approach allowed this study to explore quantitative data related to the clinical and education components of the telehealth program, explore quantitative data that demonstrated how the telehealth program, along with other strategies, can influence healthcare associated infections, and then use qualitative data to explore all the factors that influence clinician transfer of knowledge into practice in burn management. Phase 1 consisted of three quantitative studies, followed by Phase 2 which consisted of one qualitative study that sought to explore all factors which influence practice.

Participants

Participants varied between phases of the study.

Phase 1

Study 1: Telehealth for paediatric burn patients in rural areas: a retrospective audit of activity and cost savings.

The participants for the first study were all paediatric patients referred to the paediatric burn telehealth service following burn injury in WA from 1st August 2005 to 31st July 2013.

Study 2: Burns education for non-burn specialist clinicians in Western Australia.

Participants for the first stage of the second study were non-burn specialist medical, nursing, allied health and other health professionals working throughout more than 180 government hospitals and nursing posts in WA. None of these healthcare facilities had burns units.

Participants for the second stage of the second study were clinicians from over 40 hospitals, health services or nursing posts throughout WA who attended the various education sessions and completed pre- and post-tests.

Study 3: The implementation of an infection control bundle within a Total Care Burns Unit.

The participants for the third study were all paediatric acute burn inpatients admitted to the state paediatric burns inpatient unit between January 2012 and February 2014.

Phase 2
Study 4: Factors influencing the implementation of best practice in paediatric burns management.

The participants for the study in Phase 2 were nurses and doctors who provided acute pre-admission care for paediatric patients who sustained burn injuries admitted to PMH in WA.

Ethical approval

Prior to recruitment, in addition to registering all the Phase 1 strategies and obtaining approval from the hospital’s GEKO (Governance Evidence Knowledge Outcomes) clinical audit system approval committee, the approval of both PMH and ECU ethics committees was obtained to research “best practice in acute paediatric burn management: compliance and influencing factors in Western Australia” (approval number 8410).

<table>
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<tr>
<th>Phase 1: Quantitative</th>
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<td>Telehealth for paediatric burn patients in rural areas: a retrospective audit of activity and cost savings.</td>
<td>PMH GEKO clinical audit system approval committee</td>
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<th>Phase 2: Qualitative</th>
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<td>Factors influencing the implementation of best practice in paediatric burns management</td>
<td>PMH ethics committee ECU ethics committee</td>
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Ethical considerations

Confidentiality/Anonymity

Confidentiality and anonymity of all participants in all phases of the study was assured as much as possible by the researcher by ensuring no names or personal details of participants were recorded anywhere to ensure privacy. Patients whose medical records were reviewed in the study were de-identified. Their potential inclusion in the study was recorded through the hospital patient management system only via their UMRN (unique medical record number). All data obtained during the clinician interviews were de-identified. Data will be retained for five years from publication and stored in a secure, password protected, electronic file. The study complied with the National Health and Medical Research Council guidelines (NHMRC, 2018).

Informed Written Consent of Participants

Clinicians who had documented the provision of initial assessment and management in the patient notes were approached to participate in the interview study by the investigator by phone within one month of admission. Those who wished to participate were faxed or emailed (whichever was more convenient for the clinician) an information letter and consent form for
completion prior to the interview. Those clinicians who completed surveys and pre-post tests were advised that this was part of a study and that completing the survey or pre-post test voluntarily and returning it to the researcher implied consent. Clinicians were also advised that all answers were completely anonymous. Patient data were de-identified and extracted from pre-existing databases approved by the hospital’s clinical audit system approval committee (GEKO system).

**Potential harm to participants**

The concepts of non-maleficence and beneficence were adhered to in this study to ensure risks would not be greater than benefits. As this study consisted of patient chart reviews, clinician surveys, pre-post tests and interviews, there was no potential physical harm to any participant. There was, however, the potential for participants to become distressed during interviews. No participant did become distressed during interviewing, but if they had, they would have been provided with the contact details of counsellors. Counselling services information was not included in the information letter provided to participants, but is readily available for all healthcare workers in WA Health.

**Recruitment**

**Phase 1**

*Study 1: Telehealth for paediatric burn patients in rural areas: a retrospective audit of activity and cost savings.*

For the first study, following approval from the PMH clinical audit system approval committee, an 8-year retrospective chart audit was conducted for all patients referred to the paediatric burn telehealth service in WA from 1st August 2005 to 31st July 2013. The patient notes were already in the hospital’s medical records department and the UMRNs were in webpas to identify patients referred to the service for inclusion in the study.

*Study 2: Burns education for non-burn specialist clinicians in Western Australia.*

For the first part of the second study, following approval from the PMH clinical audit system approval committee, all relevant medical and executive directors in WA were mailed a notification letter describing the study, along with a copy of the survey, with a request that they contact the author if they do not wish their health service to participate. No objections were received, and therefore a two-page paper based state-wide survey was delivered via mail to the nurse managers or directors of nursing of all hospitals and nursing posts throughout WA for distribution to clinical staff. The only exclusions were the two tertiary hospitals in WA with on-site burn services.

For the next part of the second study pre- and post-test questionnaires were emailed to each registered healthcare facility's local telehealth contact for printing, distribution and collection at each education session. Clinicians who attended an education session were asked to complete the pre-test questionnaire prior to the session commencing, and were then asked to complete the post-test questionnaire after the session finished. Clinicians were then asked to either mail or scan and email their pre- and post-test questionnaires back to the author for inclusion in the
study. Education sessions were delivered monthly. As all questionnaires were completed anonymously it was unknown if clinicians attended one or multiple sessions. Anonymity for emailed questionnaires was ensured by the researcher printing the attached questionnaire only, not the email, and randomly placing the printing in a pile of mailed questionnaires when adding data to the spreadsheet.

**Study 3: The implementation of an infection control bundle within a Total Care Burns Unit.**

For the third study, retrospective surveillance of healthcare associated infections amongst paediatric patients admitted to PMH following burn injury was conducted from January 2012 to February 2014 by the infection control CNC (Clinical Nurse Consultant) by reviewing patient medical records. All patient specimens were sent to the microbiology laboratory for microscopy, culture and sensitivity. Approval from the hospital’s quality improvement committee was obtained to ensure we were able to include all paediatric acute burn inpatients admitted to the state paediatric burns inpatient ward between January 2012 and February 2014, a total of 626 patients.

**Phase 2**

**Study 4: Factors influencing the implementation of best practice in paediatric burns management.**

Purposive sampling was used in this study to recruit participants. A purposive sample allows the researcher to select participants based on characteristics of a population and the objective of the study. This ensures that participants have experience and knowledge of the topic under investigation (Palinkas et al., 2015). Following approval from the hospital’s ethics committee, participants were identified by a review of the medical records of all patients transferred and admitted to the total care burns unit or intensive care unit at the participating tertiary hospital following an acute burn injury over a two-year period. Records were examined for documented evidence of the clinician who had provided the initial assessment and/or care prior to admission. Clinicians who had documented the provision of initial assessment and management in the patient notes were approached to participate in the study by the investigator by phone within one month of admission. Participants included nurses and doctors who provided acute pre-admission care for paediatric patients admitted to PMH following burn injuries. Nineteen clinicians were interviewed. All clinicians contacted agreed to an interview.

**Sample**

**Phase 1**

**Study 1: Telehealth for paediatric burn patients in rural areas: a retrospective audit of activity and cost savings.**

The sample for the first study comprised 904 patients referred to the state paediatric burns telehealth service between August 2005 and August 2013. The patients were aged between 3 weeks and 16 years, with the majority (54%) in the toddler age range (1–4 years). Of these patients, 33.2% self-identified as Aboriginal and 58.1% were male. Overall, 36.7% of the patients in the study were reviewed by telehealth post admission or in the outpatient clinic only,
22% were reviewed by telehealth both prior to and post admission, while 40.9% were reviewed via telehealth only and never required transfer to Perth for care.

**Study 2: Burns education for non-burn specialist clinicians in Western Australia.**

The sample for the first part of the second study, after 1,000 surveys were sent out via mail to over 180 health care facilities throughout WA, comprised 281 returned and completed surveys. The response rate was, therefore, 28.1%. Responding clinicians included nurses (81.1%), doctors (10.3%), allied health staff (occupational and physio therapists) (7.8%) and Aboriginal health workers (0.7%), from all regions of WA and with various levels of experience within their respective profession (ranging from 2 weeks to 42 years, with an average of 17.8 years). Respondent experience of caring for paediatric burn injured patients varied. Those who had never cared for a burn injured patient comprised 7.5%, 43.4% had cared for less than five burn injured patients, and 49.1% had cared for more than five paediatric burn injured patients.

The sample for the second part of the second study consisted of the clinicians who attended the acute burn education sessions via videoconference. A total of 137 pre-post tests were completed and returned to the researcher. As the pre-post tests were completely anonymously it is not known whether the same clinicians returned pre-post tests for multiple sessions.

**Phase 2**

**Study 4: Factors influencing the implementation of best practice in paediatric burns management.**

Nineteen nurses and doctors who provided acute pre-admission care for paediatric patients admitted to PMH following burn injuries were interviewed. All care providers who were contacted agreed to an interview. Participant interviews were continued until data saturation was reached, at which point no new themes emerged (Guest, Bunce, & Johnson, 2006).

**Instrument**

The BEM was used throughout the entire study to provide an overarching framework. This framework identified factors which influence practice and guided strategies such as state-wide clinical advice, then state-wide education, then a fully integrated state-wide infection control bundle. In the second phase the BEM was used to fully explore all factors which influence the implementation of best practice in burn care.

**Phase 1**

**Study 1: Telehealth for paediatric burn patients in rural areas: a retrospective audit of activity and cost savings.**

The first study used a retrospective chart audit and excel spreadsheet to collect data, therefore, no specific instrument was used for this study.

**Study 2: Burns education for non-burn specialist clinicians in Western Australia.**

The second study used a mail survey to assess the experience and learning needs of non-burn specialist clinicians in WA. Suggested burn topics were based on two well-respected burns...
books: “Total Burns Care” (Herndon, 2012) and the “Emergency Management of Severe Burns Course Book” (ANZBA, 2011). Next to each burns topic a Likert scale was used to indicate whether respondents strongly agreed/agreed/disagreed/strongly disagreed with various statements regarding their perception of relevance to their current practice and confidence in their own knowledge/skills on a variety of paediatric burn care topics. Likert scales measure the degree of agreement or disagreement with a statement, in this case, the relevance of a given topic to the clinicians’ current practice (De Winter & Dodo, 2010).

Once the learning needs analysis was complete, it led the development of a state-wide burns education program using an integrative learning model. The burns education program was then delivered state-wide and evaluated. Pre- and post-test forms were developed based on the key learnings from each acute management education session and emailed to participating healthcare centres for completion.

**Study 3: The implementation of an infection control bundle within a Total Care Burns Unit.**

The third study used ongoing review of charts to identify healthcare associated infections. The internationally recognised Peck, Weber, McManus, Sheridan and Heimbach (1998) criteria was used for defining and identifying burn wound infection. These burn wound infections were identified by the infection control CNC by reviewing patient specimens and documentation of any clinical assessment undertaken by medical or senior burns nursing staff. Retrospective surveillance of healthcare associated urinary tract infections, pneumonia, upper respiratory tract infections and sepsis was conducted from the Burns Minimum Data Set (paediatric burns inpatient database) which uses all data from a patient’s inpatient medical record, collected by a senior research nurse specialising in burn care. Identification of such infections in paediatric patients with burn injuries in the PMH burns unit was based on patient specimens and clinical assessment by medical staff, which was always verified by a treating burns consultant and clearly documented in a patient’s medical record. The criteria used to identify sepsis reflects the current definition of life-threatening organ dysfunction caused by a dysregulated host response to infection (Singer et al., 2016).

**Phase 2**

**Study 4: Factors influencing the implementation of best practice in paediatric burns management.**

The fourth study used semi-structured interviews based on the BEM. In this study the BEM was used as a framework for exploring factors which influence the implementation of best practice in burn care in WA. This resulted in the following questions, which formed the basis of the semi-structured clinician interviews:
1. Could you describe your access to guidelines, policies or protocols for the initial assessment and management of paediatric burn patients?

2. Could you describe what these guidelines, policies or protocols are and where or how you access them?

3. Could you discuss whether you receive feedback regarding your care of burn patients?

4. If yes: How do you receive this feedback and from whom?

5. How have you obtained your knowledge of paediatric burn assessment and management?

6. What do you know about best practice initial management of paediatric burn patients?

7. Could you describe what skills you have developed with regard the initial management of paediatric burn patients?

8. When caring for this patient, could you please discuss what equipment you required, and whether you felt you had all the necessary equipment available to assess and manage this child’s injury? This can include facilities to apply cool running water while keeping the patient warm, airway equipment, Lund & Browder chart, intravenous fluids and lines, indwelling catheters, Acticoat dressings.

9. If no: Which equipment did you not have access to? Do you know why you were unable to access it?

10. Could you describe your current role and what qualifications do you have which enable you to fulfil this role?

11. In your hospital or ward/practice, what external or organisational incentives are there for providing optimal patient care?

12. How do you feel about providing the initial care for children with a burn injury?

Table 3. Interview guide

**Research Methods**

**Phase 1: Quantitative questions**

The overall research question for the first two studies—How effective was the state-wide telehealth education program in transferring knowledge of best clinical practice?—was answered using four specific research question:

*Study 1: Telehealth for paediatric burn patients in rural areas: a retrospective audit of activity and cost savings.*

Can clinical advice delivered via a state-wide burns telehealth program reduce unnecessary patient transfers and inpatient bed days over an 8 year period (2005–2013)?

Does clinical advice delivered via a state-wide burns telehealth program result in cost savings?

*Study 2: Burns education for non-burn specialist clinicians in Western Australia.*
What are the learning needs of multidisciplinary non-burn specialist clinicians in WA regarding the assessment and management of paediatric burn injured patients?

Does the implementation of a state-wide education program delivered via videoconference increase clinician knowledge of burns assessment and management?

**Study 3: The implementation of an infection control bundle within a Total Care Burns Unit.**
The overall research question for the third study—How effective was the state-wide infection control bundles in changing practice related the use of best practice?—was answered using the specific research question:

Does the implementation of a state-wide infection control bundle reduce healthcare associated infections in paediatric burn injured patients in WA?

**Phase 1: Data collection**

**Study 1: Telehealth for paediatric burn patients in rural areas: a retrospective audit of activity and cost savings.**
Data for the period August 2005 to August 2013 were collected directly from patient medical records through retrospective chart reviews and entered into an Excel spreadsheet. Data collected included the number of patients reviewed, number of wound reviews, number of avoided acute transfers, number of reduced/avoided inpatient days, number of scar reviews, number of avoided scar review transfers, and review type. Using this data, avoided inpatient costs and avoided transfer costs were calculated.

**Study 2: Burns education for non-burn specialist clinicians in Western Australia.**
The first phase of Study 2 used a survey to collect data. A learning needs assessment survey was mailed out to clinicians and included questions concerning participant occupation, years of clinical experience, burn care experience, perceived relevance of burns related topics, confidence with burns related care, whether the clinician would access burn education via videoconference and how they would access burns advice. The suggested burn topics listed in the survey were obtained by referring to the “Australian New Zealand Burn Association Emergency Management of Severe Burns Course Book” (Australian New Zealand Burn Association [ANZBA], 2011) and “Total Burn Care” (Herndon, 2012). Both these texts are considered highly relevant to the acute management of burn injuries in clinical settings. Participants were asked to use a Likert scale to indicate whether they strongly agree/agree/disagree/strongly disagree with various statements regarding their perception of relevance to their current practice and confidence in their own knowledge/skills regarding various paediatric burn care topics. The Likert scale measured the degree of agreement or disagreement with an expressed statement, such as the relevance of a given topic to the clinicians’ current practice (De Winter & Dodo, 2010).
The second phase of Study 2 involved completion of pre- and post-test forms, both before and after attending the education sessions. Participants were asked to complete the paper-based pre-test before each educational session commenced and reminded to also complete the post-tests immediately following attendance at the session. Pre- and post-tests consisted of key points from each education session, with a variety of true/false questions and open-ended questions to demonstrate learning. Tests were not completed under controlled conditions as the program was conducted within a state-wide clinical context. These tests were anonymously returned to the state tertiary paediatric hospital's burn unit and were assessed by the burns CNC for accuracy against information provided in the education session. Anonymity for emailed questionnaires was ensured by the researcher printing the attached questionnaire only, not the email, and randomly placing the printing in a pile of mailed questionnaires when adding data to the spreadsheet.

Study 3: The implementation of an infection control bundle within a Total Care Burns Unit.

The third study retrospectively collected de-identified data from the medical records of all paediatric acute burn inpatients admitted to the state paediatric burns inpatient ward between January 2012 and February 2014. Retrospective surveillance of healthcare associated infections amongst paediatric patients admitted to PMH following burn injury was conducted by the infection control CNC by review of patient medical records. The well-established Peck (1998) criteria was used for defining burn wound infection, through patient specimens and reviewing documentation of clinical assessment by medical or senior burns nursing staff. Retrospective surveillance of healthcare associated urinary tract infections, pneumonia, upper respiratory tract infections and sepsis was conducted from the Burns Minimum Data Set. Identification of such infections in paediatric patients with burn injuries in our unit was based on patient specimens and clinical assessment by medical staff, always verified by a treating burns consultant and clearly documented in patient medical records. The criteria used to identify sepsis reflects the current definition of life-threatening organ dysfunction caused by a dysregulated host response to infection (Singer et al., 2016).

Phase 1: Data analysis

Study 1: Telehealth for paediatric burn patients in rural areas: a retrospective audit of activity and cost savings.

The estimates of avoided patient transfer cost savings were calculated based on reduced transfers, which may be by plane (for patients in the Pilbara or Kimberley regions of WA) or by car (for patients outside these regions), and reduced inpatient bed days. In 2012/13 the telehealth service was fully integrated within the burns model of care, and, therefore, reflects cost savings for an established, imbedded burns telehealth service. All costs presented in the paper were in Australian dollars (AUD) at 2013 (AUD $1 = approximately US $0.9282).

Avoided (for patients not requiring transfer) or reduced (for patients requiring transfer and admission) inpatient bed days were calculated for each individual patient using the difference between the actual inpatient bed days and the estimated bed days in the previous model of care.
(without a telehealth service) through examination of each patients’ medical records. This is based on the historical clinical practice of transferring and admitting rural patients to the burn unit until they required only simple and small dressing changes not needing opioid analgesia. This approach to calculating reduced or avoided inpatient bed days reflects the actual patients seen by the telehealth service (rather than averages based on metropolitan inpatients who have access to day leave) and is, therefore, a more accurate reflection of reduced bed days. Inpatient costs are high and complex to calculate following burn injury, with hospital stay costs consistently representing the largest cost for these patients (Ahn & Maitz, 2012). Actual avoided inpatient stay costs—AUD 1,497 for burn inpatients per night within our burn unit for the 2012/13 financial year, as provided by the unit's business manager were, therefore, used for patients in this study.

Avoided transfer costs were calculated for each individual patient by using actual costs of travel to/from the location in which they presented for clinical care, as specified in accordance with the Western Australia Health Patient Assisted Travel Scheme guidelines. As paediatric patients are entitled to a paid adult escort, the cost of travel reflected one adult and one child travelling. Patients living in the Pilbara and Kimberley regions were, therefore, costed according to flights, while patients living in all other non-metropolitan regions were costed according to car travel at AUD 0.16 per kilometre.

**Study 2: Burns education for non-burn specialist clinicians in Western Australia.**

In the first phase of the study, participants anonymously completed the survey and either returned them via mail or scanned and returned them via email to the author. Data were entered into an Excel spreadsheet and the Spearman rank correlation coefficient was used to compare perceived relevance and confidence in all aspects of burn care.

In the second phase of the study, pre-post test data were entered into an Excel spreadsheet. The Wilcoxon matched pairs signed rank test was used to analyse non-parametric data to determine if a statistically significant increase in knowledge occurred as a result of attendance at an education session. Significance level was set at 0.05 (p < 0.05).

**Study 3: The implementation of an infection control bundle within a Total Care Burns Unit.**

An interrupted time series was used to assess the healthcare associated infection rates prior to and post the implementation of the infection control bundle. Poisson regression was used to perform the analysis of healthcare associated infection rates, which produced incidence ratios and 95% confidence intervals.

**Validity and reliability**

Validity refers to “the extent to which a concept is accurately measured,” while reliability refers to the “accuracy of an instrument” (Heale & Twycross, 2015). The BEM used in this study provided a clear framework with which to categorise, identify, guide and analyse factors which support competence, plus factors which are possible barriers to competence in the management
of paediatric burns in WA (Gilbert, 2013; Chevalier, 2003). The BEM categorises six factors that are necessary for performance and together create a system which supports either competence or incompetence (Gilbert, 2013). The BEM has been used as a valid framework to explore performance and behaviour in a variety of settings, including healthcare settings, to explore factors which influence an employee’s performance (Kyle-Needs & Lindbeck, 2011; Chae & Park, 2019). This framework allowed researchers to explore and identify strategies that influence patient care in Phase 1, then explore these factors further through clinician interviews in Phase 2 of the study (Chae & Park, 2019).

A Likert scale was used in the second study to assess the learning needs of non-burn specialist clinicians. The researchers wanted to investigate whether a variety of burn related topics was relevant to the clinicians’ practice and whether the clinicians felt confident in this area of burn management. The validity of Likert scales is related the topic to which it is applied and the participants’ understanding of the context (Joshi, Kale, & Chandel, 2015). It is therefore a valid and reliable instrument to use as it assesses what the researchers wanted to know: What is relevant to clinical practice and are clinicians confident in their care? The surveys were completely anonymous and were sent to all non-burn acute healthcare facilities in WA to reduce the risk of sampling bias.

Following the development of the education program, pre- and post-test evaluations forms were used to assess knowledge obtained as a result of attending the education session. The forms were double-sided to ensure the pre- and post-test of each participant were together to reduce any potential error if multiple forms were sent in one envelope. The pre-test post-test design has long been recognised as a valid tool to assess the effectiveness of educational interventions (Dugard & Todman, 1995). As the evaluations were sent to all participants and all answers were completely anonymous, potential for sampling bias was reduced.

In the third study, the use of healthcare associated infection rates was a valid instrument for assessing the effectiveness of the infection control bundle. By ensuring that the infection rates were assessed by the infection control CNC (burn wound infection) or senior nurse researcher (all other healthcare associated infections), this removed the researcher who implemented the bundle from being responsible for collecting data related to the outcome of the bundle, thus reducing the potential for bias.

**Phase 2: Qualitative questions**

*Study 4: Factors influencing the implementation of best practice in paediatric burns management.*

The study in Phase 2 aimed to answer the overall question of what factors influence frontline clinician compliance with best practice acute paediatric burn management in WA? This was answered using three specific research questions:
1. What factors influence pre-admission clinician compliance with best practice acute paediatric burn management in WA?

2. What are the environmental factors which influence compliance with best practice acute paediatric burn management in WA?

3. What are the individual factors which influence compliance with best practice acute paediatric burn management in WA?

Phase 2: Participants

*Study 4: Factors influencing the implementation of best practice in paediatric burns management.*

Using purposive sampling, potential participants were identified by a review of the medical records of all patients transferred and admitted to the Total Care Burns Unit or Intensive Care Unit at PMH following an acute burn injury over a two-year period. The patient medical records were examined for documented evidence of the clinician who had provided the initial assessment and/or care prior to admission. Clinicians who were documented in the patient notes as having provided initial assessment and management were approached to participate in the study by the investigator by phone within one month of admission. Those who wished to participate were faxed or emailed (whichever was more convenient for the clinician) an information letter and consent form for completion prior to the interview. Participants included nurses and doctors who provided acute pre-admission care for paediatric burn injured patients admitted to PMH. Nineteen clinicians were interviewed. All clinicians contacted agreed to be interviewed.

Phase 2: Data collection

*Study 4: Factors influencing the implementation of best practice in paediatric burns management.*

Data was collected using interviews. Participants recruited as described above were interviewed using open-ended, semi-structured interview questions based on the BEM.

Phase 2: Interviews

*Study 4: Factors influencing the implementation of best practice in paediatric burns management.*

All interviews were conducted via telephone, following the receipt of the consent form. The researcher approached potential participants by phone and participants were, therefore, aware of the researcher’s role, and had an understanding of the research study. The interviewer maintained a calm, neutral position throughout all interviews to ensure participants felt
comfortable sharing their experiences of both barriers and supporting factors when caring for patients following burn injury. All interviews were taped and transcribed verbatim by the researcher, with interviews taking between 9 and 43 minutes, with a mean time of 20 minutes.

An advantage of phone interviews was that it enabled clinicians throughout WA to be interviewed without the need to travel, and facilitated confidential conversations with clinicians who are often shift workers (Opdenakker, 2006; Rahman, 2015). A disadvantage of phone interviews was the lack of social cues that may indicate to the interviewer the feelings and attitudes of the interviewee (Opdenakker, 2006; Rahman, 2015). It was, therefore, important that the interviewer developed rapport with each interviewee and maintained a polite neutral position throughout interviews by introducing herself, thanking participants for their agreement to participate in the study and explaining how the interview would proceed. Interviews were continued until data saturation was reached, at which point it was evident that common themes were being expressed by participants and no new themes emerged (Guest et al., 2006).

**Phase 2: Thematic analysis**

*Study 4: Factors influencing the implementation of best practice in paediatric burns management.*

The interviews were taped and transcribed verbatim. The researcher independently read and coded the transcripts. By analysing the data, themes emerged which outlined the factors that influenced the transfer of clinician knowledge of burn care into practice. This approach reflects the theory that individual and environmental factors influence clinician practice and the use of the Gilbert BEM to guide data collection, namely, data, instruments, incentives, knowledge, capacity and motives (Gilbert, 2013). The questions used to interview participants were based on these topics and by reading and coding the responses of participants within each topic, categories emerged through the identification of similar experiences. Inductive coding, as outlined in Thomas’ (2006) general inductive approach, was used to analyse data. Interviews were read in-depth, categories were created, and refined and revised to reduce overlap and highlight the most relevant and important themes.

**Trustworthiness**

Trustworthiness in qualitative research concerns whether the data reported is credible, transferable, dependable and confirmable (Korstjens & Moser, 2018). In this study unlimited interview timeframes strengthen the credibility of the results. This allowed clinicians plenty of time to describe and discuss factors influencing their practice, and enabled clarification to be sought by the researcher, if a response was unclear. Transferability is ultimately decided by the reader (Korstjens & Moser, 2018). To facilitate this, however, the researcher described the participants occupation and context in which they practice to assist the reader in deciding whether the results are transferrable to the context in which they practice or not. Dependability has been demonstrated by clearly describing the research process, how participants were recruited for the study, the questions used for interviews and how the data were coded.
Confirmability was demonstrated by transparency of the research process, transcribing interviews verbatim, coding these verbatim data, and including a large number of direct quotes in the published paper titled “Factors influencing the implementation of best practice in paediatric burns management”. This helped the reader to confirm that the analysis is a fair and accurate representation of the clinicians’ experiences and that themes derived from this data are accurate.

**Chapter overview**

To explore factors which influence burn care in WA, a sequential mixed methods approach was used. Despite some limitations, this approach has many advantages in the pursuit of new knowledge in complex systems. Quantitative methods were used to explore the effectiveness of strategies such as the clinical and education telehealth programs and infection control bundle to increase knowledge and improve burn care. Qualitative methodology, in the form of semi-structured clinician interviews, was then used to explore all factors which influence burn care in WA.
CHAPTER 4: RESULTS AND FINDINGS

Introduction
Chapter 4 presents the results of the study, both Phase 1 (quantitative data) and Phase 2 (qualitative data). The first study evaluates the activity and cost savings of the WA state-wide paediatric burns telehealth service, which provides advice to non-burn specialist clinicians. Building on this service, the state-wide learning needs analysis and burns education programme via telehealth was developed and evaluated. Incorporating the telehealth clinical advice and education programs, an infection control bundle was developed and evaluated in order to improve patient outcomes. Non-burn specialist clinician interviews were then conducted to explore factors which influence the implementation of best practice in burn care.
Phase 1 Quantitative Data

“Telehealth for paediatric burn patients in rural areas: a retrospective audit of activity and cost savings”


Highlights
• Telehealth services provide consultancy for both acute and rehabilitative burn injured patients.
• Telehealth can avoid unnecessary transfers and reduce inpatient days for burn injured patients.
• In 2012/13 the WA paediatric burns telehealth service saved AUD 1.89 million.

Abstract
Introduction: Since 2005, the Western Australian paediatric burn unit has provided a state-wide clinical consultancy and support service for the assessment and management of acute and rehabilitative patients via its telehealth service following a burn injury. Since then, the use of this telehealth service has steadily increased as it has become imbedded in the model of care for paediatric burn injuries. Primarily, the service involves acute and long-term patient reviews conducted by the metropolitan-located burn unit in contact with health practitioners, advising patients and their families who reside outside the metropolitan area, thereby avoiding unnecessary transfers and inpatient bed days. A further benefit of the paediatric burn service using telehealth is more efficient use of tertiary level burn unit beds, as only those patients meeting clinical criteria for admission are transferred.

Aim: To conduct a retrospective audit of avoided transfers and bed days in 2005/06–2012/13 as a result of the use of the paediatric burns telehealth service and estimate their cost savings in 2012/13.

Method: A retrospective chart audit identified activity, avoided unnecessary acute and scar review patient transfers, inpatient bed days and their associated avoided costs to the tertiary burn unit and patient travel funding.

Results: Over the period 2005/06–2012/13 the audit identified 4,905 avoided inpatient bed days, 364 avoided acute patient transfers and 1,763 avoided follow-up review transfers for a total of 1,312 paediatric patients with burn injuries as a result of this telehealth service. This paper presents the derivation of these outcomes and an estimation of their cost savings in 2012/13 of AUD 1.89 million.

Conclusion: This study demonstrates avoided patient transfers, inpatient bed days and associated costs as the result of an integrated burns telehealth service.

Introduction
Telehealth refers to the delivery of healthcare and the exchange of healthcare information across distance (Craig & Patterson, 2005). The use of this system for paediatric burn injured patients residing outside the metropolitan area has resulted in reduced travel costs and inconvenience for patients, increased access to and quality of specialist services, improved education and more collaborative clinical care (Moffatt & Eley, 2010). The health system benefits from reduced transfers and hospitalisations, better use of tertiary inpatient bed days and the provision of advice for non-burn specialist clinicians in both the initial and ongoing long-term care of burn injuries for these patients (Holt, Faraklas, Theurer, Cochran, & Saffle, 2012; McWilliams, Gilroy, & Wood, 2007; Saffle, Edelman, Theurer, Morris & Cochran, 2009; Turk et al., 2011; Wallace, Hussain, Khan, & Wilson, 2012).

Optimal acute burn assessment and management has the potential to reduce morbidity and mortality (Kasten, Makley, & Kagen, 2011). Telehealth in the acute burn phase facilitates early advice from burn clinicians to guide this assessment and management, as the majority of burn injured patients receive their initial care by non-burn specialist clinicians locally. The potential improvement to patient outcomes through early specialist burns advice and real-time education of these clinicians is significant, with the importance of telehealth identified in the acute phase of burn assessment and management to improve patient care and avoid unnecessary transfers (Saffle, 2006). The use of telehealth in burn care is widespread, with a national survey of United States burn centres showing 84% of responding centres used telemedicine (Holt et al., 2012).

Review of photographs using store and forward technology is often used for the assessment of burns in the acute phase and ongoing wound healing progression in conjunction with telephone communication with the local clinician regarding the patient's condition. The accuracy of burn wound assessment is established using this method (Jones, Wilson, & Andreas, 2003) with experienced burns nurses assessing and managing burn injuries with similar levels of accuracy as burn consultants (Jones, 2005). Digital images of burn wounds facilitate assessment of the size, depth and location of the burn, plus whether the burn is circumferential during an acute consult to enable appropriate advice regarding initial management. Early specialist input facilitates effective assessment, triage, advice and organisation of follow-up, whether it be locally via telehealth, transfer and admission via emergency air transfer, commercial flights, family transport or planned booked admission (Saffle et al., 2009). Ongoing burn wound digital images for those patients not requiring transfer to a burn unit facilitates burn clinician review for possible burn depth conversion, infection, complications and to assess healing, allowing real-time advice regarding ongoing wound and early scar management. The use of telehealth systems to facilitate specialist reviews of burn wounds closer to the patient's home in collaboration with local clinicians reduces inpatient bed days for those rural/remote patients admitted to a burn unit, as patients may be discharged home earlier ensuring effective use of specialty burn unit resources.

The assessment and management of burn injured patients in the rehabilitative phase via telehealth is also established in the literature, with advantages for both patients and the health service by reducing inconvenience, travel and subsequent costs (McWilliams et al., 2007;
Wallace et al., 2012; Smith, Kimble, Brien, Mill & Wootten, 2007). Videoconferencing for follow up of patients with burns is accurate (Smith, Kimble, Mill, Bailey, O’Rourke & Wootten, 2004) and allows assessment of scar maturity, height, colour, pliability, itch, function, psychosocial considerations and discussion regarding treatment plans. Multidisciplinary assessment and follow up for the rehabilitating burns patient via videoconference with rural/remote sites improves state-wide communication and collaboration to guide long-term patient care, while empowering non-burn clinicians to participate in the rehabilitation of these patients.

Avoidance of over-triage and subsequent unnecessary transfer and admission of patients to burn units is a benefit of telehealth in the acute phase, resulting in cost savings through avoided travel and inpatient costs (Saffle et al., 2009; Reiband, Lundin, Alsbjorn, Sorenson, & Rasmussen, 2014; Vercruysse, Ingram, & Feliciano, 2011). Rose, Hassan, Davenport, Evan, and Falder (2010) highlighted the issue of patients being “under-referred” to specialist burn clinicians in the acute phase following burn injury, and telehealth may prevent this from occurring, thereby avoiding subsequent complications. Patients clinically requiring admission to the burns unit, may also be discharged earlier with the option of dressing changes at their local healthcare facility with telehealth support, thereby avoiding inpatient bed costs. Paediatric burn inpatient costs are significant (Kai-Yang et al., 2009; Klein et al., 2008), therefore the avoidance of unnecessary transfer and admissions plus the reduction of bed days have the potential to provide the health system with significant cost savings and more efficient use of tertiary level burn unit beds. Ongoing follow-up of scarring for patients with burn injuries face-to-face in the outpatient clinic can be changed to videoconference reviews for patients who reside outside the metropolitan area, thereby reducing the cost of travel to burn units for the health system.

Cost savings of USD 16,186 for 40 burn injured patients instead of face-to-face outpatient follow-up have been demonstrated, while other North American studies showed savings of an average of USD 146 and CAD 598.33 per patient visit (Massman et al., 1999; Nguyen et al., 2004; Redlick et al., 2002). A 2007 evaluation of a centrally coordinated telepaediatric service in Queensland, Australia, whose activity included burns consultations (6% of activity) showed net savings of AUD 600,000 for the health service over a 5-year period (Smith, Scuffham & Wootten, 2007).

In Western Australia (WA) there is only one state tertiary paediatric hospital total care burns unit which provides a state-wide acute, reconstructive and rehabilitative paediatric burn service for a population that spans an area of over 2.5 million km², the Princess Margaret Hospital for Children Burn Unit. Providing this service to patients and families living in rural and remote areas presents challenges for both the multidisciplinary burn team and rural/remote clinicians. In 2005, over 30% of paediatric burn inpatients and over 11% of paediatric burn outpatients resided in rural/remote areas and all referred rural/remote patients with burns were transferred to Perth for admission for lengthy periods due to limited follow up post discharge with high rates of non-attendance noted, reducing subsequent follow-up care.
To improve rural/remote patient follow-up, a burns telehealth service was established in August 2005 by initially recruiting five rural/remote patients with a history of significant burn injury and with a history of non-attendance at burn outpatient scar clinics to a “telehealth” videoconference clinic. This initiative resulted in the successful review of these patients without the need for travel and all subsequent rural/remote paediatric burn scar review patients were referred to the burns telehealth service. The service evolved to include patients requiring wound reviews via photograph post discharge, followed by rural clinicians referring acute burns for initial review. Following acute review, when transfer was not clinically indicated clinicians and patients received ongoing management advice via telehealth.

The paediatric burns telehealth service is centrally coordinated by the burns clinical nurse consultant, who accepts the majority of acute burn referrals and provides clinical advice within office hours, while the on-call registrar or senior ward nursing staff accept referrals and provide ongoing advice after hours and on weekends. Photos for acute and ongoing burns advice are emailed to a secure, generic health email account (accessible to only senior burns clinicians and protected by the WA Department of Health firewall), accompanied by a phone call from the referring clinician to enable comprehensive assessment of the patient and facilitate accurate comprehensive advice, while allowing for support and real-time education for referring clinicians. All information received and advice provided is documented in the patients’ paper-based medical record at both the consulting and referral sites. This model of burns care reflects the findings of Jones (2005) which support the role of experienced burns nurses in the provision of burns telehealth services. Escalation of advice to the on-call burns consultant is as required: for major burns, those requiring transfer or those patients who present unwell.

Patients requiring transfer to the inpatient burns unit for admission are placed on the “expects” list in the emergency department to facilitate a seamless transfer and admission. Those patients who are discharged from the tertiary paediatric burns inpatient unit or their local health care facility and require ongoing wound reviews are added to a list of acute telehealth patients to allow the clinical nurse consultant to track when wound reviews are due and to follow up if patients do not attend. Once healed, patients are booked into a multidisciplinary videoconference clinic to ensure they receive a follow up scar review at approximately 6 weeks from the date of original burn, at which time subsequent follow-up is arranged. The flow of patients through the telehealth service therefore follows a set path depending upon the burn and patient's clinical condition (Fig. 1). This paper presents the derivation of avoided transfers and bed days for the 8 years of operation of the paediatric burn telehealth service as well as an estimation of cost savings from these high unit cost service components in 2012/13. This study represents the cost savings of an established, fully integrated burns telehealth service which includes both acute and rehabilitative components of care.
Aim

The aim of the study was to undertake a retrospective audit of the avoided transfers and bed days over an 8-year period (2005–2013) as a result of the use of the paediatric burns telehealth service. The second aim of the study was to evaluate the potential cost savings over a 1-year period (2012/13) as a result of the paediatric burns telehealth service.

Method

An 8-year retrospective chart audit was conducted for all patients referred to the paediatric Burn telehealth service in WA from 1st August 2005 to 31st July 2013. Notably, the service has evolved over an 8-year period and has now been imbedded for a number of years. The audit examines the number and type of patient reviews over time, their avoided acute and scar review transfers and avoided hospitalisations. Estimates of cost savings for these outcomes are based on reduced transfers which may be by plane (for patients in the Pilbara or Kimberley regions of WA) or by car (for patients outside these regions) and reduced inpatient bed days. In 2012/13 the telehealth service was fully integrated within the burns model of care, and therefore reflects cost savings for an established, imbedded burns telehealth service. All costs presented in the paper are in Australian dollars (AUD) at 2013 (AUD $1 = approximately US $0.9282).

Inpatient bed days
Avoided (for patients not requiring transfer) or reduced (for patients requiring transfer and admission) inpatient bed days were calculated for each individual patient using the difference between the actual inpatient bed days and the estimated bed days for each individual patient in the previous model of care (without a telehealth service) through examination of each patients’ medical records. This is based on the historical clinical practice of transferring and admitting rural patients to the burn unit until they required only simple and small dressing changes and
did not require opioid analgesia. This approach to calculating reduced or avoided inpatient bed days reflects the actual patients seen by the telehealth service (rather than averages based on metropolitan inpatients who have access to day leave) and is therefore a more accurate reflection of reduced bed days.

Inpatient costs are high and complex to calculate following burn injury, with hospital stay costs consistently representing the largest cost for these patients (Ahn & Maitz, 2012). Actual avoided inpatient stay costs were therefore used for patients in this study, using the average inpatient stay cost of AUD 1,497 for burn inpatients per night within the PMH burn unit for the 2012/13 financial year provided by the unit's business manager.

Transfers
Avoided transfer costs were calculated for each individual patient by using actual costs of travel to/from the location they presented for clinical care as specified in accordance with the WA Health Patient Assisted Travel Scheme guidelines. As paediatric patients are entitled to a paid adult escort, the cost of travel reflects one adult and one child to travel where air travel was required. Patients living in the Pilbara and Kimberley region were therefore costed to flights, whilst patients living in all other non-metropolitan regions were costed to car travel at AUD 0.16 per kilometre.

Other
As this is a retrospective audit of reduced transfers and avoided inpatient bed days, only cost savings related to these two outcomes are estimated. Other costs related to burn care (Ahn & Maitz, 2012) for telehealth patients (including costs for the rural centres) and the costs that would have been incurred under the previous model of burn care are not derived. Hence, a cost benefit analysis of paediatric burn care using telehealth (Davalos, French, Burdick, & Simmons, 2009) is beyond the scope of this paper.

Ethical approval

Approval to conduct the audit was obtained from the hospital’s clinical audit system approval committee (GEKO system) with the associated ethics committee advised of the authors’ intention to publish (approval number 2564).

Results

Between August 2005 and August 2013, a total of 904 patients were referred to the paediatric burns telehealth service. Patient ages ranged from 3 weeks to 16 years old, with the majority (54%) of patients in the toddler (1–4 years) age range. Among these patients, 33.2% self-identified as Aboriginal and 58.1% were male.
Overall, 36.7% of patients were reviewed by telehealth post admission or outpatient clinic only, 22% were reviewed by telehealth both prior to and post admission, while 40.9% were reviewed via telehealth only, and never required transfer to Perth for care. Over the 8-year period, the profile of review types changed as the service evolved in response to increasing rural clinician
awareness and demand for acute reviews and increased publicity regarding availability of the service. An increasing proportion of patients were reviewed before and after transfer or via telehealth only (Fig. 2).

![Figure 2: Telehealth review type by year.](image)

Overall a total of 4,068 wound reviews were conducted, resulting in 4,905 avoided bed days and 364 avoided acute transfers over an 8-year period. A total of 1,863 scar reviews were conducted via videoconference instead of face-to-face in the Perth based outpatient clinic, resulting in 1,763 avoided patient flights (Table 1).

<table>
<thead>
<tr>
<th>Financial year</th>
<th>Number of patients reviewed during each year</th>
<th>Number wound reviews</th>
<th>Number avoided acute transfers</th>
<th>Reduced/avoided length of stay (days)</th>
<th>Number scar reviews</th>
<th>Number of avoided scar review transfers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005/06</td>
<td>21</td>
<td>4</td>
<td>0</td>
<td>9</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>2006/07</td>
<td>113</td>
<td>202</td>
<td>8</td>
<td>330</td>
<td>319</td>
<td>320</td>
</tr>
<tr>
<td>2007/08</td>
<td>140</td>
<td>410</td>
<td>9</td>
<td>526</td>
<td>380</td>
<td>379</td>
</tr>
<tr>
<td>2008/09</td>
<td>101</td>
<td>398</td>
<td>24</td>
<td>439</td>
<td>244</td>
<td>243</td>
</tr>
<tr>
<td>2009/10</td>
<td>116</td>
<td>418</td>
<td>49</td>
<td>696</td>
<td>229</td>
<td>222</td>
</tr>
<tr>
<td>2010/11</td>
<td>134</td>
<td>627</td>
<td>55</td>
<td>1,002</td>
<td>211</td>
<td>203</td>
</tr>
<tr>
<td>2011/12</td>
<td>143</td>
<td>697</td>
<td>61</td>
<td>777</td>
<td>131</td>
<td>127</td>
</tr>
<tr>
<td>2012/13</td>
<td>293</td>
<td>1,312</td>
<td>158</td>
<td>1,126</td>
<td>309</td>
<td>229</td>
</tr>
<tr>
<td>Total</td>
<td>4,068</td>
<td>3,648</td>
<td>4,905</td>
<td>1,863</td>
<td>1,763</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Paediatric burns telehealth service activity.

<table>
<thead>
<tr>
<th>Source of avoided costs</th>
<th>Telehealth only</th>
<th>Telehealth pre and post admission</th>
<th>Telehealth post admission only</th>
<th>Telehealth pre admission only</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>177</td>
<td>73</td>
<td>36</td>
<td>7</td>
<td>293</td>
</tr>
</tbody>
</table>

Wound reviews
Table 2: 2012/13 Patient streams, avoided transfers and bed days and associated avoided costs.

Table 2 shows the profile of 1,312 patients referred to the telehealth service in 2012/13. The majority of these rural/remote patients were reviewed by telehealth only (no transfer to Perth required; n=177) or by telehealth both before and after transfer and admission to the burn unit (n=73) (Table 2). A small number (n=36) of patients were reviewed by telehealth post admission only. These patients were either injured while in Perth, then moved home to their residence post discharge, or were long-term patients receiving ongoing annual scar reviews who were not reviewed via telehealth acutely when they were originally burned. Finally, a smaller proportion (n=7) of patients was reviewed via telehealth pre admission only, and these patients either moved to Perth or interstate post admission, or did not attend their local healthcare facility post discharge for follow-up as requested.

Also shown in Table 2 are the avoided bed days and transfers for each of the four telehealth groups in 2012/13. Of the 699 wound reviews for 177 telehealth only patients (column 1), 621 bed days costing AUD 1,497 per day were avoided. For the other telehealth groups (columns 2 to 4), a total of 505 bed days were avoided. Transfers from rural/remote locations by plane and car for wound and scar reviews are also costly with considerable savings made by the telehealth only group who remained in situ for their reviews and treatment.
The total avoided costs of transfer and bed days for all patients reviewed by the paediatric burns telehealth service in 2012/13 was AUD 1,892,584, or AUD 6,460 per patient.

The average bed days of patients referred to the paediatric burns telehealth service who actually required transfer and admission to the burn unit was 9.9 (range of 1–93 days). The non-attendance rate for telehealth wound reviews was 0.009% (12/1,324) while the non-attendance rate for telehealth scar reviews was 26.6% (112/421).

**Discussion**

Telehealth is used increasingly in burn care due to the benefits it brings to patient care and service provision by facilitating access to immediate specialist burns advice for rural/remote patients close to their home. The paediatric burns telehealth service in WA began as a small project which expanded as rural clinicians and families became increasingly aware of and familiar with the service. Over an 8-year period, the service has evolved, with particular growth in the area of acute burn assessment and management advice. Expansion has been facilitated by integration of the service into the state-wide model of care, increased awareness and demand from rural/remote clinicians, state-wide telehealth burns education sessions and the establishment of a burns clinical nurse consultant, who conducts over 97% of wound reviews for this service.

The paediatric burns telehealth service facilitates acute patient review and advice prior to transfer for admission (for those meeting admission criteria), and early, ongoing acute wound reviews for those patients not requiring transfer and admission to Perth. This has improved the ability to provide immediate expert advice on the acute assessment and management of paediatric burn injured patients in WA and a reduction in unnecessary patient transfers and admissions as clinically appropriate. In 2004/5 the average inpatient bed days for all burn inpatients in our burn unit was 6.9 days, increasing to 7.7 days in 2005/6, when acute wound reviews via telehealth were just beginning (four wound reviews which avoided nine inpatient days in 2005/6). With the increased use of telehealth for acute burn reviews the average inpatient bed days in 2012/13 reduced to 4.2. However, the impact of the telehealth service may be underestimated when based on bed days alone, as those patients admitted now tend to have higher acuity due to enhanced triage at point of referral.

Acute burns assessment and advice is further supported by the WA state-wide burns education program via videoconference (McWilliams et al., 2015), a series of monthly education sessions delivered to multidisciplinary clinicians explaining the theory and practice of adult and paediatric burn care. Burn scar assessment and management via videoconference now delivered via large state-wide telehealth clinics each week also enables patients to complete their rehabilitation closer to home with input from their local clinicians in collaboration with the state paediatric burns team. The education program increased awareness of the telehealth service as a source of clinical advice, but also improved rural/remote clinician knowledge and skill in burn care and the importance of early patient referral.
In addition to clinical benefits for patients, the use of telehealth benefits the healthcare system through cost savings. Paediatric burn telehealth services represent a larger cost saving than adults, as a child requires an adult escort, which doubles the cost of air travel for each review. The WA paediatric burns telehealth service avoided an estimated AUD 1,892,584 in costs for 2012/13 for the tertiary burn unit and patient travel funding. Cost outcomes for burns telehealth services are limited in the current literature. In 2007, Smith et al. demonstrated cost savings for a centralised telepaediatrics service model (of which 6% were patients with burn injuries) in Australia, compared with faceto-face outpatient follow-up only, with a net cost saving of approximately AUD 600,000 over 5 years. This service had been evaluated positively, demonstrating high level patient family satisfaction and improved access to specialist advice (Smith et al., 2004). Our service differs slightly from this model, as all burns referrals are phoned directly to burns clinicians and follow-up is coordinated by clinicians. Sustainable funding can be a challenge for many telehealth services in today's economic climate. The clinical nurse consultant had previously incorporated both clinical and administrative telehealth related duties within her role. With the expansion of services and increasing patient numbers this was not sustainable, therefore, in 2013 the service secured hospital funding for part-time administrative support. For widespread complete integration of telehealth into models of care, funding of both clinical and administrative staff needs to be sustainable to ensure timely review of all burn injured patients irrespective of where they reside and a more efficient use of tertiary burn unit beds.

A limitation of this study is the absence of a control group. Due to integration of the telehealth program into the model of care, all rural and remote patients were referred to the telehealth service during the study period. Another limitation is the estimation of cost savings using retrospective data. The cost savings are attributable only to reduced rural/remote transfers and burn unit bed days made possible by the provision of wound and scar reviews to patients via telehealth in 2012/13. A prospective cost benefit analysis of a burn telehealth service should include more comprehensive annualised costs and benefits, including labour and equipment costs (at both the burn unit and rural/remote sites), and benefits, such as better use of metropolitan burn inpatient services and reduced time away from home and work for family members who would otherwise act as an escort or driver for transfers.

Conclusion

Telehealth is used increasingly in burn care. In addition to clinical benefits for patients, the use of telehealth has benefits for the health system in terms of cost savings. Burn telehealth services assist in early burns clinical advice, avoiding unnecessary transfers and admissions, and facilitating early discharge, thereby avoiding transfer and inpatient costs. Additionally, scar reviews via telehealth reduce unnecessary travel for families and represent cost savings for health system patient travel funding. Future research could use the avoided costs identified in this study to estimate, using cost benefit analysis, the net present value of annual telehealth provision of burn care for non-metropolitan based paediatric patients.

Declaration
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References


“Burns education for non-burn specialist clinicians in Western Australia”


**Highlights**

- A state-wide learning needs assessment of non-burn specialist clinicians was conducted.
- Differences between perceived relevance and confidence in some areas of burn care demonstrated the need for further education and support.
- Data were used to develop a state-wide burns education program delivered live to clinicians via videoconference.
- Significant improvement in non-burn specialist clinician knowledge was demonstrated following attendance for most education sessions.
- Videoconferencing is an acceptable and effective method of delivery for burns education.

**Abstract**

**Background:** Patients often receive their initial burn care by non-burn specialist clinicians, within increasingly collaborative burn models of care. The provision of relevant and accessible education for these clinicians is therefore vital for optimal patient care.

**Design/methods:** A two-phase design was used. A state-wide survey of multidisciplinary non-burn specialist clinicians throughout Western Australia identified learning needs related to paediatric burn care. A targeted education program was developed and delivered live via videoconference. Pre- and post-test analysis evaluated changes in knowledge as a result of attendance at each education session.

**Results:** Non-burn specialist clinicians identified numerous areas of burn care relevant to their practice. Statistically significant differences between perceived relevance of care and confidence in care provision were reported for aspects of acute burn care. Following attendance at the education sessions, statistically significant increases in knowledge were noted for most areas of acute burn care.

**Conclusions:** Identification of learning needs facilitated the development of a targeted education program for non-burn specialist clinicians. Increased non-burn specialist clinician knowledge following attendance at most education sessions supports the use of videoconferencing as an acceptable and effective method of delivering burns education in Western Australia.

**Introduction**

Morbidity and mortality following burn injury is reduced with optimal treatment (Klein et al., 2009; Latenser, 2009). Patients who sustain a burn injury often receive initial care in their local health care facility by non-burn specialist clinicians in Western Australia (WA), as the state-wide paediatric burn service covers an area of 2.5 million km² delivered from the state's tertiary
paediatric hospital in the capital Perth (Geoscience Australia, 2014; Rea et al., 2005). Faced with the challenges of distance and the associated long patient transfer times, burns telehealth services were established for WA in 2005, with the understanding that the initial treatment provided influences patient outcomes. Rural/remote clinicians therefore play an important role in the management of burn injured patients living in rural/remote areas of WA in collaboration with the state tertiary paediatric hospital's burns team (McWilliams, Gilroy, & Wood, 2007).

Collaborative approaches to burn care for rural/remote patients encourage initial healthcare providers to utilise their important role in the provision of appropriate triage and initial treatment, and to recognise and refer complications to the burn multidisciplinary team, facilitating the best possible treatment for burn injuries (Ewings & Pollack, 2008). Although clinical support and advice is provided for rural/remote clinicians treating burn injured patients via the telehealth service, a further support mechanism was proposed to provide a continuous state-wide clinician education program.

Rural/remote clinicians practice in geographic isolation, have unique learning needs and less access to professional development and function in clinical environments different to clinicians practicing in metropolitan hospitals and tertiary burn units (Fairchild et al., 2013; Paliadelis, Parmenter, Parker, Giles, & Higgins, 2012). For many rural/remote clinicians, attendance at specialised courses can be challenging due to the barrier of distance, especially in a state as large as WA. E-health technologies such as videoconferencing are often used to overcome distance when accessing education from metropolitan teaching hospitals and the use of such education programs have demonstrated improvement in clinician knowledge (W. Chang, Sheen, P. Chang, & Lee, 2008; Chipps, Brysiewicz, & Mars, 2012). When developing an education program, adult learning theory highlights the importance of involving the target audience in the planning phase through the use of a learning needs analysis to identify areas of knowledge to focus on for increased competence (Prusakova, 2010; Hauer & Quill, 2011). Self-reported confidence is a consequence of clinical competence, therefore a disparity between perceived relevance and confidence amongst participating clinicians represents an area requiring education and clinical support (Smith, 2011). Building on the established telehealth network, the development of a collaborative, relevant burns education program that was accessible to rural/remote clinicians was therefore the next step in supporting optimal burn care for patients.

**Aims**

This study aimed to

(1) Identify the learning needs of multidisciplinary non-burn specialist clinicians in WA regarding the assessment and management of paediatric burn injuries.

(2) Develop a targeted burns education program for non-burn specialist clinicians in WA.

(3) Evaluate the effectiveness of the education program delivered via videoconference in increasing clinician knowledge of burns assessment and management.

**Methods**
A two-phase design was used to address the aims of this study.

Phase 1
A survey of the learning needs of non-burn specialist clinicians in WA was conducted.

Survey distribution
All relevant medical/executive directors in WA were posted a notification letter describing the study along with a copy of the survey, requesting they contact the author if they did not wish their health service to participate. Two weeks after initial letters were sent, no objections were received.

A two-page paper based state-wide survey was delivered via mail to the nurse managers or directors of nursing of all hospitals and nursing posts throughout WA for distribution to clinical staff, with the exception of the two tertiary hospitals in WA with on-site burn services.

Sample
The sample consisted of non-burn specialist medical, nursing, allied health and other health professionals working in more than 180 government hospitals and nursing posts, all without burns units, in WA.

Data collection
Data collected through the learning needs assessment survey included participant occupation, years of clinical experience, burn care experience, perceived relevance of burns related topics, confidence with burns related care, whether respondents access burn education via videoconference and how they access burns advice. Suggested burn topics listed were obtained by referring to the “Australian New Zealand Burn Association Emergency Management of Severe Burns Course Book” (Australian New Zealand Burn Association, 2011) and “Total Burn Care” (Herndon, 2012), both texts considered highly relevant to the acute management of burn injuries in clinical settings.

Respondents were asked to use a Likert scale to indicate whether they strongly agree/agree/disagree/strongly disagree with various statements regarding their perception of relevance to their current practice and confidence in their own knowledge/skills regarding various paediatric burn care topics. The Likert scale measured the degree of agreement or disagreement with an expressed statement, such as the relevance of a given topic to the clinicians’ current practice (De Winter & Dodo, 2010).

Data analysis
Respondents completed the survey anonymously, returned them via mail to the author and data was entered into an Excel spreadsheet. A Spearman rank correlation coefficient was used to compare perceived relevance and confidence in all aspects of burn care.

Phase 2
Utilising the learning needs survey results, a comprehensive, multidisciplinary curriculum was written, promoted and delivered state-wide throughout WA via live videoconference sessions. Internet protocol (IP) videoconferencing equipment was used at both the delivering and receiving sites, with the use of an IP “bridge,” which enabled multiple sites to attend the education sessions simultaneously throughout WA.

The curriculum was divided into six 45-minute modules of PowerPoint sessions delivered on the first Tuesday of each month at 1330hrs by videoconference by senior members of the burns multidisciplinary team. The mode of delivery enabled state-wide access to the programme and audience capacity limited only by the room size of each participating site. The module topics were burns prevention and first aid; airway and inhalation injury; circulation and fluid resuscitation; burn wound assessment, management and dressings; chemical and electrical burns; and pain assessment and management. Education was delivered by medical staff (burns consultants) and senior burns nursing staff (advanced practice nurses). Live delivery of the education sessions enabled participants to interact with the clinicians delivering the education if desired, particularly with regards clarification and questions at the completion of each presentation.

The modules were delivered on the first Tuesday of each month at 1330 h via videoconference to clinicians throughout WA, free of charge. This time maximised potential participation by coinciding with nursing staff shift overlap time. No incentives or continuing education credits were offered for attendance.

Pre- and post-test distribution
Pre- and post-tests were emailed to each registered healthcare facility's local telehealth contact for printing, distribution and collection at each education session.

Sample
The sample consisted of participants from over 40 hospital/health services/nursing posts throughout WA who attended the various education sessions and completed pre- and post-tests.

Data collection
Participants completed the paper-based pre-test before each educational session commenced and completed post-tests immediately following completion of the session. Pre- and post-tests consisted of key points from each education session, with a variety of true/false questions and open-ended questions to demonstrate learning. Tests were not completed under controlled conditions as the program was conducted within a state-wide clinical context. Tests were anonymously returned to the burn unit of the state tertiary paediatric hospital. All tests were marked by the burns clinical nurse consultant for accuracy against information provided in the education session.

Data analysis
Pre-post test data were entered into an Excel spreadsheet. The Wilcoxon matched pairs signed rank test was used to analyse non-parametric data to determine if a statistically significant increase in knowledge occurred as a result of attendance at an education session. Significance level was set at 0.05 ($p < 0.05$).

**Ethical approval**

Approval to conduct the study was received from the relevant quality and ethics committees and written approval for publication obtained. All surveys and pre-post tests were anonymous to maintain confidentiality of participants and complied with the National Health and Medical Research Council guidelines.

**Results**

**Phase 1**

One thousand surveys were sent out via mail to over 180 healthcare facilities throughout WA and 281 completed surveys were returned, representing a 28.1% response rate. Some participants did not complete the entire survey. Responding clinicians were nurses (81.1%), doctors (10.3%), allied health staff (occupational and physio therapists) (7.8%) and Aboriginal health workers (0.7%), from all regions of WA with various levels of experience within their respective profession (ranging from 2 weeks to 42 years, with an average of 17.8 years) (Table 1). Reported experience with caring for paediatric burn injured patients varied. Those who had never cared for a burn injured patient comprised 7.5%, 43.4% had cared for less than five burn patients, and 49.1% had cared for more than five burn patients.

<table>
<thead>
<tr>
<th>Learning needs assessment participants</th>
<th>Nurse 81.1% ($n = 228$)</th>
<th>Doctor 10.3% ($n = 29$)</th>
<th>Allied health 7.8% ($n = 22$)</th>
<th>Aboriginal health worker 0.7% ($n = 2$)</th>
<th>All clinicians 100% ($n = 281$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experience in profession (years)</td>
<td>Range: 0.16–42</td>
<td>Range: 0.04–32</td>
<td>Range: 0.5–28</td>
<td>Range: 4–11</td>
<td>Range: 0.04–42</td>
</tr>
<tr>
<td></td>
<td>Average: 18.8</td>
<td>Average: 15.6</td>
<td>Average: 10.1</td>
<td>Average: 7.5</td>
<td>Average: 17.8</td>
</tr>
<tr>
<td>Number of burn patients treated in career</td>
<td>0 pts: 5.7% ($n = 13$)</td>
<td>&lt;5 pts: 27.6% ($n = 8$)</td>
<td>&lt;5 pts: 54.5% ($n = 12$)</td>
<td>&lt;5 pts: 100% ($n = 2$)</td>
<td>0 pts: 7.5% ($n = 21$)</td>
</tr>
<tr>
<td></td>
<td>&lt;5 pts: 43.8% ($n = 100$)</td>
<td>&gt;5 pts: 72.4% ($n = 21$)</td>
<td>&gt;5 pts: 9.1% ($n = 2$)</td>
<td>&gt;5 pts: 100% ($n = 2$)</td>
<td>&lt;5 pts: 43.4% ($n = 122$)</td>
</tr>
<tr>
<td></td>
<td>&gt;5 pts: 49.5% ($115$)</td>
<td></td>
<td></td>
<td></td>
<td>&gt;5 pts: 49.1% ($n = 138$)</td>
</tr>
<tr>
<td>Experience with minor burns</td>
<td>Yes: 93% ($n = 212$)</td>
<td>Yes: 100% ($n = 29$)</td>
<td>Yes: 54.5% ($n = 12$)</td>
<td>Yes: 100% ($n = 2$)</td>
<td>Yes: 90.1% ($n = 253$)</td>
</tr>
<tr>
<td></td>
<td>No: 7% ($n = 16$)</td>
<td></td>
<td>No: 45.5% ($n = 10$)</td>
<td>No: 9.9% ($n = 28$)</td>
<td>No: 9.9% ($n = 28$)</td>
</tr>
<tr>
<td>Experience with major burns</td>
<td>Yes: 56% ($n = 128$)</td>
<td>Yes: 69% ($n = 20$)</td>
<td>Yes: 27.3% ($n = 6$)</td>
<td>Yes: 100% ($n = 2$)</td>
<td>Yes: 54.8% ($n = 154$)</td>
</tr>
<tr>
<td></td>
<td>No: 44% ($n = 100$)</td>
<td>No: 31% ($n = 9$)</td>
<td>No: 72.7% ($n = 16$)</td>
<td>No: 45.2% ($n = 127$)</td>
<td>No: 45.2% ($n = 127$)</td>
</tr>
<tr>
<td>Experience with inhalation injury</td>
<td>Yes: 30% ($n = 68$)</td>
<td>Yes: 41.4%</td>
<td>Yes: 9% ($n = 2$)</td>
<td>Yes: 100% ($n = 2$)</td>
<td>Yes: 29.2%</td>
</tr>
<tr>
<td></td>
<td>No: 70% ($n = 160$)</td>
<td></td>
<td>No: 91% ($n = 20$)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The survey demonstrated over 80% of responding clinicians in WA perceived all suggested burns topics as relevant to their current practice (Table 2). Additional comments from some respondents indicated a reported learning need for pain management and this was acknowledged and included in the curriculum.
Table 2: Survey results: burn care relevance and confidence (*p<0.05)

Statistically significant differences between perceived relevance and confidence in the care of burn wounds, fluid resuscitation and major burns were found, illustrating the need for clinical support and education (Table 2).

State-wide, 95.7% of respondents indicated they would attend education sessions covering paediatric burns topics via videoconference. This response indicated that videoconferencing is an acceptable means of accessing education for most clinicians surveyed.

The majority of participants indicated that when faced with a burn injured patient in their facility, the majority (92.9%) would phone the burn unit for advice, whilst 27.4% would also look at the intranet page of the burn unit for information.

**Phase 2**
Statistically significant improvements in clinician knowledge were observed in all pre-test/post-test answer comparisons for clinicians attending sessions on burns prevention and first aid, airway and inhalation injury, circulation and fluid resuscitation (Table 3). High levels of both pre- and post-test knowledge were found in responses to questions on burn wound management (correct post test scores for 88–100%), pain and itch (correct post-test scores for 92%) and questions 4, 6 and 7 of the chemical and electrical burns session (correct post-test
scores for 100%), which resulted in non-significant increases in knowledge following attendance at the session (Table 3). Unfortunately, only 50% of clinicians correctly answered the question related to first aid for chemical burns correctly in the pre-test and knowledge did not significantly increase following attendance at the education session, highlighting an area for further education and reinforcement in future sessions.

<table>
<thead>
<tr>
<th>Pre- and post-test paediatric burns education topic and questions</th>
<th>Number of participants</th>
<th>Number of health care sites participating</th>
<th>Increased knowledge (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burns prevention &amp; first aid</td>
<td>56</td>
<td>13</td>
<td>0.001 *</td>
</tr>
<tr>
<td>Name one important strategy to prevent burn injury in children. Describe any other relevant factors.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name the three important aspects of optimal burns first aid.</td>
<td></td>
<td></td>
<td>0.000 *</td>
</tr>
<tr>
<td>List three benefits of optimal burns first aid.</td>
<td></td>
<td></td>
<td>0.000 *</td>
</tr>
<tr>
<td>How long after a burn injury is first aid still effective?</td>
<td></td>
<td></td>
<td>0.000 *</td>
</tr>
<tr>
<td>Airway &amp; inhalation injury</td>
<td>93</td>
<td>32</td>
<td>0.003 *</td>
</tr>
<tr>
<td>When conducting your initial patient history, what findings may indicate potential inhalation injury?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What patient signs &amp; symptoms may indicate potential inhalation injury?</td>
<td></td>
<td></td>
<td>0.001 *</td>
</tr>
<tr>
<td>What are the three types of inhalation injury?</td>
<td></td>
<td></td>
<td>0.000 *</td>
</tr>
<tr>
<td>What impact can circumferential torso burns have on respiration?</td>
<td></td>
<td></td>
<td>0.001 *</td>
</tr>
<tr>
<td>Outline three important components of management of patients with inhalation injury?</td>
<td></td>
<td></td>
<td>0.005 *</td>
</tr>
<tr>
<td>Circulation &amp; fluid resuscitation</td>
<td>60</td>
<td>26</td>
<td>0.000 *</td>
</tr>
<tr>
<td>When estimating the % total body surface area burns (TBSA) in children, which tool is used?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete this sentence: Paediatric burn patients aged under 18 months with a burn greater than ___% TBSA, or aged over 18 months with a burn greater than ___% TBSA, require fluid resuscitation and transfer to the burn unit.</td>
<td></td>
<td></td>
<td>0.000 *</td>
</tr>
<tr>
<td>What formula is used to estimate fluid resuscitation for paediatric burn patients?</td>
<td></td>
<td></td>
<td>0.000 *</td>
</tr>
<tr>
<td>In paediatric burn patients receiving fluid resuscitation, what is the optimal hourly urine output?</td>
<td></td>
<td></td>
<td>0.000 *</td>
</tr>
<tr>
<td>Burn wound management</td>
<td>70</td>
<td>25</td>
<td>0.083</td>
</tr>
<tr>
<td>What is the recommended initial dressing for all burns (except the face area) in WA?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What should be used to moisten Acticoat dressings for activation?</td>
<td>Nil change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burn patients with a transfer time to the burn unit of greater than 2 h should have silver dressings applied, with Acticoat being the preferred silver dressing. True or false?</td>
<td></td>
<td></td>
<td>0.317</td>
</tr>
<tr>
<td>According to the Jackson Burn Wound Model, optimal first aid and wound management are factors which can salvage the zone of _______ and therefore reduce the depth and size of burn and therefore subsequent outcomes for the patient.</td>
<td></td>
<td></td>
<td>0.004 *</td>
</tr>
<tr>
<td>Pre- and post-test paediatric burns education topic and questions</td>
<td>Number of participants</td>
<td>Number of health care sites participating</td>
<td>Increased knowledge (p-value)</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td>------------------------</td>
<td>-----------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Chemical &amp; electrical burns</td>
<td>73</td>
<td>29</td>
<td>0.083</td>
</tr>
<tr>
<td>Optimal first aid for chemical burns is:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Following appropriate first aid, what should be applied to the burns area following hydrofluoric acid burns?</td>
<td></td>
<td></td>
<td>0.047 *</td>
</tr>
<tr>
<td>Hydrofluoric acid, which is absorbed systemically, may affect the patient's ____ levels,</td>
<td></td>
<td></td>
<td>0.014 *</td>
</tr>
<tr>
<td>Tissue damage following electrical injuries may be worse than the initial appearance of the outer skin/wound indicates. True or false?</td>
<td></td>
<td></td>
<td>Nil change</td>
</tr>
<tr>
<td>Why is the patient's urine examined and closely monitored following electrical injury?</td>
<td></td>
<td></td>
<td>0.017 *</td>
</tr>
<tr>
<td>Why is an ECG performed on patients following electrical injury?</td>
<td></td>
<td></td>
<td>0.084</td>
</tr>
<tr>
<td>Patients with chemical electrical burns require referral to burn unit. True or false?</td>
<td></td>
<td></td>
<td>0.157</td>
</tr>
<tr>
<td>Pain &amp; itch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify appropriate analgesia for dressing changes in patients with minor burn injuries.</td>
<td>38</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>What are the potential side effects of this analgesia?</td>
<td></td>
<td></td>
<td>0.056</td>
</tr>
<tr>
<td>Increasing burn pain may be a sign of burn wound _____.</td>
<td></td>
<td></td>
<td>0.025 *</td>
</tr>
<tr>
<td>Burn itch may be reduced by _____.</td>
<td></td>
<td></td>
<td>0.083</td>
</tr>
</tbody>
</table>

Table 3: Pre-post test results: clinician knowledge (*p<0.05)

**Discussion**

Multidisciplinary non-burn specialist clinicians of varying levels of experience in rural/remote WA self-identified numerous areas of burn care as relevant to their clinical practice, but reported low levels of confidence in providing some aspects of this care. Numerous studies report concerns regarding knowledge levels of non-burn specialist clinicians who provide initial burn care, and recommend improved education, support and collaboration between burn centres and non-burn centres (Bezuhley, Gomez, & Fish, 2004; Chipp, Walton, Gorman, & Moiemen, 2008; Linn, 1980; DeKoning, Hakeneworth, Platts-Mills, & Tintinallu, 2009; Tourtier et al., 2011). Concerns found in the literature regarding the triage and referral of burn injured patients from non-burn centres, highlight the need for education in combination with a collaborative relationship to not only increase knowledge, but provide support and guidance when burn injured patients initially attend healthcare facilities (Bezuhley et al., 2004; Chipp et al., 2008; DeKoning et al., 2009; Tourtier et al., 2011; Carter, Neff, & Holmes, 2010; Davis et al., 2012; Rose et al., 2010; Vercruysse et al., 2011).

In order to support non-burn specialist clinician identified needs in WA, the curriculum developed addressed relevant burn care topics with a rural/remote perspective to each session, representing a collaborative approach to the development of the education program. This included discussions on criteria for and the logistics of patient transfers, importance of seeking
early burns advice and how to access this advice in WA via the state-wide clinical telehealth service.

The majority of rural/remote clinicians surveyed viewed videoconferencing as an acceptable form of receiving burns education, confirming this was an appropriate and accessible method of delivery for participants. Asynchronous web-based education, such as ABLS-now and WoundsWest provide clinicians with access to valuable burns education at any time, but does not enable participants to interact with the clinicians providing the education. The provision of education delivered live via videoconference allows for interaction between participants and educators, and is used internationally to teach students, doctors, nurses and allied health staff, especially in support of rural/remote clinicians (Chipps et al., 2012; Augestad & Lindsetmo, 2009; Doorenboos, Kundu, Eaton, Demiris, Haozous, & Towle, 2011; Smith et al., 2012).

The results of our study support the assertion that education delivered via videoconference was effective in increasing clinician knowledge of burn care, with statistically significant (p < 0.05) increases in knowledge demonstrated in pre-post tests for the majority of the burns education topics delivered. Most areas of burn care that did not show a statistically significant increase in knowledge following attendance at the education sessions showed high levels of pre-existing pre-test and subsequent post-test knowledge and therefore significant changes were not seen. This is acceptable, as although significant changes were not seen as a result of the sessions, clinician knowledge levels remained high, which is the ultimate aim of an education program. Changes to the chemical burn education session have been made as a result of the study. Increased discussion of first aid for patients following chemical burns is now included. A combined education session titled “major burns” is now also included which covers all aspects of the initial management of paediatric patients with major burns, to reinforce the content of all previous sessions in the program.

The state-wide burns education program via videoconference is now an established service. The program endeavours to provide educational support to clinicians throughout WA on a continuous basis to ensure the changing workforce is offered frequent opportunities to keep up-to-date with burn care. Further investigation into the transfer of knowledge into practice is required in the future, as part of a wider study, to evaluate whether the provision of education and increased clinician knowledge improves patient care.

Limitations

One limitation of the study is that the learning needs expressed represent only those multidisciplinary clinicians working in WA healthcare facilities that do not include an on-site burn service. Another limitation of the study is that knowledge was not tracked over time, instead it aimed to evaluate whether the education was being delivered in a way that was clear to non-burn specialist clinicians and resulted in immediate knowledge transfer.

Conclusion
The identification of learning needs specific to non-burn specialist clinicians facilitated the development of a relevant education program which encouraged participation from the planning stage. Confirming videoconferencing as an acceptable method of education delivery for the majority of these clinicians ensured it was both accessible and acceptable to the target audience. Evaluation of the delivered education program demonstrated participant learning as a result of attendance at the majority of the sessions and provided feedback that will inform future changes and improvements to ensure knowledge is transferred effectively during all future sessions. This study confirmed that the provision of a successful state-wide burns education program is possible by encouraging clinician participation from the planning stage and through the use of established communication networks and videoconferencing resources.

Conflict of interest statement
The authors declare that there are no conflicts of interest.

Acknowledgements
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References


“The implementation of an infection prevention and control bundle within a Total Care Burns Unit”


Abstract

**Aim:** To evaluate the impact of the implementation of a best practice infection prevention and control bundle on healthcare associated burn wound infections in a paediatric burns unit.

**Background:** Patients are vulnerable to infection following burn injury. For this patient population, infection is associated with increased morbidity and mortality, thereby representing a significant challenge for burns clinicians who care for them.

**Methods:** An interrupted time series was used to compare healthcare associated burn wound infections in paediatric burn injured patients before and after implementation of an infection prevention and control bundle. Prospective surveillance of healthcare associated burn wound infections was conducted from 2012 to 2014. Other potential healthcare associated infection rates were also reviewed over the study period, including urinary tract infections, pneumonia, upper respiratory tract infections and sepsis. An infection prevention and control bundle developed in collaboration between the paediatric burn unit and infection control clinicians was implemented in 2013 in addition to previous standard practice.

**Results:** During the study period a total of 626 patients were admitted to the paediatric burns unit. Healthcare associated burn wound infections reduced from 34 in 2012 to zero in 2014 following the implementation of the infection prevention and control bundle. Pneumonia and sepsis also reduced to zero in 2013 and 2014; however, one upper respiratory tract infection occurred in 2013 and urinary tract infections persisted in 2013.

**Conclusion:** The implementation of an infection prevention and control bundle was effective in reducing healthcare associated burn wound infections, pneumonia and sepsis within our paediatric burns unit. Urinary tract infections remain a challenge for future improvement.

**Background**

Healthcare associated infections (HAI) are defined as “infections that patients acquire during the course of receiving treatment for other conditions” (McKibben et al., 2005. p. 218). HAIs consume healthcare resources whilst increasing healthcare costs, inpatient length of stay, morbidity and patient mortality (Hodle, Richter, & Thompson, 2006; Kuper & Septimus, 2009; Peck & Heimbach, 1989). HAIs are a contributing factor in 87.1% of hospitalised patient deaths with HAI rates ranging from 11 to 32.5% in adult burn injured patient populations and 13.6 to 33.9% in paediatric burn populations (Alp, Coruh, Gunav, Yontar, & Doganay, 2012; Geyik,
Aldemir, Hosogiu, & Tacyildiz, 2003; Souza et al., 2015; Weber, Sheridan, Pasternack, & Tompkins, 1997; Wibbenmeyer et al., 2006).

Burn wound infections are the most common HAI amongst this population, with paediatric burn populations reporting burn wound HAI rates of 10.1 to 55% (Alp et al., 2012, Santucci, Gobara, Santos, Fontana, & Levin, 2003; Weber et al, 1997; Wibbenmeyer et al., 2006). Common burn wound pathogens include *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterobacter cloacae*, *Escherichia coli*, *Enterococcus* species, *Candida albicans*, *Acinetobacter* and *Aspergillus* species, with an increasing incidence of multi-drug resistant organisms reported (Alaghehbandan, Azimi, & Rastegar, 2012; Alangaden, 2011; Deotale, Attal, & Narang, 2015; Kandati et al., 2015; Lepelletier et al., 2015). Peck (1998) summarises standardised criteria for burn wound infection to enable surveillance including clear definitions for burn wound impetigo, open burn-related surgical wound infection, burn wound cellulitis and invasive infection in unexcised burn wounds.

Infection prevention for the burn injured patient requires both contact and protective precautions, as these patients are at risk of infection, but also represent a source of potential infection to their environment and other patients. The presence of microorganisms in the wound plus high levels of wound exudate contaminate surroundings through direct contact and aerosolisation of micro-organisms, especially during dressings changes (Bache et al., 2013, Bache et al., 2015). Bacterial contamination of the patient environment contributes to recurrent outbreaks of infection amongst burn units (Zanetti et al, 2007). Multiple strategies to control the transfer of infection to and between patients are needed and the role of the nurse in burn care is significant, as he/she implements many infection prevention and control (IPC) interventions and educates colleagues, families and patients about these on an ongoing basis. Collectively, such interventions represent an IPC bundle.

Bundles “reorganise the structure and organisation of care processes” through the implementation of key interventions, or “elements” to improve patient outcomes (Borgert, Goossens, & Dongelmanns, 2015). IPC bundles rely on behavioural changes of both clinicians (especially nurses who have frequent patient contact) and visitors to implement a variety of policies and practices (Aboelela et al., 2007). Van Duin et al. (2014) demonstrated the effectiveness of multiple interventions in reducing HAIs in a large burn intensive care unit, preventing an estimated 428 HAIs and 118 deaths. Barbut, Yezli, Minoun, Pham, Chauat, and Otter (2013) implemented an IPC bundle in a burn unit, demonstrating a reduction of Methicillin resistant *Staphylococcus aureus* (MRSA) and *Acinetobacter baumanii* HAIs by 89.3 % and 88.8%, respectively. This paper investigates the effectiveness of implementing an IPC bundle, with emphasis on nursing interventions, to reduce such healthcare associated burn wound infections within the paediatric burn unit in Western Australia (WA).

The state tertiary paediatric burn unit in WA provides the only paediatric burns service for an area covering 2.5 million km², for a population of over 2.5 million people, through its nine-bed separate inpatient burns unit, adjacent outpatient clinic and integrated rural/remote telehealth service. It is comprised of a high-efficiency particulate air (HEPA) filtered, closed burn unit
with two single isolation rooms, two two-bedded rooms and one three-bedded room, with no anteroom facilities adjoining any rooms.

In 2012, the IPC clinical nurse consultant (CNC) and burns CNC, both specialised advanced practice registered nurses, in collaboration with the burns unit medical director and microbiology head of department, reviewed and implemented several changes to policy, practice and the ward environment, namely an IPC bundle, in an effort to reduce HAIs for burn injured patients. The bundle was evaluated as a single entity, and impact was demonstrated through the reduction in the number of HAIs over time. To facilitate the implementation of the bundle, a theoretical framework was used to ensure all aspects of performance were addressed.

**Theoretical Framework**

Changing behaviour is important to successfully implement clinical care bundles (Steinmo, Fuller, Stone, & Michie, 2015). The Gilbert Behavioural Engineering Model (Gilbert, 2013) was used as a framework for the bundle to improve performance of all healthcare professionals caring for the burn injured patient, with particular emphasis on the nursing staff as they have the greatest amount of direct patient contact. This model, with an emphasis on factors that influence clinician behaviour when seeking to reduce healthcare infections, is supported by the study by De Wandel, Maes, Labeau, and Vereecken (2010), which highlighted the importance of clinician behaviour when seeking to improve compliance in hand hygiene in intensive care units. By focussing on the various factors which can influence behaviour, we sought to improve clinician behaviour and therefore clinical practice.

Established standard care which was reviewed by the burns and IPC CNCs, and deemed appropriate, was continued (Appendix 1); however, potential areas of change for improvement were discussed and implemented. These changes to policy and practice represent the IPC bundle, implemented to improve care, and summarised in Table 1.
Table 1: Infection and Prevention Control Bundle

**Aim**

The study aimed to evaluate the implementation of changes to policy and clinical practice (an IPC bundle) on HAIs within a paediatric burn unit in WA.

**Method**
An interrupted time series evaluated the effectiveness of the implementation of the IPC bundle by comparing healthcare associated infection rates amongst paediatric burn inpatients before and after this intervention.

Healthcare associated burn wound infections were identified and investigated by the Infection Control CNC as part of routine ongoing surveillance, which reduced bias as this role is separate to the burns unit. Urinary tract infections, pneumonia, upper respiratory tract infections and sepsis were identified and documented in patients’ medical records by treating medical staff based on clinical symptoms and positive microbiological culture. Identification of such infections by nursing staff and medical staff are always discussed with the treating consultant, therefore providing two levels of verification of the presence of infection.

**Design**

This study used an interrupted time series, a quasi-experimental design which evaluates the impact of the changes within our burn inpatient population by investigating rates of HAIs at specific time points, both before and after implementation of the changes (Penfold & Zhang, 2013). The bundle was implemented in January 2013.

**Data Collection**

All paediatric acute burn inpatients admitted to the state paediatric burns inpatient ward between January 2012 and February 2014 were included in the study, totalling 626 patients. At least eight time points, both before and after the intervention, should be used to evaluate the intervention statistically (Penfold & Zhang, 2013) and this is reflected in the length of time used to evaluate the intervention in this paper. Retrospective surveillance of healthcare associated infections amongst paediatric patients admitted to Princess Margaret Hospital for Children in WA following burn injury was conducted from January 2012 to February 2014 by the infection control CNC from review of patient medical records.

The well-established Peck (1998) criteria was used for defining burn wound infection, by reviewing documentation of clinical assessment by medical or senior burns nursing staff and patient specimens. Retrospective surveillance of healthcare associated urinary tract infections, pneumonia, upper respiratory tract infections and sepsis was conducted from the Burns Minimum Data Set (paediatric burns inpatient database), which uses all data from a patient’s inpatient medical record, and is collected by a senior research nurse specialising in burn care. Identification of such infections in paediatric burn injured patients in our unit is based on clinical assessment by medical staff and patient specimens, and is always verified by the treating burns consultant and clearly documented in a patient’s medical record. The criteria used to identify sepsis reflects the current definition of life-threatening organ dysfunction caused by a dysregulated host response to infection (Singer et al., 2016).

**Data Analysis**
Poisson regression was used to perform the analysis, which produced incidence ratios and 95% confidence intervals.

Results

The data from a total of 626 paediatric burn inpatients was collected one year prior and 16 months following the implementation of an IPC bundle. Patients in the two groups were similar in age, ranging from 8 days to 17 years, with a median age of 3 years (IQR 1.38 - 8 years) in 2012, versus 2013-14 when patient ages ranged from 1 day to 17 years, with a median age of 3 years (IQR 1 - 9 years). Injury size (burn TBSA) was similar for the two groups, ranging from 0.1-32% in 2012, with a median of 2% (IQR 1 - 4), versus a range of 0.1-23% in 2013/14, with a median of 2% (IQR 1 - 3.5). There were nil patients with inhalation injury during the study period. Inpatient length of stay in 2012 ranged between 6 hours and 75 days (average of 7 days), while in 2013/14 inpatient length of stay ranged between 6 hours and 44 days (average of 5 days).

Graph 1: Healthcare associated infections

In 2012, a total of 34 healthcare associated burn wound infections were identified amongst paediatric burn inpatients within our burn unit, reflecting an overall annual HAI rate of 1.14%. In 2013, following implementation of changes to internal policy, practice and clinician/visitor education interventions, a total of six healthcare associated wound infections were identified amongst the paediatric burn inpatients. This number reduced to zero between August 2013 and February 2014 (Graph 1). There was a statistically significant reduction in healthcare associated wound infection rates (11.4 to 1.6 per 1000 bed days) following implementation of
the IPC bundle, equating to an 86% reduction in healthcare associated infections (p<0.001). Following nine months of zero healthcare associated burn wound infections, the IPC CNC and burns CNC continued to observe clinically for further infections as per usual clinical practice. This change of practice and prevention of healthcare associated burn wound infections has continued, with CHADx data confirming clinical observation of no healthcare associated burn wound infections amongst paediatric burn inpatients in the past six months, between August 2015 and February 2016.

In 2012, a total of three healthcare associated pneumonias were identified amongst paediatric burn inpatients within our burn unit. In both 2013 and 2014 following implementation of the bundle there were zero pneumonias identified, demonstrating a clinically significant reduction in these types of infections amongst our inpatients, but was not statistically significant (p=0.055), which may be related to small sample size.

In 2012, a total of three upper respiratory tract infections were identified amongst paediatric burn inpatients within our unit. In 2013, following implementation of the bundle, this reduced to one case, and zero cases were identified in 2014. This demonstrated a clinically significant reduction in these types of infections, but again due to small sample size the reduction was not statistically significant (p=0.158).

In 2012, three cases of sepsis were identified amongst our paediatric burn inpatients. In 2013 and 2014, following implementation of the bundle, zero cases of sepsis were identified. This reduction in sepsis to zero was not statistically significant (p=0.055) which may be due to sample size, but it is a clinically significant improvement in this serious complication.

In 2012, two cases of healthcare associated urinary tract infections were identified. In 2013 three cases of urinary tract infection case were identified, demonstrating no reduction and therefore a continuing issue despite implementation of the IPC bundle.

**Discussion**

The results of this study demonstrate that compliance with practice contained in the IPC bundle within a paediatric burn unit can reduce HAIs. In this study wound, pneumonia and sepsis HAIs were reduced to zero following implementation of all components of the bundle. Urine and upper respiratory HAIs were not able to be reduced to zero, demonstrating potential gaps in the bundle. The continued presence of urinary tract infections shows the importance of assessing for potential urinary sources in a febrile patient, but also the importance of sterile technique during urinary catheter insertion and ensuring urinary catheters are not left in situ longer that clinically required. These results will allow us to expand the bundle to incorporate the above factors.

Sharma (2005) highlighted three important factors influencing infection in the burn injured population, namely the infection source, transmission and the patient susceptibility. A systematic review of ICU patients demonstrated that patients with burn injuries were at highest
risk of developing sepsis, and when they did, displayed worse outcomes than other patients (Mann, Baum, Meininger, & Wade, 2012), whilst Kallinen, Maisniemi, Bohling, Tukiainen, and Koljonen (2012) found 40% of burn deaths were caused by multisystem organ failure, all of which were associated with sepsis. The reduction in the number of patients with sepsis is therefore significant, due to its high mortality rate.

The implementation of clear policies was an important component of an IPC program to ensure consistent practice regarding strict isolation, contact precautions and environmental cleaning. To further improve, the unit has also recently introduced the use of hydrogen peroxide vapour for terminal decontamination following patient discharge and daily for the ward bathroom, which has been demonstrated in the literature to be effective in the decontamination of clinical areas (Lemmen et al., 2015; Manian et al., 2011).

The role of nurses and medical staff in the education of all staff and visitors who have contact with burn injured patients along the patient journey is important for the implementation of policy into practice. This education was not only provided on a state-wide basis via a successful videoconference education program (McWilliams et al, 2015), but also in real time through advice to treating clinicians phoning the burns unit for acute advice immediately following the burn injury. The importance of ongoing clinician education, real-time communication and state-wide collaboration between non-burn specialist clinicians and the burns team demonstrates the importance of multiple approaches to support optimal patient care. By ensuring patients are washed, debrided and dressed with Acticoat pre-transfer, the patient is protected for wound infection throughout their patient journey. Ongoing education delivered through education sessions, state-wide distributed posters, online self-directed learning packages and pamphlets also reinforced policies and supported the implementation of best practice.

A limitation of the study was that the cost of implementation of the bundle was not assessed. Greater compliance with hand hygiene and strict gowning practices would have increased the amounts of these items used, but it is expected that the resultant reduction in patient infectious complications and potentially avoided increased length of stay would balance out these costs. Another limitation of the study was that by studying a group of interventions together as one bundle, we were unable to isolate whether any of the interventions were more influential than others in reducing HAIs. As a stand-alone paediatric only burns unit, our population and environment are unique to our unit and may be different to the population and environment of other burn units. Another limitation of the study is the small sample size, which highlights the need for a larger study to further this work.

Ethics
Approval from the hospital’s quality improvement committee was obtained (approval number GEKO 5655). There were no potential conflicts of interest.

Conclusion
The prevention of HAIIs is a central role for nurses caring for patients with burn injuries, and all members of the healthcare team must work together to ensure it is successful. The implementation of an IPC bundle within our burn service has resulted in a reduction in HAIIs amongst our paediatric burn inpatients. The importance of policy, education and resources to reinforce and facilitate practice supports this approach to planning an IPC bundle.

**Declarations**
Ethical approval and consent to participate.
Approval from the hospital’s quality improvement committee was obtained (approval number GEKO 5655).

**Consent for publication**
Approval from the hospital’s quality improvement committee was obtained (approval number GEKO 5655) and included intention to publish.

**Acknowledgements**
Natasha Bear, Senior Biostatistician assisted with data analysis.

Appendix 1
<table>
<thead>
<tr>
<th>Routine Care for Burns Patients</th>
<th>Education</th>
<th>Practice</th>
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<tbody>
<tr>
<td><strong>State-wide</strong></td>
<td></td>
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</tr>
<tr>
<td>State-wide Clinical Practice Guidelines for Initial Management of Paediatric Burn Patients</td>
<td>State-wide distribution of burn assessment &amp; management poster</td>
<td>Early first aid, debridement &amp; Acticoat</td>
</tr>
<tr>
<td>Total Care Burns Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Care Burns Unit: Burns Infection Prevention and Control Policy use</td>
<td>In-service and in practice real time education regarding infection prevention and control</td>
<td>Strict single room isolation of all burn patients on admission. Single room isolation only lifted if patient well, wound swabs negative, no signs of infection and all open wounds</td>
</tr>
<tr>
<td>WoundsWest Burns Module Online Self Directed Learning Package</td>
<td>Swab all burn areas: on admission, if any signs of infection, 48 hours pre discharge, dressing for minimum of first 48 hours for all burn patients</td>
<td>Early debridement of all loose skin/blisters, wound swabs and bandage. Acticoat dressing for minimum of first 48 hours for all burn patients</td>
</tr>
<tr>
<td>WoundsWest Burns Module Online Self Directed Learning Package</td>
<td>Early surgical intervention with microbiologically appropriate intravenous antibiotics on induction of general anaesthetic for all patients undergoing surgical debridement in theatre</td>
<td>Early feeding to prevent gut bacterial translocation (&gt;10% TBSA)</td>
</tr>
<tr>
<td>WoundsWest Burns Module Online Self Directed Learning Package</td>
<td>Early adherence to the &quot;5 Moments for hand hygiene&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.: Routine infection prevention and control care

References


Phase 2: Qualitative Data

“Factors influencing the implementation of best practice in paediatric burns management”

McWilliams, T., Twigg, D., Hendricks, J., & Wood, F. Factors influencing the implementation of best practice in paediatric burns management. Draft.

Abstract

Aims and objectives: This study aimed to determine the factors which influence clinician behaviour and compliance with best practice when clinicians provide the initial care for paediatric patients requiring admission to a burns unit after sustaining a burn injury.

Background: Optimal initial care of burn injuries influences morbidity and mortality. Non-burn specialist clinician compliance with best practice is influenced by previously unexplored factors.

Design: General inductive qualitative methods were used to explore factors that influenced clinicians providing acute pre-admission burn care for children in Western Australia.

Methods: Interviews with nineteen clinicians using standardised open-ended questions based on the Gilbert Behaviour Engineering Model were used to collect data.

Results: The main influencing factors identified were the telehealth service which supported practice, whilst IT issues provided challenges to clinicians.

Conclusion: Telehealth services support clinicians to provide burn care; however, IT issues are a major barrier to both best practice and accessing the telehealth service and should be optimised to support clinical care.

Impact statement: What does this paper contribute to the wider global community? This paper provides burn clinicians with an insight into the factors that facilitate optimal care for patients prior to transfer to burn units, as well as the barriers faced by non-burn specialist clinicians when patients initially present for care. Models of care that acknowledge these factors can help facilitate optimal patient care.

Introduction

Burn injury is a leading cause of childhood injury internationally. In Western Australia (WA) children with severe burns are referred and admitted to the state paediatric burn unit for inpatient burn treatment, whilst many patients with minor burns are managed as outpatients or via the State-wide telehealth service. The initial assessment and management of burn injured patients in WA often occurs in local healthcare facilities by clinicians with varying levels of burn management knowledge and experience, mainly emergency department clinicians, remote area nurses or general practitioners. The acute care provided by these clinicians has a significant impact on patient outcomes, and therefore should comply with best practice recommendations.
There are many factors which influence clinician practice when caring for patients following burn injury. In this study, factors influencing frontline clinician compliance with best practice in acute paediatric burn care was explored using the Gilbert Behaviour Engineering Model [BEM] (Gilbert, 2013) as a framework. The importance of this study centres on the unprecedented exploration of factors which influence non-burn specialist clinician practice when providing acute care for burn injured patients. Investigating factors which support or hinder best practice is important to enable burn clinicians to support their non-burn specialist colleagues, lead any necessary changes and advocate for optimal patient care through the translation of knowledge into clinical practice.

Background

The World Health Organisation (WHO) estimates that worldwide each year 180,000 burn-related deaths occur and 11 million people require medical attention following burn injury (WHO, 2018). Between 1983 and 2008, 23,450 people were admitted to WA hospitals following burn injuries, with the highest rate of admission noted in patients aged 0-4 years (Duke, Rea, Semmens & Wood., 2011). Most burn injuries in WA are due to flame or scald, with almost half the children aged 0-4 years admitted due to scald injuries (Duke et al., 2011). During this 25-year time period there were 233 burn-related deaths in WA (Duke et al., 2011). The burden of burn injury to the individual, the community and the healthcare system is significant and therefore optimal care for these patients is vital.

Initial burn care involves accurate and comprehensive assessment, including primary and secondary surveys, assessing burn specific injuries and signs of concomitant injury and/or illness (Emergency Management of Severe Burns Course Book, 2018). Paediatric patients require age and weight specific burn management, with a reduced margin for error compared to adult patients. Seminal work by Jackson (1953) demonstrated the importance of the initial management of burns, suggesting a burn injury can be conceptually divided into three parallel zones: the inner zone of coagulation (cells destroyed), the adjacent zone of stasis (cells injured but can be salvaged) and the outer zone of hyperaemia (cells are inflamed only). The Jackson Burn Model described how multiple factors may influence the destruction or salvage of the zone of stasis, and therefore how the size and depth of a burn injury can be reduced or increased by the care the patient receives (Jackson, 1953). Burn size and depth are important determinants of fluid and surgical management, morbidity, mortality and ultimate scar outcome (Kraft et al., 2012; Wallace, Fear, Crowe, Martin, & Wood, 2017). Research demonstrates that the estimation of burn size in paediatrics is vitally important for care, yet frequently remains inaccurate, with significant variation in clinician assessment, and therefore variations in fluid requirement estimates and fluid given (Giretzlehner et al., 2013; Goverman et al., 2015; Parvizi et al., 2014).

Adequacy of fluid resuscitation is usually assessed through monitoring urine output, therefore fluid resuscitation should also be continuously evaluated and adjusted through close monitoring of patient vital signs and clinical appearance (Gillenwater & Garner, 2017). Studies have found
that burn injured patients are over resuscitated, receiving more fluid than is optimal, which may affect wound depth, contribute to compartment syndromes and respiratory complications (Dries, 2009; Saffle, 2015). Oedema formation following major burn injury is rapid (Rae et al., 2016) with the seminal work of Barrow, Jeschke, and Herndon (2000) demonstrating that delays of greater than two hours in the commencement of fluid resuscitation in paediatric burn injured patients was associated with a higher incidence of sepsis, renal failure, cardiac arrest and mortality. Accurate burn assessment followed by early and appropriate treatment is therefore vital to ensure reduced mortality and improved long-term outcomes (Palmieri, 2016).

The provision of optimal first aid following burns is associated with reduced depth of burn, reduced time to heal, reduced probability of grafting, reduced probability of ICU admission and reduced hospital length of stay (Wood et al., 2016). First aid has been demonstrated as effective within up to three hours from the time of burn injury (McCormack, La Hei, & Martin, 2003). This is further supported by the recent findings into burn cell death in the zone of stasis, which demonstrate that intervention within the first four hours is required to limit the progression of the injury (Lanier et al., 2011). Despite the known benefits of first aid for burns, it is not always administered by clinicians providing initial care, with only 68% of patients included in the Burn Registry of Australia and New Zealand receiving any cooling prior to admission to a burn centre (Wood et al., 2016). The provision of appropriate first aid for patients following burn injury is vital during the initial assessment and management phase.

It is well established that compliance with best practice and management guidelines reduces patient mortality and improves outcomes (Rice, Morris, Tortella, Wheeler, & Christenson, 2012). In addition to evidence in the available literature, WA clinicians also have access to a wide variety of educational resources and programs which teach assessment and management of burn injured patients (McWilliams, Hendricks, Twigg, & Wood, 2015). International reviews of emergency department initial assessment and management of burn injured patients have identified the occurrence of sub-optimal care, particularly in the areas of burn size assessment, first aid, intravenous fluid management, wound management and analgesia (Nguyen & Dung, 2008; Fagenholz, Sheridan, Harris, Pellitier, & Camargo, 2007; Bezuhly, Gomez, & Fish, 2004; Allison, 2002). A 10-year retrospective review of paediatric burn related deaths at Shriners Burn Hospital in Texas, demonstrated that in 71 children who died, sub-optimal initial airway maintenance, fluid resuscitation and/or prevention of burn wound infection were deemed the main contributing factor in 50% of the deaths (Gore et al., 2007). Another U.S. study found that over a two-year period, all patients who died when cared for by non-burn clinicians met the criteria for referral to a burn unit, indicating the need for early transfer for specialist care, which was not provided and resulted in a poor patient outcome (Carter, Neff, & Holmes, 2010). Vercruysse, Ingram, and Feliciano (2011) acknowledged the importance of educating and supporting the emergency department, non-burn specialists who care for these patients through various methods. Although to date, research has not explored the influences which preclude healthcare professionals at the front line from using best practice standards when managing a paediatric burn injured patient.
The Gilbert BEM was used to facilitate the exploration of factors which influence clinician performance and therefore clinical practice (Gilbert, 2013) (Table 1). The model was used to identify and analyse staff perception of performance enhancers and barriers to the use of best practice when providing the initial care for paediatric patients following burn injury (Weinberger, 1998; Ripley, 2003).

<table>
<thead>
<tr>
<th>Environmental Factors</th>
<th>Information</th>
<th>Instrumentation</th>
<th>Motivation</th>
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<tr>
<td></td>
<td>Data</td>
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<tr>
<td>Individual Factors</td>
<td>Knowledge</td>
<td>Capacity</td>
<td>Motives</td>
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Table 1: Gilbert Behaviour Engineering Model (Gilbert, 2013).

The BEM provides a framework which enabled the systematic identification and analysis of factors which build and promote competence, as well as factors which are potential barriers to competence in the provision of initial burn care (Gilbert, 2013; Chevalier, 2003). The BEM categorizes six factors which are necessary for performance: individual factors of knowledge, capacity and motives, plus environmental factors of data, instruments and incentives. These six factors influence a clinician’s performance and together create a system which supports either competence or incompetence (Gilbert, 2013). The BEM has been used to explore performance and behaviour in a variety of settings, including healthcare settings, to explore factors that influence an employee’s performance (Kyle-Needs & Lindbeck, 2011; Chae & Park, 2019). The model allowed researchers to explore and identify a variety of factors which influence patient care (Chae & Park, 2019).

The environmental factors of data, instruments and incentives will now be explained. Data refers to staff having clear guidelines regarding adequate performance and feedback about their performance (Gilbert, 2013). In this study, this includes the availability of initial burn assessment and management guidelines, plus feedback relating to the appropriateness of clinical practice and therefore patient care. Instruments include the tools and resources available to perform the expected work (Gilbert, 2013). In this study, this means the availability of the necessary equipment to provide best practice clinical care. For example, airway equipment, Lund & Browder chart, intravenous fluids and lines, indwelling catheters, Acticoat dressings and the availability of experts for advice.

Incentives include the available monetary and non-monetary incentives as well as performance-based career opportunities (Gilbert, 2013). In this study, local healthcare facility incentives for performance, such as bonuses or ‘employee of the month’ and available promotional opportunities were considered.

Individual factors include knowledge, capacity and motives (Gilbert, 2013). Knowledge refers to an individual’s knowledge and skills as a result of both education and non-training interventions (Gilbert, 2013; Binder, 1998). In this study this means clinician knowledge of best
practice in burn assessment and management and their skill in providing that care. For example, the ability to successfully insert an intravenous cannula into a small child, or the ability to apply an Acticoat dressing correctly.

Capacity refers to the selection of appropriate people and the adaption of appropriate staff whose physical and intellectual abilities, plus personal qualities and social skills enable the work to be performed (Gilbert, 2013; Binder, 1998). In this study this means the appropriate recruitment, selection, rostering and availability of clinicians with approved qualifications and abilities to perform tasks. For example, suitably qualified staff who have completed appropriate training and professional development.

Motive refers to people’s attitudes and preferences regarding the type of work and the work environment, and their willingness to work for the incentives available (Gilbert, 2013; Binder, 1998). In this study, this means the clinician’s attitude and preferences regarding the assessment and management of a child who has sustained a burn injury, and their willingness to participate in that patient’s care.

The factors above reflect possible influences on the provision of best practice in the initial management of paediatric burn injuries. By identifying and analysing the factors which facilitate and provide barriers to optimal performance in the initial management of burn injured patients, future strategies can be targeted to ensure optimal care of this patient group.

Methods

Aim of Study

The aim of this study was to determine the factors that influence clinician behaviour and compliance with best practice when clinicians provide the initial care for paediatric patients requiring admission to a burns unit after sustaining a burn injury. This study therefore explored the factors that influence clinician transfer of knowledge into clinical practice within the context of paediatric burn care in WA.

Research Questions

This study investigated initial paediatric burn management in WA. Specifically, factors influencing compliance with best practice. There were three research questions:

1. What factors influence pre-admission clinician compliance with best practice acute paediatric burn management in WA?
2. What are the environmental factors which influence compliance with best practice acute paediatric burn management in WA?
3. What are the individual factors which influence compliance with best practice acute paediatric burn management in WA?

Research Design
General inductive qualitative methods were used to explore factors that influenced clinicians providing acute pre-admission burn care for children in WA. Inductive coding involves in-depth reading of the qualitative data, creating categories and refining and revising categories to reduce overlap (Thomas, 2006). This approach allows the researcher to identify themes which are most relevant to the aims of the study, and therefore the most important themes in the data (Thomas, 2006). An inductive approach allows in-depth understanding of clinician behaviour and dynamics between clinicians and their operational environment to identify patterns and common themes experienced by participants related to factors which support or provide challenges to their practice. A general inductive approach to the analysis of qualitative data facilitates the generation of summary data, assists in linking research objectives with summary data and establishes a framework to better understand the processes and experiences of the participants (Thomas, 2006).

Participants

Purposive sampling was used to recruit participants. A purposive sample allows the researcher to select participants based on characteristics of a population and the objective of the study, to ensure participants have experience and knowledge of the research topic (Palinkas et al., 2015). Participants were identified by a review of the medical records of all patients transferred and admitted to the total care burns unit or intensive care unit at the participating tertiary hospital following an acute burn injury over a two-year period. Records were examined for documented evidence of the clinician who had provided the initial assessment and/or care prior to admission. Clinicians who were documented in the patient notes as having provided initial assessment and management were approached to participate in the study by the investigator by phone within one month of admission. Those who wished to participate were faxed or emailed (whichever was more convenient for the clinician) an information letter and consent form for completion prior to the interview.

Participants included nurses and doctors who provided acute pre-admission care for paediatric burn injured patients admitted to Princess Margaret Hospital for Children in WA. Nineteen clinicians were interviewed. All care providers who were able to be contacted agreed to be interviewed.

Data Collection

All interviews were conducted via telephone, following the receipt of the consent form by the researcher. The researcher conducting the interviews is the burns clinical nurse consultant (CNC), an experienced nurse with extensive knowledge of burn management in WA and an interest in exploring factors that influence the implementation of best practice in her state. The researcher approached potential participants by phone and participants were therefore aware of the researcher’s role, as well as an outline of the research. The interviewer maintained a calm, neutral position throughout all interviews to ensure participants felt comfortable sharing their experiences of both barriers and supporting factors when caring for burn injured patients. Open-ended questions, based on the BEM, were used to gather information from participants.
All interviews were taped and transcribed verbatim by the researcher, with interviews taking between 9 and 43 minutes, with a mean of 20 minutes. This reflects 115 pages of transcribed interview data.

An advantage of phone interviews was that they enabled clinicians from across WA to be accessed without the need to travel and allowed for confidential conversations regarding care provision with clinicians who are often shift workers (Opdenakker, 2006; Rahman, 2015). A disadvantage of phone interviews was the lack of social cues that may indicate to the interviewer the feelings and attitudes of the interviewee (Opdenakker, 2006; Rahman, 2015). Due to this, it was important that the interviewer developed rapport with the interviewee and maintained a polite neutral position when interviewing clinicians by introducing herself, thanking the participant for their agreement to participate in the study and explaining how the interview would proceed. Participant interviews were continued until data saturation was reached, at which point no new themes emerged (Guest, Bunce, & Johnson, 2006).

**Ethical Considerations**

Ethical considerations centred on confidentiality, anonymity and informed consent. Written permission to conduct the study was obtained from the university’s ethics committee and the hospital’s ethics committee prior to commencement (ethical approval number 2032EP). All data obtained during the interview were de-identified. Data will be retained for five years from publication and stored in a secure, password protected electronic file. The study complied with the National Health and Medical Research Council guidelines (2018).

**Data Analysis**

Inductive coding, as outlined by Thomas’ (2006) general inductive approach, was used to analyse data by in depth reading of the interviews, creating categories, refining and revising of categories to reduce overlap and highlight the most relevant and important themes addressing the aims of the study. By analysing the data themes emerged that outlined the factors that influenced the transfer of clinician knowledge of burn care into their practice. This approach reflects the theory that individual and environmental factors influence clinician practice and the use of the Gilbert BEM to guide data collection, namely data, instruments, incentives, knowledge, capacity and motives (Gilbert, 2013). The questions used to interview participants were based on these topics and by reading and coding the responses of participants within each topic, categories emerged from the data through the identification of similar experiences.

**Findings**

All nineteen participants were registered practicing clinicians working in WA who provided the initial assessment and management of new paediatric burn injured patients transferred and
admitted to the state paediatric burns unit. Ten participants were nurses and nine were doctors, with between one and 29 years of clinical experience.

**Environmental Factors**

The first component of the BEM under environmental factors was data. Participants were asked to describe their access to guidelines, policies or protocols for the initial assessment and management of paediatric burn injured patients. They responded that guidelines and policies were accessed in a few ways. Many centres printed copies to allow immediate access to posters, booklets, printed copies of guidelines. Some participants also accessed these guidelines online, in addition to supplementing these guidelines by accessing real-time advice from burns clinicians:

- **We know that there’s PMH (hospital) guidelines and we have downloaded them so we have a file in the emergency department and it’s called the referral file.** (verbatim, Participant 17)
- **There’s a poster that I’ve been familiarised with which is in the surgical registrar room which I can familiarise myself with and refer to if need be.** (verbatim, Participant 5)
- **I would prefer to have it as it is now in a hard copy and read it and I’ll have this bound up as a resource manual left in the clinic handy at the desk ... I’ve downloaded them and printed them.** (verbatim, Participant 2)
- **There’s a poster up in the doctor’s room ... from you guys ... That’s the one I’ve gone through ... very useful.** (verbatim, Participant 14)

Some participants reported that the printing of policies was a “work around” to overcome issues some participants experienced accessing guidelines and policies due to poor internet access:

- **I have trouble getting access to policies ... and guidelines. I don’t get the internet, the health intranet ... I can get on at times though. When I do, I read policies like mad ... I can’t get on everyday so I print some and if someone walks in the door if I want to find the guidelines to treat that person, I can’t do it via the internet all the time, so with ___ the other day I actually used the Queensland RFDS manual. It’s the security on the intranet ... it will take about two hours to actually get through the security and then it’s about a ten second latency between me typing and the keys turning up.** (verbatim, Participant 16)
- **We can get online, it’s just that sometimes our computers are very slow and can’t be relied on to get anywhere very quickly. That’s why we have a hard copy in the department ... make sure that all our referral and management protocols are up-to-date.** (verbatim, Participant 17)
- **Our computers are so slow here it would take so much longer to actually sit down at the computer away from the ED area to look up any information, ..... our web sites are slow and complicated . It’s much easier to face-to-face if you want something in an emergency.** (verbatim, Participant 6)
Three clinicians reported receiving constructive feedback both in real-time and retrospectively regarding their management:

- When I phoned up they were quite happy with the way that they had received her and I did, I got the information that, yes, silver would have been better and is the protocol and but essentially they were happy. (verbatim, Participant 2)

- Yes, sometimes we do when the CNCs contact us or email us back or contact us during the week, we normally get feedback. Yeah, they tell us if we’ve done a good job or what we should do different next time. Yes, I think it’s very useful because I was saying that I haven’t really achieved much for burns so just over the, you know, last six months or so getting that feedback gives you a little bit of confidence so that you can initiate, you know, treatment earlier without relying, you know, waiting on the phone calls or the emails coming back especially over the weekend you feel like you can dress it confidently and wait until like Monday when you get your feedback or something which is good. (verbatim, Participant 9)

- Not so much retrospect feedback, but, you know, moment to moment how best to manage the kid. So no, it wasn’t so much a case of we sort of did things and then sort of received feedback afterwards. It was the case it was just being on the phone direct from an early stage saying, well what would you like us to do, they’re going to be coming your way? It was more real-time feedback, yeah, rather than retrospectively being called the next day. (verbatim, Participant 10)

Three participants reported not receiving feedback regarding their care of paediatric burn injured patients transferred for admission to the burn unit and felt this would have been helpful:

- It would be good because, because of two reason I would say, (the feedback) itself is a booster, for our staff. There is someone to watch you and that there is someone you know to who you are responsible or answerable to... particularly as a health worker or healthcare professional. At the same time for the family (it) would be beneficial. That’s what I reckon. Yes, I think it would be beneficial for both. (verbatim, Participant 3)

- Yes, I think it would be nice to know that we’re doing it right or if there is anything we could improve.on. (verbatim, Participant 4)

- I think it would be useful as well, or even just to know. Trouble is that we never really found out how our patients get on. We send them down but that’s kind of the end of it, we never know the outcome ....with you guys. So maybe some kind of an amalgamation of a bit of feedback with, like this is what happened, would be useful. (verbatim, Participant 7)

**Resources**

The use of the telehealth service to share photos in order to access burns clinicians who can assess and direct care was reported as a useful tool in providing care for patients:
• You could assess the actual size ... then after discussion ... making sure we could accurately assess the blistered area. (verbatim, Participant 13)
• It’s essential, very very useful ... prevented a child being intubated. (verbatim, Participant 13)
• We have a low threshold of taking a photo and sending it across ... calling them five minutes later and say this is what it looks like ... what do you think? (verbatim, Participant 14)
• We do initial first aid if we need to and then we take photos and we make a referral by the telehealth west down at XXX and then we call to follow up and get advice, even some minor burns. I think most nurses will still call and get some advice. (verbatim, Participant 9)

IT and computer access were raised by some participants as a challenge when accessing burns advice via the telehealth service:

• Really a lack of IT support to actually connect to the city and not enough access to hospitals in a reasonable time frame. (verbatim, Participant 1)
• So I get worse IT than most of Kimberley. So it just seems to be an area here that’s, I don’t know what it is, but they’ve come out and they’ve worked at it they’ve set it up and then I’ve tried to use it and it just, it’s difficult to use. (verbatim, Participant 16)
• These computers are so slow it’s unbelievable. I’ve got my phone in my pocket today because I just couldn’t get anywhere fast and I’m showing people things on my phone because I can’t use the computer ... these last couple of days it’s been back, you know, just loading things up is taking ages. I’ve got three computers running. I run out of patience and I go and get me phone, you know. So yes, IT is a barrier. (verbatim, Participant 17)

Incentives

External organisation incentives were not available to any of the participants, but internal incentives—to provide optimal care for patients—were reported:

• Just good heart and happiness, feedback I guess, but nothing apart from that. (verbatim, Participant 14)
• That’s why I’m here I guess, I want to provide optimum care ... the only reason I’m here is to provide the best care that I can provide with the skills and scope of practice I’ve got. Yeah, so that the incentive is self-drive. (verbatim, Participant 16)
• In practice, there are no actual incentives other than our own personal incentives to keep up-to-date and do our best. (verbatim, Participant 6)

Appreciation from supervisors or families was also identified as an incentive for providing optimal care:
• At the time our NUM would say you did well with that. (verbatim, Participant 6)
• The family usually will say thank you, you know that was really good and appreciate what you’ve done for them, the community are very, very appreciative of what we do. (verbatim, Participant 6)

Individual Factors

Knowledge

A number of participants identified courses or education sessions as a source of their burns assessment and management knowledge:

• We’re really encouraged to go to as many courses as we can to cover any sort of trauma, I also went to a trauma course … [I’ve] been sent to sessions of training for burns. (verbatim, Participant 4)
• Going to wound and burn study days and looking at the information that’s been there on first aid burns and then just consulting with colleagues and just learning as you see them when they come through. (verbatim, Participant 6)
• I have been to some presentations. I have in the last few years attended a burns course. (verbatim, Participant 17)

The use of real-time advice and feedback through the state burns telehealth service was also identified by a number of participants as a way they increased their knowledge of burn care:

• New management of burns comes from phoning PMH. (verbatim, Participant 8)
• On the job, so looking after patients with burns and when some of my senior nurses or nurses that are more qualified with burns, education from them. I’ve done a little bit of reading with just research articles and things that I’ve found along the way but mainly it’s been, yeah, looking after patients and speaking to you guys. (verbatim, Participant 9)
• Through individual study, through seeing patients and then feedback. (verbatim, Participant 12)
• We ring if we need to and we’re making sure that we’re doing what we need to do correctly and, also, we’re looking at your resources and making sure that we are up to date. (verbatim, Participant 17)

Two participants only reported obtaining their knowledge through written information. This suggested that, although useful, the majority of participants found that education through in-service sessions, courses and real-time advice was more effective in increasing their knowledge:

• Mix of text books and, I mean, I have looked up the guidelines. (verbatim, Participant 10)
• Through guidelines of work and by seeing patients. (verbatim, Participant 11)
Capacity

All participants (nurses and doctors) were clinicians in roles suitable for treating burn injured patients. Only nurses and doctors with the appropriate qualifications can be registered and hired in Australia. Their experience ranged from one to 29 years.

Motives

Some clinicians highlighted their role in impacting the outcome of patients as a motivator to provide excellent care:

- *We have the ability to potentially change the outcome of the burn.* (verbatim, Participant 15)
- *We can still make a difference just by a phone call.* (verbatim, Participant 15)
- *I feel responsible for the outcome. I really do, you know, I feel a huge responsibility around that and I know you know I’m fully aware that the, you know, first aid management of a burn like this is really central to optimising the outcome.* (verbatim, Participant 2)
- *The incentive is patient advocacy to do the best for the patient and that’s the reason why, you know, I enjoy my job. That’s what I want, I want the best outcome for the patient and that’s all the incentive I need to ensure that the patient gets the best outcome as much of and I do my best for the patient.* (verbatim, Participant 5)

A number of clinicians reported a fear of burn care, often linked to knowledge and experience, which improved with experience and feedback:

- *I feel better than before I was very very worried and scared about burns but now I’m a bit better. The difference was not being sure, not knowing what you do, not knowing what you need to do was a scary factor, or like a fear factor, but now you get positive feedback you did this well kind of thing. I think it has improved things.* (verbatim, Participant 14)

Some clinicians were reflective of their own practice following their initial care of the burn injured patient, using the experience to explore further professional development:

- *I know I need to go back and look at a more comprehensive policy than what I used ... I will expand my knowledge on caring for burns ... you only know what you know, you don’t know what you don’t know.* (verbatim, Participant 16)

Discussion

This study aimed to address a gap in the literature by investigating the factors that influence best practice in paediatric burn care, as identified by the clinicians who provide this care. Using a qualitative approach to assess the factors influencing the implementation of best practice in
the initial assessment and management of paediatric patients following burn injuries is vital to improving patient care and requires a sound theoretical framework. The use of the BEM provided structure for this study to comprehensively explore both individual and environmental factors that influence clinician compliance with best practice.

The study found that a variety of both individual and environmental factors supported and provided barriers to the implementation of best practice in burn care in WA. The main influencing factors which emerged through the data were the use of the integrated burns telehealth service (which provides both real-time patient advice and ongoing videoconference education for clinicians), burns education, an internal drive by clinicians to provide optimal care for patients and struggles with IT issues. The main individual factors were therefore knowledge gained through a variety of burn education programs, such as monthly burns education videoconferences and courses, and motivation amongst clinicians to provide the best care they can for patients. The main environmental factors were the real-time support, advice and education obtained through the telehealth program and the barriers presented by IT issues often overcome with the use of paper-based printed information and phoning for advice.

<table>
<thead>
<tr>
<th>Environmental Factors</th>
<th>Data</th>
<th>Information</th>
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<th>Resources</th>
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<tr>
<td></td>
<td>Printing/accessing online guidelines to overcome IT issues</td>
<td>Telehealth service photo review &amp; phone advice useful</td>
<td>Internal incentive present to provide optimal patient care</td>
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<td></td>
<td>Provision of real-time advice (telehealth service) assisted</td>
<td>IT issues provided challenges for clinicians</td>
<td>Supervisor &amp; family appreciation noted</td>
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<td></td>
<td>IT issues with accessing policies (printed as workaround)</td>
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<td>Some feedback received by clinicians</td>
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<td>Further feedback would be useful</td>
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<thead>
<tr>
<th>Individual Factors</th>
<th>Knowledge</th>
<th>Resources</th>
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<th>Motives</th>
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<tr>
<td></td>
<td>Courses or education sessions attended by some clinicians</td>
<td>Telehealth service photo review &amp; phone advice useful</td>
<td>Internal incentive present to provide optimal patient care</td>
<td>Motivated by impacting outcome of patients</td>
</tr>
<tr>
<td></td>
<td>Real-time advice &amp; feedback via telehealth service beneficial</td>
<td>IT issues provided challenges for clinicians</td>
<td>Supervisor &amp; family appreciation noted</td>
<td>Some fear of burn care</td>
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Table 2: Gilbert Behaviour Engineering Model Results (Gilbert, 2013)

Clinicians in this study identified a number of factors that facilitated or impeded the provision of best practice during the initial care of paediatric burn injured patients (Table 2). The challenge of integrating best practice into clinical practice is universal. Gagliardi and Dobrow (2016) demonstrated that clinicians, managers and researchers identify multiple individual, professional and organisational challenges to the implementation of best practice. Gagliardi et al. (2016) also demonstrated that integrated knowledge translation in health remains a challenge, with no clear strategies for improvement. Some studies have suggested possible factors which can contribute to sub-optimal care include lack of treatment policies or knowledge, as well as solutions such as education and closer collaboration with burn centres (Fagenholz et al., 2007; Rea & Wood, 2005; Bezuhly et al., 2004; Allison, 2002). Although lack of knowledge being addressed by education may assist in improving knowledge, it does not guarantee the knowledge is transferred into practice. Although these studies highlight poor compliance of initial burn care with best practice within a defined population, they were not
designed to actually investigate the factors which are impacting on this compliance; therefore, any statements regarding rationale for clinical practice or solutions to sub-optimal practice, are not founded on evidence. A significant gap in the current literature exists regarding why the initial assessment and management of burns by non-burn clinicians does not always reflect best practice.

The provision of external incentives was not identified by any clinician, instead, many identified a personal incentive to provide optimal care for patients. This was again reflected when exploring motives, whereby clinicians were internally motivated to provide the best care possible. The lack of external incentives was a universal theme and may represent a potential area for improvement in the future.

IT issues were identified as barriers to the provision of best practice in paediatric burn care. Issues included not having access to computers where patient care was provided and issues with internet access, inhibiting clinician access to policies and guidelines and slowing access to photos emailed to burns clinicians for advice. To overcome these issues staff needed to run between clinical areas and where the computers were placed while providing patient care and were printing off guidelines in anticipation of ongoing IT issues to allow immediate access if a patient attended in the future. IT issues, as these clinicians experienced, especially internet speed and access, is a recognised problem in some rural and remote areas of Australia with internet and broadband connectivity identified as a major issue in rural and remote areas of Australia Park (2017).

The telehealth service which provides acute and ongoing advice by phone with the support of emailed clinical photographs relies upon clinicians having access to computers and internet to allow them to send clinical photos and access optimal phone advice from burns clinicians, a factor clearly supporting the implementation of best practice. Unfortunately, the factor identified as the main support for the implementation of best practice is intrinsically linked and reliant upon IT, which has been identified as the biggest barrier to its implementation for our patients. This situation demonstrates the difficult position clinicians find themselves in, when their interview data demonstrate a clear internal motivation to provide the best care and readily available specialist advice, but IT resources may hinder their access to this advice in a timely manner. A number of clinicians identified effective workarounds to this challenge, by printing out policies or using posters for fast access. This finding helps identify future strategies which will assist clinicians, such as the use of paper-based resources that reflect online content, for those living in areas of poor internet reception due to geographical remoteness. Whilst paper based resources are not ideal due to difficulties with updates, in areas where internet is not available at all times this may be a possible solution for these very remote clinicians.

Clinicians perceived the telehealth service as useful and supportive, providing real-time advice through the use of photo reviews and phone advice when patients with acute burn injuries attended their health service for assessment and treatment. This provided clinicians with relevant clinical advice and feedback on the accuracy of their assessment and appropriateness of their management in real-time which increased their knowledge of burn care. The perceived
provision of feedback to clinicians was mixed. Some reported receiving no feedback, while others received it in real-time during consultation with the acute burns telehealth service or retrospectively following transfer of the patient. Clinicians felt this was valuable. Providing formal feedback is a potential area for improvement. This will improve compliance with best practice by ensuring accountability and further enhance collaboration between the burns team and non-burn specialist clinicians who provide the initial care for patients.

Education provided by the telehealth service was also a source of knowledge. This demonstrated that providing ongoing clinical education, accessible by videoconference, together with the provision of real-time advice and support when clinicians are applying their knowledge to patient care, supports best practice. Many clinicians reported that a variety of courses and the provision of real-time advice through the telehealth service increased their knowledge of burn care. This finding shows the importance of ongoing provision of burns education by burns teams through formal educational events to provide clinicians with cumulative information on the assessment and management of burn injured patients. Education is important for theoretical knowledge, however it does not always translate into patient care. The provision of real-time education, guidance and feedback within the context of an individual patient’s care is therefore vital for these clinicians and the patients they treat as it reinforces the theoretical knowledge they gain though formal education but contextualises it for each individual patient. This feedback is reflective of the expanding use of telehealth in WA, with non-burn specialist clinicians driving the demand for the burns telehealth service by referring increasing numbers of patients each year in order to receive specialist advice (McWilliams et al., 2016).

Based on these findings, the continuation of the integrated burns telehealth service, both for clinical advice and ongoing education, is vital for our patients; however, IT resources need to improve to enhance clinician access to this advice and information. Planning of clinical areas needs to consider how IT and telehealth are used for providing clinical care, especially in emergency/acute care situations and how these could be integrated into clinical areas. Improved internet access and speed for rural clinicians is also vital to enable them to access the most up-to-date policies and guidelines without the need to print copies that may have been superseded.

**Conclusion**

Clinicians who provide the initial care for burn injured patients in WA identified issues which both supported and impeded their care provision. The use of real-time advice by experienced burns clinicians through the state-wide burns telehealth service was a supporting factor, as was a personal clinician drive to provide optimal care. IT issues were identified as barriers, especially in rural areas, which were worked around through the use of paper-based resources. This information can drive future strategies to overcome barriers and support clinicians to ensure optimal patient care in the future.
Relevance to clinical practice: Telehealth services support clinicians when providing burn care and internal motivation drives clinicians to provide the best care they can. However, IT issues pose an important barrier to both best practice and access to the telehealth service and should be optimised to support clinical care.

References


Gagliardi, A.R., & Dobrow, M.J. (2016) Identifying the conditions needed for integrated knowledge translation (IKT) in health care organisations: qualitative interviews with researchers and research users. BMC Health Services Research, 16, 256.


Appendix

Interview Schedule

This interview will focus on factors which you perceive influence your recent care of a paediatric burn patient admitted to PMH over the past week.

Data

Could you describe your access to guidelines, policies or protocols for the initial assessment and management of paediatric burn patients?
Could you describe what these guidelines, policies or protocols are and where or how you access them?
Could you discuss whether you receive feedback regarding your care of burn patients?
If yes: How do you receive this feedback and from whom?

Knowledge

How have you obtained your knowledge of paediatric burn assessment and management?
What do you know about best practice initial management of paediatric burn patients?
Could you describe what skills you have developed with regard to the initial management of paediatric burn patients?

Instruments

When caring for this patient, could you please discuss what equipment you required, and whether you felt you had all the necessary equipment available to assess and manage this child’s injury? This can include facilities to apply cool running water while keeping the patient warm, airway equipment, Lund & Browder chart, intravenous fluids and lines, indwelling catheters or Acticoat dressings.
If no: What equipment did you not have access to? Do you know why you were unable to access it?

Capacity

Could you describe your current role and the qualifications you have which enable you to fulfil this role?

Incentives

In your hospital or ward/practice, what external or organisational incentives are there for providing optimal patient care?

Motives

How do you feel about providing the initial care for children with a burn injury?
CONSENT FORM – CONSENT TO PARTICIPATE IN RESEARCH

Project Title: Best practice in acute paediatric burn management: compliance and influencing factors in Western Australia

Chief Investigator.
Tania McWilliams. Edith Cowan University School of Nursing and Midwifery and Princess Margaret Hospital for Children. Telephone Number: 9340 8257

Research Supervisors.
Joyce Hendricks. Edith Cowan University, School of Nursing and Midwifery. Telephone Number: 6304 3511.
Di Twigg. Edith Cowan University. School of Nursing and Midwifery. Telephone Number 134 328.
Fiona Wood. Princess Margaret Hospital for Children. Telephone Number 9340 8222.

I ___________________________ hereby give consent to be interviewed by
(first name)              (surname)
telephone or videoconference by the chief investigator of this study (Tania McWilliams) for the purpose of obtaining information as outlined in the accompanying information letter.

I also acknowledge that I:

- Have been provided with a copy of an information letter explaining the research study cited above.
- Have read and understood the information provided.
- Have been given the opportunity to ask questions and have had any questions answered to my satisfaction.
- Am aware that if I have any additional questions I can contact the research team.
- Understand that participation in the research project will involve an interview with the chief investigator of this study discussing my recent care of a paediatric burn patient and the various decisions made related to that care.
- Understand that the interview will be recorded for the purpose of data collection for this research project only and that the recording will be destroyed after five years from publication of the results.
- Understand that the information provided will be kept confidential, and that my identity will not be disclosed without consent.
- Understand that the information provided will only be used for the purposes of this research project, and understands how the information is to be used.
- Understand that I am free to withdraw from further participation at any time, without explanation or penalty.
- Freely agree to participate in the project.
- Understand that if I disclose any information regarding clinician or institution practice which may potentially harm patients, the researcher must disclose this information in writing to the Director of the WA Burn Service.

Signed: ___________________________ Date: ________________________
INFORMATION LETTER

Project Title: Best practice in acute paediatric burn management: compliance and influencing factors in Western Australia

Chief Investigator.
Tania McWilliams. Edith Cowan University School of Nursing and Midwifery.
Telephone Number: 9340 8257

Research Supervisors.
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Telephone Number: 6304 3511.
Di Twigg. Edith Cowan University. School of Nursing and Midwifery.
Telephone Number 134 328.
Fiona Wood. Princess Margaret Hospital for Children. Telephone Number 9340 8222.

This research project aims to evaluate acute pre-admission paediatric burn care in Western Australia. It also aims to explore the various factors which influence the clinical decisions made by multidisciplinary clinicians when providing the initial assessment and treatment of paediatric burn patients who require transfer and admission to the PMH Total Care Burns Unit.

Clinicians from throughout Western Australia who have provided the initial assessment and treatment for paediatric burn patients requiring transfer and admission to the PMH Total Care Burns Unit will be approached as potential participants in the research. Those clinicians will to participate will be interviewed via telephone (as per the participant’s preference) using a semi-structured interview format. These interviews will be taped in order to facilitate transcribing of interview data.

Interview data will remain anonymous and confidentiality will be maintained for all participants. Information obtained though the collection of interview data will be analysed and used to identify themes of factors influencing clinician practice.

Participants can withdraw from the study at any time.

Thank you for considering participation in this study.

Tania McWilliams
PhD Candidate
School of Nursing and Midwifery
Edith Cowan University
Chapter overview

The results of the quantitative phase demonstrated the effectiveness of implemented strategies. The retrospective audit of the state-wide burns telehealth program demonstrated its effectiveness in changing clinical practice by providing advice. Significant numbers of inpatient bed days (4,905 days), unnecessary patient transfers (364) and follow up review transfers (1,763), over a 7-year period were avoided. This resulted in a savings of AUD 1.89 million. The integration of a state-wide education component to the existing telehealth program was shown to be effective in transferring knowledge to non-burn specialist clinicians, resulting in statistically significant increases in clinician knowledge in most areas of acute burn care. Building on the state-wide telehealth service, an infection control bundle was implemented which improved the care provided to burn injured patients by reducing healthcare associated burn wound infections and sepsis to zero. The infection control bundle was not as effective for upper respiratory or urinary tract infections, reflecting the complexity of patient care. An exploration of all factors influencing clinician transfer of knowledge into burn practice in WA through a qualitative study using interviews demonstrated that IT issues presented challenges, but were overcome by the use of real-time advice through the state-wide telehealth service. Overall, the study demonstrated that the strategies implemented were effective and that telehealth is a major factor in improving the quality of burn care, although IT issues remain a potential barrier.
CHAPTER 5: DISCUSSION AND GENERAL CONCLUSION

Introduction

Chapter 5 presents an overall discussion and the conclusion of the thesis, addresses limitations of this study and implications of the findings for future research, education, policy and practice. The integrated state-wide clinical and educational telehealth service has improved patient care through the provision of real-time clinical advice and ongoing clinician education. By focusing on the state-wide prevention of infections in burn injured patients, from the initial point of care and throughout the patient journey, the infection control bundle has been effective in reducing the infection rate for paediatric patients following burn injury in WA. The substantial influence of telehealth on clinical practice is highlighted throughout the study and its importance to the burns model of care in WA is demonstrated. The potential impact of IT issues on clinicians accessing information and burns advice is therefore concerning and finding ways to overcome this is important for future practice and research.

Discussion

Burn injuries affect millions of people each year internationally. Many of these patients will receive their initial care in a variety of clinical settings from non-burn specialist clinicians. Knowledge of factors which influence the practice of these clinicians is vital, as research demonstrates the care provided in this acute phase significantly impacts patient morbidity and mortality (Khorasani & Mansouri, 2010; Kim, Martin, & Holland, 2012; Naumeri, Ahmad, Malik, & Sarwar, 2018). Despite the importance of this initial care, research into factors influencing acute burn care is currently lacking. The purpose of this study was to close this gap in knowledge by exploring the factors that influence burn care in WA. The study achieved this by answering three overall research questions:

• How effective was the state-wide telehealth education program in transferring knowledge of best clinical practice?
• How effective was the state-wide infection control bundle in changing practice related to the use of best practice?
• What factors influence frontline clinician compliance with best practice in acute paediatric burn management in WA?

The new knowledge generated is significant. The identification of factors that influence the transfer of clinician knowledge into clinical practice when treating burn injured patients, obtained through the uptake of integrated state-wide programs, is critical. This knowledge has the power to guide effective strategies to facilitate best practice and overcome challenges both now and in the future.
<table>
<thead>
<tr>
<th>Overall Study Research Questions</th>
<th>Individual Project Research Questions</th>
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<tbody>
<tr>
<td>Phase One</td>
<td>How effective were the state-wide telehealth clinical and education programs in transferring knowledge of best clinical practice? Can clinical advice delivered via a state-wide burns telehealth program reduce unnecessary patient transfers and inpatient bed days over an 8-year period (2005–2013)? Does clinical advice delivered via a state-wide burns telehealth program result in cost savings? What are the learning needs of multidisciplinary non-burn specialist clinicians in WA regarding the assessment and management of paediatric burn injured patients? Does the implementation of a state-wide education program delivered via videoconference increase clinician knowledge of burns assessment and management? How effective was the state-wide telehealth program infection control bundles in changing practice related the use of best practice? Does the implementation of a state-wide infection control bundle reduce healthcare associated infections in paediatric burn injured patients in WA?</td>
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<tr>
<td>Phase Two</td>
<td>What factors influence frontline clinician compliance with best practice acute paediatric burn management in WA? What factors influence pre-admission clinician compliance with best practice acute paediatric burn management in WA? What are the environmental factors which influence compliance with best practice acute paediatric burn management in WA? What are the individual factors which influence compliance with best practice acute paediatric burn management in WA?</td>
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Table 5. Study Phases and research questions

Using the Gilbert BEM and an explanatory sequential mixed methods approach, a framework for implementing and evaluating strategies to improve burn care and explore influencing factors was developed. Phase 1 used quantitative data and initially focused on the evaluation of the provision of state-wide clinical advice for non-burn specialist clinicians through a burns telehealth program. This strategy targeted information factors of the BEM, with the burns team providing non-burn specialist clinicians with real-time clinical advice and feedback on their practice. The provision of clinical advice to support and guide non-burn specialist clinicians providing care for burn injured patients is important. As noted in the Introduction, burns are a leading cause of injury worldwide (WHO, 2018), and the initial care for these injuries in WA is provided mainly by non-burn specialist clinicians (Rea et al., 2005).

A recent review of burns emergency care revealed that burn size is frequently over or underestimated (relative error of 75 – 3500%), 28 to 53% of endotracheal intubations were unnecessary, patients were commonly over fluid resuscitated, wound care was at times inappropriate, hypothermia was an issue and analgesia was often inadequate (Harshman et al., 2019). The provision of clinical advice for this service is based on clinical photos and phone calls for the review of acute burn injured patients and wounds, with videoconferencing used for the review of patient scars. These are common methods for reviewing burn injuries at the acute and rehabilitative stages of their treatment within a telehealth service (Hoseini, Ayatollahi, & Salehi, 2016). The use of photos and phone calls to review burn injured patients remotely when they present for initial care is important for the accurate assessment of injuries. It has long been acknowledged that due to the visual nature of burn injuries, the use of telehealth to assist in the assessment and provision of advice for non-burn specialist clinicians is accurate and can prevent patient injury severity being under or overestimated (Saffle, Edelman, Theurer, Morris, & Cochran, 2009). Over estimation of burn size is common amongst non-burn specialist clinicians, which can lead to over resuscitation of the patient, and the unnecessary
transfer of patients (Reiband, Lundin, Alsbjorn, Sorenson, & Rasmussen, 2014; Swords, Hadley, Swett, & Pranikoff, 2015) who could be safely treated closer to home with telehealth support. The combined use of video images and phone discussions to enable burn clinicians to assess a patient and provide advice, results in significant improvements in the accuracy of fluid resuscitation and mode of transfer (Wibbenmeyer et al., 2016). In WA the provision of such advice for the acute assessment and management of paediatric burn injuries using photos and phone calls through a state-wide telehealth program expanded over time as a result of clinician demand.

This study demonstrated that clinical practice throughout WA changed due to this provision of real time burns advice, as many centres were able to treat smaller burn injuries locally with specialist burns team support and unnecessary transfers were prevented. As a result the service resulted in the avoidance of 364 acute and 1,763 follow-up unnecessary transfers of patients who could be treated closer to home with ongoing telehealth support over a 7-year period. Such findings are applicable to many acute emergency presentations utilising telehealth services (Natafji et al., 2018), but are especially important to WA due to its vast geographical size. Underestimation of burn injury severity by non-burn specialist clinicians can result in delays in appropriate management and transfer, which can increase morbidity and mortality (Aggarwal et al., 2019). In addition to avoiding unnecessary transfers, anecdotally, it is known that the service also prevented unnecessary delays of 80 transfers through the provision of immediate advice regarding management for all patients requiring transfer and admission, including those in need of immediate transfer. This is important as telehealth advice ensures patients are not transferred unnecessarily, but also those patients who require transfer are transferred immediately, with the appropriate treatment in place.

The telehealth service also reduced the inpatient length of stay for those requiring admission, as follow-up via the telehealth service was available. This avoided 4,905 inpatient days over a 7-year period. The telehealth service resulted in bed days saved owing to avoided unnecessary transfers and reduced length of stay; however, the question remained: could the provision of optimal initial care itself also be playing a role in changing the inpatient length of stay by preventing complications and therefore reducing morbidity and mortality? This is important to consider, especially for those patients injured in rural or remote areas, as the initial care by non-burn specialist clinicians has an impact on outcomes. The large state-wide catchment area for the service results in some patients receiving initial treatment thousands of kilometres from the state paediatric burn unit. These patients also face long transfer times due to vast distances and the potential for transfer delays. Thus, it is imperative that clinicians providing care for patients, especially in rural and remote areas, are supported and educated on optimal burns management.

To improve the clinician support provided, the next study of Phase 1 expanded the existing clinical telehealth program by integrating a state-wide education program by videoconference. Following a state-wide learning needs analysis, a state-wide burns education program was developed. This program delivered ongoing education for non-burn specialist clinicians state-wide, ensuring those who provide care for burn injured patients in WA had unlimited access to
both real-time clinical advice and ongoing burns education by videoconference each month. The study again focused on information factors of the BEM and an evaluation of the program demonstrated that attendance at the education sessions was effective in increasing knowledge of the attending clinicians, with statistically significant increases in knowledge noted in most areas of acute burn care following attendance at the program. From the above two strategies it was demonstrated that non-burn specialist clinicians had access to both ongoing education and real-time advice which were effective in increasing clinician knowledge and preventing unnecessary acute and follow-up patient transfers, as noted above. This combination of both ongoing education and real-time education and feedback for clinicians caring for burns patients is vital. Education and subsequent knowledge alone does not always result in the implementation of best practice. The provision of ongoing education, plus real-time specialist feedback and individualised real-time education does assist the novice in developing further knowledge, experience and skills which provide improved care for patients and implementation of best practice. This mirrors the findings of others, such as Green et al.’s (2005) PRECEDE model, which found that health behaviour change needs more than education; policy, reminders and feedback are also needed to support and reinforce the use of gained knowledge. Building on the existing telehealth clinical advice and education programs, the burns team in collaboration with the infection control team explored whether we could prevent one of the most significant complications for patients following burn injury starting from the point of initial care: infection.

Integrating clinical advice and ongoing formal education into the burns telehealth service was a central strategy within the subsequent state-wide burns infection control bundle which was developed in 2012 and implemented in 2013. Using the BEM framework, multiple factors influencing care were targeted to reduce healthcare associated infections in burn injured patients. This strategy was unique amongst infection control bundles. Instead of commencing on arrival at an inpatient burn unit, infection prevention strategies commenced from the point of initial presentation for care. For this reason, the bundle ensured best practice along the entire patient journey from emergency assessment, stabilisation and transfer, and throughout burn unit inpatient admission. This study demonstrated that by implementing and integrating state-wide strategies into an infection control bundle, knowledge obtained by clinicians is transferred into clinical practice and reflected in improvements in patient care. Statistically significant improvements in burn wound infection rates and the reduction of sepsis and pneumonia to zero were demonstrated as a result of the bundle. Unfortunately, however, not all healthcare associated infections were reduced to zero. One upper respiratory tract infection and three urinary tract infections occurred following implementation of the bundle. Of the three patients who developed urinary tract infections, two had indwelling catheters inserted for urine output monitoring due to the size of their burn. A recent study demonstrated that changes in the urinary bacterial microbiome and innate immune response following major burn injury may make adult burn patients more susceptible to urinary tract infections (Plichta et al., 2017), something which may also be applicable in paediatrics and cannot be prevented with an infection control bundle. Barbadoro et al. (2015) demonstrated that the settings in which urinary catheters are inserted also play a role in the development of urinary tract infections. Carter, Pallin, Mandel, Sinnette, and Schuur (2016) found that in three emergency departments included in their study, urinary
catheters were inserted without compliance with aseptic technique, or by staff who were untrained. When required for paediatric burns in WA, urinary catheters are usually inserted in emergency departments or remote clinics, with a distressed child and parent, which may also play a role in the development of subsequent urinary tract infections. Barbadoro et al. (2015) also demonstrated that prolonged use of urinary catheters, more than four days is another risk factor for urinary tract infections (Barbadoro et al., 2015). Patients with burn injuries severe enough for them to require indwelling catheters often need these in situ for a number of days. The prolonged use potentially increases the risk or urinary tract infection. This again points to the fact that patient care is complex and multi-factorial in nature. Although these strategies aimed to address many of the factors known to influence care, only through further enquiry could we learn which factors, from the perspective of the clinician providing care, are actually involved.

In order to explore and explain the factors that influence clinician transfer of knowledge into practice, Phase 2 used a qualitative approach, interviewing non-burn specialist clinicians who provided initial care for patients with burn injuries requiring transfer and admission to the state paediatric burns unit. The BEM again provided a framework, this time for the comprehensive assessment of the factors influencing the implementation of best practice in WA. A literature review to investigate the factors influencing the implementation of best practice in initial burn care failed to find any relevant literature from other burn units. Broadening the review identified studies that explored factors influencing the transfer of knowledge into clinical practice in a variety of health services. The review identified five main themes: individual factors, organisational factors, education and training, policies and resources (Davies et al., 2011; Duncombe, 2018; Moloney, 2013; Nayeri & Khosravi, 2013; Ploeg et al., 2007; Rycroft-Malone et al., 2004). The review reinforced the complexity of knowledge transfer and the importance of the context in which the transfer occurs.

Our study also found that multiple factors influence the care clinicians provide during initial burn management in WA, but two main themes emerged: the provision of real-time advice through the telehealth service supported clinical practice and IT issues presented challenges in accessing information. The study reflected the previous findings of reduced unnecessary transfers and reduced healthcare associated infection rates, confirming that the telehealth service is a major factor in the optimal care of burn injured patients in WA. The provision of real-time advice through an integrated telehealth service improved patient care as shown through the reduction of unnecessary transfers and the reduction of healthcare acquired infections. In addition, confirmation of its impact on clinical care through clinician interviews demonstrated its importance to the WA burn service model of care today and into the future. In addition to the provision of real-time advice when clinicians are providing hands-on patient care, accessible and effective education has resulted in a non-burn specialist clinician workforce in WA which possesses increased knowledge of burn care and an awareness of the availability of advice from the burn service in Perth. Non-burn specialist clinicians in WA are now better equipped to provide patient care at a distance due to their use of this known source of ongoing clinical support. These studies confirm the importance of the telehealth service as
a major factor in determining the implementation of best practice and the improvement of burn care in WA.

Implications for clinical practice, education and future research

This study demonstrated that the implementation of a state-wide telehealth service which integrates clinical advice and education is effective in ensuring appropriate management and transfer of paediatric burn injured patients. In addition, telehealth services improve initial patient care by preventing unnecessary transfers and some important infective complications. Due to the clinical and financial advantage of the telehealth service, and its ability to ensure the use of health resources appropriate to a patient’s needs, the continued integration of the telehealth service within the WA state-wide burn model of care is vital. The continued support of telehealth to provide clinical advice and regular clinician education will facilitate supported and educated non-burn specialist clinicians in WA, despite the ever-changing staff within the healthcare workforce, especially in rural and remote areas. It is important that such innovative models of care are supported by legislation, policy, funding and hospital executives to ensure the service continues for the benefit of clinicians, patients and families throughout WA. Indeed, the Department of Health Sustainable Health Review (2019) recognises the importance of telehealth now and in the future for WA Department of Health. It is also vital that organisations such as the Independent Hospital Pricing Authority continue to recognise the resources required and the validity of telehealth reviews for burn injured patients provided by all members of burns multidisciplinary teams, and that these organisations ensure continued activity-based funding for these services into the future.

Despite the use of telehealth to support the care of burn injured patients, IT issues are reported as an ongoing challenge for referring clinicians. This finding represents a conundrum, as, in addition to real-time advice via phone, most referring clinicians will email photos through to the burns team for review. The recognition of IT issues as a barrier to accessing information such as online policies and advice has significant implications for practice as it could prevent the sending of images to the burns team for review. Photos are an important component of an acute burns telehealth service as they facilitate the accurate assessment of burn size and depth, major determinants of subsequent acute management. If IT issues exist, this can result in delayed or unsent photos. The ability to overcome IT issues for acute burn telehealth consults is vital to ensure clinicians are receiving appropriate advice. Alternate methods of accessing photos securely, yet rapidly, may be a way to overcome such IT issues in the future in WA.

Den Hollander and Mars (2017) describe the use of smart phones to transmit photos between referring and burns clinicians in South Africa. This may represent an alternative solution, as many rural clinicians will discuss patient care via mobile phone but send photos via email due to current WA Health policies. A possible future strategy to overcome these issues, but avoid the security concerns surrounding the use of personal mobile devices to send and receive clinical photos, may be the Mobile Image Communication Exchange (M.I.C.E.) mobile phone platform currently being trialled at Fiona Stanley Hospital Burns Unit (McLeod, Wood, &
The platform enables the use of personal mobile devices to take clinical photos, but ensures they are sent to the patient’s notes and not stored on the clinician’s phone (McLeod et al., 2019). The integration of such an application within the paediatric burns telehealth service would involve changes to policy and state-wide education; however, due to the pre-existing telehealth service and the collaboration between the two state burn units, communication of such changes would be relatively straightforward. If implemented, it would be important to not only assess such changes from a burns point of view, but also from a referring clinician perspective. That is, if IT issues with mobile services are greater than computer IT issues, as may be the case in some areas, the use of a hybrid system may be needed to ensure accessibility of advice for all.

IT issues also have the potential to affect access to telehealth burns education sessions. Currently, education is provided by videoconference, which can be affected by internet protocol (IP) bandwidth. Although we did not receive feedback that this was an issue in any of the studies, it is a potential barrier to future access to the program if rural or remote IT issues are not addressed. Another potential issue is that the education program is not accessible at any time other than during the live broadcast. To address this, future programs will need to focus on recording these education sessions and providing WA clinicians with access from anywhere at any time from their desktop, tablet or mobile phone via the health intranet.

Despite these IT issues and possible strategies to overcome them in the future, the provision of clinical advice is a key factor influencing burn care in WA. Communication between referring non-burn specialist clinicians and the burns team is vital and the service must ensure that clinicians are encouraged to seek clinical advice, and that avenues of communication remain open. If the provision of real-time advice is the key to patients receiving optimal care, the burns team must remain approachable and be adequately resourced to provide this service to the clinicians who reach out on a daily basis.

**Limitations**

Due to the longer timeframe required for the implementation of a sequential mixed methods study with two phases, the participation of a workforce with frequent staff changes may be a limitation of this study. The same clinicians did not participate in all components of the study—a recognised limitation of using an explanatory sequential mixed methods approach (Doyle et al., 2016). Further research into the evolution of corporate knowledge and widespread increased knowledge of burn care would further inform practice and strategies for information dissemination.

Another limitation of the study is that the results represent burn care in WA and therefore reflect factors within that state’s healthcare system. Other states and countries operate under various models and the implementation of similar strategies may or may not have the same effect in other systems. As mentioned previously, factors influencing care are contextual, so the findings of this study may not be transferable to other burn care models. Despite the
contextual nature of the study, however, many strategies may be relevant to all practice settings, for example, the provision of real-time advice in acute burn management, the provision of education by videoconference and commencing the prevention of infection from the point of initial healthcare prior to admission.

**Conclusion**

In WA the main factors influencing the implementation of best practice in burn care are telehealth and IT issues. The integrated state-wide telehealth service provides clinicians with clinical advice and education for paediatric burn assessment and management which has resulted in improved patient care and outcomes. The commencement of optimal care and a focus on the prevention of healthcare associated infections starting from the point of presentation at a non-burn specialist centre has significantly reduced the infection rate for paediatric patients following burn injury in WA. IT issues present referring clinicians with barriers to accessing information and may potentially impact their ability to share clinical photographs which is an important component of the telehealth service. It is vital that the telehealth service continues to remain an integrated component of the WA burns model of care to ensure all patients have equal access to specialist advice and optimal care along their entire patient journey. Despite the changing staff within the healthcare workforce, the fact that patient outcomes improved over time in terms of reducing hospital acquired infections, increasing demand for advice and reduced numbers of unnecessary transfers, demonstrates that knowledge is being retained by this workforce, and is perhaps being shared amongst colleagues across the state. Future research into options which facilitate the ongoing provision of immediate clinical advice and access to information, which overcome IT barriers is important for burn injured patients in WA and internationally. Sustaining this service into the future will require ongoing funding of the state-wide burns Clinical Nurse Consultant role and on-call burns registrars, as well as optimizing IT systems for fast access to images and advice.
REFERENCES


