Factors contributing to normothermia in people with a major burn injury in the first 24 hours of hospital admission

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PREFACE

Abstract

Background

Burn injuries affect not only the person's skin but other vital body systems. It is well documented that one of the key factors to survival for a burn injured person is their ability to maintain normothermia, nevertheless people with a major burn injury are often unable to achieve this. The inability to maintain normothermia puts the burn injured person at risk of serious complications such as shock, multisystem organ failure and even death. There is limited information available for nurses with regards to the factors that contribute to normothermia in people with a major burn injury. Therefore, the aim of this study was to ameliorate this situation by identifying factors are that contribute to normothermia in the burn injured person within the first 24 hours of hospital admission to a burn care hospital.

Research Question

What are the factors that contribute to normothermia in the person with burn injury greater than 10% of their total body surface area (TBSA) in the first 24 hours of admission to a burn care hospital?

Methods and Participants

The Gearing Framework (Gearing, Mian, Barber, & Ickowicz, 2006) for conducting a retrospective chart audit was the methodology chosen to guide this study. Using the nine steps of the Gearing Framework (2006), a data abstraction instrument was developed and tested. Once the data abstraction instrument was approved by a panel of experts and ethical approval received from both the burn care hospital and university the study sample was able to be identified. The sample comprised medical charts of 50 adult people with a burn injury estimated to be 10% or greater of their total

body surface area and who were admitted to a single site burn care hospital intensive care unit in Victoria, Australia between May 31, 2013 and June 1, 2015.

Data were extracted from the participants' medical charts following both ethical and hospital procedures and entered into the electronic password protected data extraction tool. Data were analysed using SPSS version 24 (IBM Corp, 2017). Descriptive statistics including: mean, percentage and standard deviation were applied. Difference between groups was determined by T- test with a p value of 0.05 being considered significant in this study. Further statistical testing included logistic regression, which was used to present correlation matrix tables to uncover the factors that contributed to normothermia in the sample group.

Result

52% of participants in the study had 10-20% Total Body Surface Area Burn (TBSA) and the remaining 48% had TBSA burn percentage of greater than 21%. The mean age of the burn injured persons was 42 years (SD 18.5; range 18-87 years), with two thirds (n=32; 64%) under the age of 45 years. Almost half (48%; n = 24) were brought to the burn care hospital from further than 50km away (average 102.5 Km; SD 119.1) and those travelling longer distances (>100km) were warmer on arrival (mean 35. 8^0C v 35.1^0C, p = .022). Initial median temperature of the group recorded on admission to the emergency department was 35.4^oC (range 31.9-37.2 ^{o}C). On average, participants took just over six hours to return to normothermia (36.5) post admission to the emergency department (M=6.2 hours, SD=4.96). Females took longer to warm compared to males (11 Vs 5.38 hours). Positive correlations were noted between initial temp on admission to ED and TBSA% and time taken to return to normothermia.

To examine the factors that predict the time to return to normothermia a two-step standard (simultaneous) regression analysis was conducted. Patient age, distance from the burn care hospital, the time between admission to the hospital emergency department (ED) and the ICU, total body surface area and initial temperature were all entered simultaneously. The model with these five variables explained 35% of the variance, with the initial temperature on arrival at ED being the biggest predictor. The lower the burn injured person's initial temperature on arrival in the ED the longer it will take to return to normothermia.

Conclusion

This research has identified the factors that contribute to normothermia in the burn injured person. Recommendations for practice include: education of nurses and health professionals with regards to the factors that contribute to normothermia in the major burn injured person, and the development of guidelines to assist nurses' care for this group of people. The findings generated by this study provide information to nurses, nurse educators and policy makers to facilitate changes in practice that may contribute to saving lives.

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My research was inspired by my experience in nursing burn injured persons requiring intensive care treatment during the 'Black Saturday' fires of 2009 in Victoria, Australia. I experienced first-hand the dangers of not returning burn injured persons to normothermia within a timely manner. It is my hope that my research will be a stepping stone in the right direction to helping meet burn injured persons' care needs. Combining this experience into my drive for undertaking my research journey and completing this thesis, I am extremely grateful for being given the opportunity and be in a position to study my Master's degree. The journey has been challenging with many hurdles faced along the way. I would like to send an enormous thank you to my Mum Stephne Clack. Without you I would never have had the opportunity to finish my thesis. Without your tireless commitment to my children and myself I would not be where I am today and

because of this I would like to dedicate my thesis to you as you have always been there supporting me all the way.

To Amber and Ned my children. Your whole lives you have seen your Mum studying with the intention to make a better life for both of you and be the role model you deserve in your life. Your ongoing love and mini pep talks of encouragement have been my driving force to be the best Mum I can be whilst completing my research studies.

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Declaration of Authorship and Originality

I, Jessica Clack the undersigned author, declare that all the research and discussion presented in thesis is original work performed by the author. No content of this thesis has been submitted or considered either in whole or in part at any tertiary institute or university for a degree or any other category of award. I also declare that any material presented in this thesis performed by another person or institute has been referenced and listed in the reference section.

Jessica Elizabeth Clack

Original signature of candidate. Date: 31/10/19

Copyright Statement

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Table of Contents

List of Tables

List of Figures

Definition of Key Terms

Degrees Celsius	Measurement of temperature
DFH	Distance from Hospital
ED	Emergency Department
HBA	Hours admission ED to ICU - the duration of hours between admission to the emergency department to intensive care
HTA	Hours to normothermia - The number of hours taken to return to normothermia
Hypothermia	Low core body temperature
ICU	Intensive care unit of a hospital
INT	Initial temperature at burn care hospital - the first temperature taken on arrival to the emergency department
Inter hospital factors	Factors that may occur within the hospital setting
IV (intravenous)	Access directly to a vein
Normothermia	Body temperature within normal temperature range
Person factors	Demographic information or specific factors about the person
Pre-hospital factors	Factors that occur prior to the burn injured person attending the burn care hospital
TBSA%	Total burn surface area percent
Injury severity score(ISS)	A scoring system applied to trauma patients to determine the degree of injury to the person.
Glasgow Coma Scale (GCS)	A 15 point neurological scoring assessment for conscious level
Systemic inflammatory response syndrome (SIRS)	A multisystem inflammatory state.
Burn Severity Index	A measure used to assess the severity of a burn injury.

CHAPTER 1: Introduction

1.1 Overview of the Thesis

This thesis reports on a retrospective chart audit that was conducted to uncover factors that contributes to normothermia in people following a major burn injury in the first 24 hours of admission to a burn care hospital. This research was important as people with a major burn injury greater than 10% of their total body surface area are generally physiologically unstable, with many requiring extensive hospital resources and specialised intensive care (Nachiappan, Gurusignhe, & Bhandari, 2012). The nine steps of the Gearing framework (2006) for chart audit guided the research (Gearing, Mian, Barber, & Ickowicz, 2006). By following the steps outlined by the Gearing Framework (2006), a detailed chart audit tool was constructed, tested and applied to address the research question. Factors that affect normothermia in people following a major burn injury in the first 24 hours of a burn care hospital admission were identified and recommendations are made for the nursing care of this group of people.

1.2 Purpose of the Study

A burn injury is considered major when it is equal to or greater than 20% total burn surface area (TBSA) (Mason et al., 2017). A burn injury of 10% or greater TBSA% was chosen for this study as this is one of the criteria the Victorian Adult Burns Service Criteria use for admission into a critical care area and is regarded to be a significant burn injury (Victorian Adult Burn Service, 2019). Further, the majority of burn injuries

in the adult population in Australia is 10-20% according to the Burns Registry of Australia and New Zealand (Australian and New Zealand Burns Association, 2019). A burn injury occurs when an extreme heat source makes contact with the skin and underlying tissue (Fiona Wood Foundation, 2019). Research has shown that targeted temperature management in people with a major burn injury in the early stages of admission increases the likelihood of avoiding complications and improves outcomes (Alharbi et al., 2012). The treatment required for the person with a major burn injury may include resuscitation, restoration of fluid balance, pain management and management of body temperature (Latenser, 2009). Although failure to manage any of these conditions can lead to death for this group of patients, maintenance of body temperature within the normal range and the prevention of hypothermia are factors most manageable by nurses (Nachiappan, Gurusignhe, & Bhandari, 2012).

It is important to note that there has been a great deal of research dedicated to the treatment of the person who has experienced both a trauma injury (Ireland, Endacott, Cameron, Fitzgerald, & Paul, 2011) and hypothermia (Faulds & Meekings, 2013). Research has shown that in the person who has experienced physical trauma, hypothermia is part of a 'lethal triad' which also includes coagulopathy and high lactate levels (Sherren et al., 2014). This lethal triad is known to lead to an increased need for blood transfusions, fluid resuscitation and longer hospital stays (Ireland et al., 2011). Research also shows that while each factor in this triad individually increases the mortality risk for the person with a major burn injury (Ehrl et al., 2018; Steele, Atkins, & Vizcaychipi, 2016; Sherren et al., 2014), hypothermia (Latenser, 2009) also increases both blood lactate levels and bleeding (Mitra et al., 2013).

There is much debate in the literature with regards to what constitutes hypothermia (Weaver et al., 2014; Nachiappan et al., 2012; Kjellman, Fredrikson, Glad-Mattsson, Sjoberg, & Huss, 2011; Singer et al., 2010). It is generally accepted in the hospital setting that in the healthy person moderate hypothermia is a reading of core body temperature below 35-degrees Celsius (Singer et al., 2010). A temperature between 35 to 36.5 degrees Celsius is considered mild hypothermia (Van den Broek, Groenendaal, Egberts, & Rademater, 2010). Nevertheless, such parameters may be different for the person with a burn injury due to the damage that may have occurred to the body's skin and insulating layers (Ehrl, Heidekrueger, Rubenbauger, Ninkovic, & Broer, 2018; Hostler et al., 2013), where the body's core temperature may reset up to two degrees Celsius above normal temperature readings (Wall & Allorto, 2015).

There is little argument that the prevention of hypothermia is vital for the survival of people with a major burn injury, nevertheless there is limited information available for nurses with regards to the factors that contribute to normothermia in this group of people (Steele et al., 2016). Therefore, the purpose of this study was to ameliorate this situation by exploring factors that impact body temperature in the person with a major burn injury. The research was needed as knowledge of these factors has the potential to influence the nursing care provided to this group of people as well as provide evidence to support changes to nursing practice that will improve both the immediate and long-term outcomes for the person with a major burn injury.

1.3 Aim of the Study

The aim of this study was to uncover factors that contribute to normothermia in people following a major burn injury in the first 24 hours of admission to a burn care hospital. In order to achieve this, a retrospective chart audit was conducted. The retrospective chart audit enabled the concepts within the aim to be explored and the factors that contribute to normothermia in the target population to be uncovered.

1.4 Research Question

The research question addressed by this study was: What are the factors that contribute to normothermia in the person with burn injury greater than 10% of their total body surface area (TBSA) in the first 24 hours of admission to a burn care hospital?

1.5 Rationale and Significance of the Study

It is important to answer the research question because normothermia is challenging to recognise and maintain in the person with a burn injury (Prunet et al., 2012) affecting greater than 10% of their total body surface area (TBSA) (Sherren et al., 2014; Kjellman et al., 2011). Normothermia can be challenging to recognise in the burn injured person due to the changing metabolic state of the burn injured person which can impact both resuscitation and prognosis (Nachiappan, Gurusignhe, & Bhandari, 2012). This is a significant problem because a person with greater than 10% of the body

burned means that they are missing a proportion of the body's insulation and are at greater risk of both heat and fluid loss (Hostler et al., 2013). In addition, as the TBSA% increases so does the extent of the injury, often resulting in this group of people requiring specialist nursing and medical care (Ehrl et al., 2018; Hostler et al, 2013). The association for the peak body of burn specialists from Australia and New Zealand (ANZBA) recommend that people with a burn injury of 10% TBSA or greater be admitted to dedicated burn injury treatment hospitals (Australian & New Zealand Burn Association, 2019). Nurses working in these dedicated burn injury treatment hospitals are required to have knowledge and skills specific to the care of this group of people. They undertake specialised training and skills development to ensure they have the knowledge and ability to provide the quality nursing care required to facilitate survival and promote recovery in the person with a major burn injury (Ehrl et al., 2018).

Yet, despite the high level nursing care provided (Ipaktchi & Arbabi, 2006) the known risks associated with burn injuries (Moore, 2015; Druery, Brown, & Muller, 2005) and increasing interest in burns care over the past decade, there is a paucity of research focusing on the factors that contribute to normothermia in the first 24 hours of a person's admission to a burn care hospital (Kjellman et al., 2011; Singer et al., 2010; Latenser, 2009). This research focused on filling this gap in the knowledge by providing nurses with information about various factors that contribute to normothermia in the person with a burn injury greater than 10% of their total body surface. Such knowledge will assist in the education of nurses who care for this group of people. In addition, this study will provide information to enable nurses to put strategies in place to protect

people with a major burn injury from adverse events that may result from their inability to maintain normothermia (Elliot, Page, & Worrall-Carter, 2011).

1.6 What is Normothermia?

In the healthy person, normothermia is the maintenance of body temperature within normal range of 36.5 to 37.5 degrees Celsius (Potter & Perry, 2013; Fossum, Hays, & Henson, 2001; Buggy & Crossley, 2000). However, this may differ in people with a major burn injury as maintaining normothermia in this group is a challenge for nurses as burn injuries affect not only the skin but other vital body systems (Hardcastle, Stander, Kalafatis, Hodgson, & Gopalan, 2013). Yet views on what constitutes normothermia in the person with a burn injury remain controversial and variations continue to exist as to which temperature point is considered true normothermia (Hostler et al., 2013). Research has shown that for the person with a burn injury a core body temperature of equal to or less than 36.5 degrees Celsius (Weaver et al., 2014) is too low and that a person with a temperature in this range is at risk of further harm and associated complications (Hostler et al., 2013). This view is supported by two recent retrospective chart audit studies (Weaver et al., 2014; Hostler et al., 2013) that both used 36.5 to 38.5 degrees Celsius as their normothermic range (Greenhalgh et al., 2007). In keeping with Hostler et al. (2013) and Weaver et al. (2014) views and recent research, this study also adopted 36.5 to 38.5 degrees Celsius as the normothermic range for the person with a burn injury greater than 10% of their total body surface area.

1.7 Background

There is clear evidence to suggest the inability to maintain normothermia places the person with a major burn injury at severe risk of mortality (Hostler et al., 2013). Being able to recognise factors that are affecting the burn injured person's ability to maintain normothermia may enable nurses to prevent serious complications (Steele et al., 2016). As such, treatment in a specialised burn care centre and maintenance of normothermia in this group of people is important to the person's immediate (Weaver et al., 2014) and long-term survival (Jeschke et al., 2011). The Australian state of Victoria, where this study was conducted, has hospitals able to care for people who have experienced a major burn (Victorian Adult Burns Service, 2019). The burn care hospitals are situated in the Victorian capital city of Melbourne and accept people who may live locally, in regional centres of Victoria or are from interstate. Recent data shows that approximately 5000 adults with burn injuries are admitted to Victorian hospitals each year, with approximately 400 of these people needing transfer to a specialist burn care hospital (Victorian Adult Burns Service, 2019).

A major burn injury for the purposes of his study is defined as a significant burn involving 10% or more total burn surface area (Victorian Adult Burns Service, 2019). The current pre-hospital treatment recommended by Ambulance Victoria for the management of body temperature for people with major burn injuries includes keeping the person sheltered and out of the wind, removing wet clothing and keeping the person, including the head area and wrapped in a warm blanket (Ambulance Victoria, 2019). According to an American study which looked at risk factors associated with the

pre-hospital care of the person with a major burn injury, those most likely to struggle to maintain normothermia included adults over the age of 60 years of age or those with a large burn injury (Weaver et al., 2014).Pre-hospital care relates to any aspect that specifically occurs prior to admission such as location of the burn injury or distance from burn site hospital (Klein et al, 2006). Weaver et al. (2014) further found that people with a major burn injury and a Glasgow coma scale of eight or less, along with associated trauma, and low body weight, also had difficulty maintaining normothermia. It was also noted from the same study that extrication from a motor vehicle and all seasons with the exception of summer further increased the inability of the burn injured person to maintain normothermia (Weaver et al., 2014). These findings reflect the results of an earlier American study by Singer et al. (2010), which looked at pre-hospital cooling using data from a burn/trauma registry in Eastern Long Island, New York. Singer et al. (2010), found that the greater the burn size, the more difficult it was for the burn injured person to maintain normothermia (Singer et al., 2010).

To date, the majority of research has focused on pre-hospital admission burn care (Weaver et al., 2014; Hostler et al., 2013; Muehlberger, Ottomann, Toman, Daigeler, & Lehnhardt, 2010; Singer et al., 2010; Lonnecker & Schoder, 2001) or trauma patients (Steele et al., 2016; Moffatt, 2013; Ireland et al., 2011). There has been limited focus on the factors that contribute to normothermia in the person with a major burn injury once admitted to hospital. Nevertheless, some researchers have attempted to address this issue and have explored the prevention of heat loss in the person with a major burn injury once they reach hospital (Shields et al., 2013). Control of ambient temperature is one such strategy that has been the focus of a number of studies, which have found it to

be effective in maintaining normothermia in burn injured persons (Latenser, 2009). This treatment was also shown to be both cost effective and to decrease the metabolic response that often occurs in the person with a major burn injury (Latenser, 2009). More recent research found that although helpful in maintaining normothermia in the person with a burn injury, there were also potential risks for nurses caring for this group of people (Pruskowski et al., 2017). These risks included infections and heat stress due to the nurses' long periods of exposure to hot environments generated by the ambient heat source (Pruskowski et al., 2017).

Further studies on reducing heat loss in the person with a major burn injury have explored issues around the minimisation of transfers (Hostler et al., 2013). The application of warming devices such as heated air blankets (Kjellman et al., 2011), while others have explored the effectiveness of invasive procedures such as warming through central venous access devices (Corallo, King, Pizano, Namias, & Schulman, 2008). Several studies have also recommended the use of pre-warmed intravenous fluids and the administration of these fluids via central venous catheters to warm the core temperature internally for people with large burn surface areas (Victorian Adult Burns Service, 2019; Muehlberger et al., 2010). When using these central access devices as a warming intervention, one early study recommended the use of warmed intravenous fluids to 38 degrees Celsius (Holm et al., 2005). Although this treatment has been shown to be effective at slowly warming the burn injured person, risks in relation to infection, along with the location and insertion of the central venous access device have limited its usefulness (Davis et al., 2013; Prunet et al., 2012; Corallo et al., 2008).

While the management of heat loss in the patient with a major burn injury has been the focus on a number of studies (Kwak et al., 2013; Prunet et al., 2012), none have focused on the factors that contribute to normothermia in people with a major burn injury within the first 24 hours of admission to a burn care hospital. Therefore, the outcomes of this study are important and add to current knowledge with regards to the factors that contribute to normothermia in the person with burn injury greater than 10% of their total body surface. Furthermore, the findings provide information able to be used to facilitate changes in practice by nurses and may contribute to saving lives.

1.8 Structure of the Thesis

This research and the structure of this thesis is consistent with the research policy guidelines devised by Central Queensland University. The structure of this thesis follows a pathway that enables the clear application of the selected methodology, the formation of arguments to support the needs for the study, presentation of results and concludes with discussion findings and recommendations. See Figure 1.1– Thesis structure.

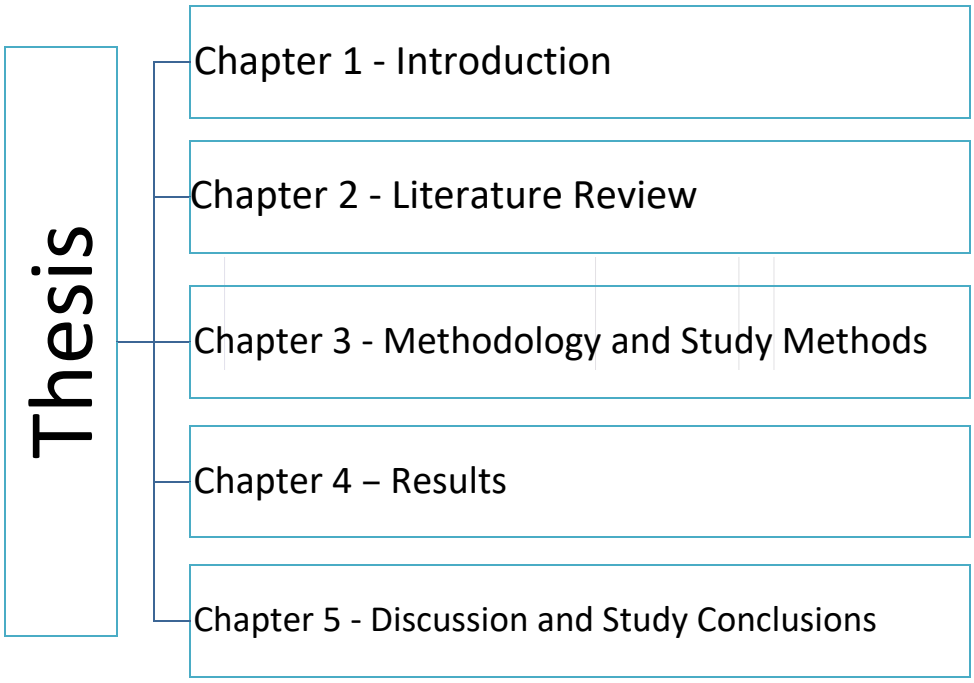


Figure 1.1 – Thesis structure

Chapter 1 contains the introduction to the thesis. The significance of the study has been presented and arguments made as to why the study was needed. Furthermore, a background to the study was included that provides further clarification around the reasons for conducting the study. In keeping with the Gearing Framework (2006), the literature review follows in Chapter 2. The literature review provides an overview on the current research that has been conducted on the topic area. Gaps in the knowledge are identified and reasons for the need for this research were justified. Key factors relating to the care of burn injured persons were identified for inclusion in the chart audit instrument. Chapter 3 presents the methodology and study methods. The placement of the methodology and study methods in Chapter 3 enabled clear application of the nine steps of the Gearing Framework (2006) for chart audit.

Justification is provided for the selection of the chart audit as the study design. Further, data collection and data analysis processes were described, along with ethical considerations. The results of the study are presented in Chapter 4, while Chapter 5 contains the discussion of the findings, recommendations for practice and conclusions.

1.9 Conclusion to Chapter 1

Temperature management of the person with a major burn injury greater than 10% of their total body surface area is challenging. Current evidence used to guide nursing practice is not clear to ensure nurses are able to provide people with a major burn injury the best possible care. This study, introduced in this chapter, has sought to fill this gap by identifying factors that contribute to normothermia in the person with a burn injury greater than 10% of their total body surface area (TBSA) in 24 hours of their burn injury.

CHAPTER 2: Literature Review

2.1 Introduction

In keeping with the requirements of the Gearing, et al. (2006) framework for developing a data abstraction instrument to be used in the chart audit process, a search of relevant databases including Cochrane, CINAHL, OVID, ProQuest and PubMed were undertaken to identify literature related to the care of the person with a burn injury. Although many sources were originally identified (see Figure 2.1) a final total of 21 relevant articles were included for review in this study. Each research article was reviewed for relevance and evaluated for quality as described below. From the information obtained through this critical appraisal of the literature, a data abstraction instrument was constructed to explore the factors that contribute to normothermia in the person with a burn injury greater than 10% TBSA in the first 24 hours of admission to a burn care hospital.

2.2 Literature Review Methods

The literature review is step 2 of the Gearing, et al (2006) framework for the development of a retrospective chart audit tool (See chapter 3 – Figure 3.1 for the full research design). The literature review process involved sourcing, reviewing and analysing literature in order to reach conclusions about the research topic and to identify the key factors to be included in the data abstraction instrument.

2.2.1 Search Strategy

A search strategy using the PICO format was developed to guide the sourcing of relevant literature (see Table 2.1 – PICO). This involved the identification of databases, key words and filters to ensure the literature search encompassed important concepts relevant to this study (Aromatis & Pearson, 2014). Cochrane, CINAHL, OVID, ProQuest and PubMed databases were chosen for the literature search as they provide high quality references of reputable health related journals and sources of evidence summaries. The databases were searched using key words that were applied in combination. The key words included: burn, critical care, factors, hypothermia, intensive care, normothermia, nursing, temperature management, and trauma. Other filters applied to the search led to the identification of the types of literature to be reviewed including papers containing the results of randomised control trials, retrospective chart audits, cohort studies, systematic reviews, case scenarios, literature reviews and meta-analyse. Further filters were applied to limit the search to resources published in English between 2004 to 2019. A set 15-year period allowed for consideration for advances in burn critical care technology and improvements in nursing care. See Table 2.1PICO

Table 2.1 - PICO.

Population	Adult burn injured people with 10% or greater TBSA% burn injury. Prehospital burn injured people and/or people in intensive care burn care hospital environment.
Interventions	Normothermia and methods to maintain normothermia in burn injured people.
Comparison	Hypothermia and factors that lead to decreased temperature in burn injured people
Outcomes	Identification of factors used to maintain normothermia in burn injured people.
The key words	burn, critical care, factors, hypothermia, intensive care, normothermia, nursing, temperature management, and trauma.
Filters	Randomised control trials, retrospective chart audits, cohort studies, systematic reviews, case scenarios, literature reviews and meta-analyse. , publication date: 2004 to 2019, peer reviewed, English language papers Only
Databases searched	Cochrane, CINAHL, OVID, ProQuest and PubMed

Application of the PICO search criteria enabled the identification of articles that focused on hypothermia, low body temperature or maintaining normothermia in adult people with a burn injury. Once the articles were identified a snowball review of the reference lists was undertaken to identify relevant citations (Holopainen, Hakulinen-

Viitanen, & Tossavainen, 2008). The aim of including this step was to identify any relevant studies which may have been missed in the electronic database search (Holopainen et al., 2008). An additional 18 references were found from reviewing the references of the articles initially sourced. Duplicate articles and those not in English were removed. The remaining articles were filtered first by title and then abstract.

2.2.2 Determining Quality of Journal Articles

All articles identified for inclusion in the study were then independently screened by the primary researcher to determined quality and research rigor. The Joanna Briggs Institute for Evidence Based Practice (JBI) audit tool relevant to the methodology of the selected study was used with each article. The JBI evidence based practice audit tools are credible tools used to assess quality of research studies. (Joanna Briggs Institute, n.d.). JBI audit tools used in the quality review process included: checklists for case reports, cohort studies, non-randomised control trials and systemic reviews. Studies were excluded at each step of the screening process if they were found not to meet the quality standards as outlined by JBI audit tools. A total of four articles were removed during the quality review process. Following the above processes 21 articles were identified as being high quality and relevant to the study. See Figure 2.1 Selection process for literature review.

Once the quality of the article was determined using the JBI audit tools and the decision made to include the paper in the study, an in-depth review of each article was undertaken. This detailed review of all 21 articles uncovered three overarching factors important in the care of the burn injured person and relevant to the research question

were identified. These factors were (1) person factors (2) pre-hospital factors and (3) in-hospital factors. These overarching factors have been used to structure this literature review and to guide the data extraction and data analysis processes.

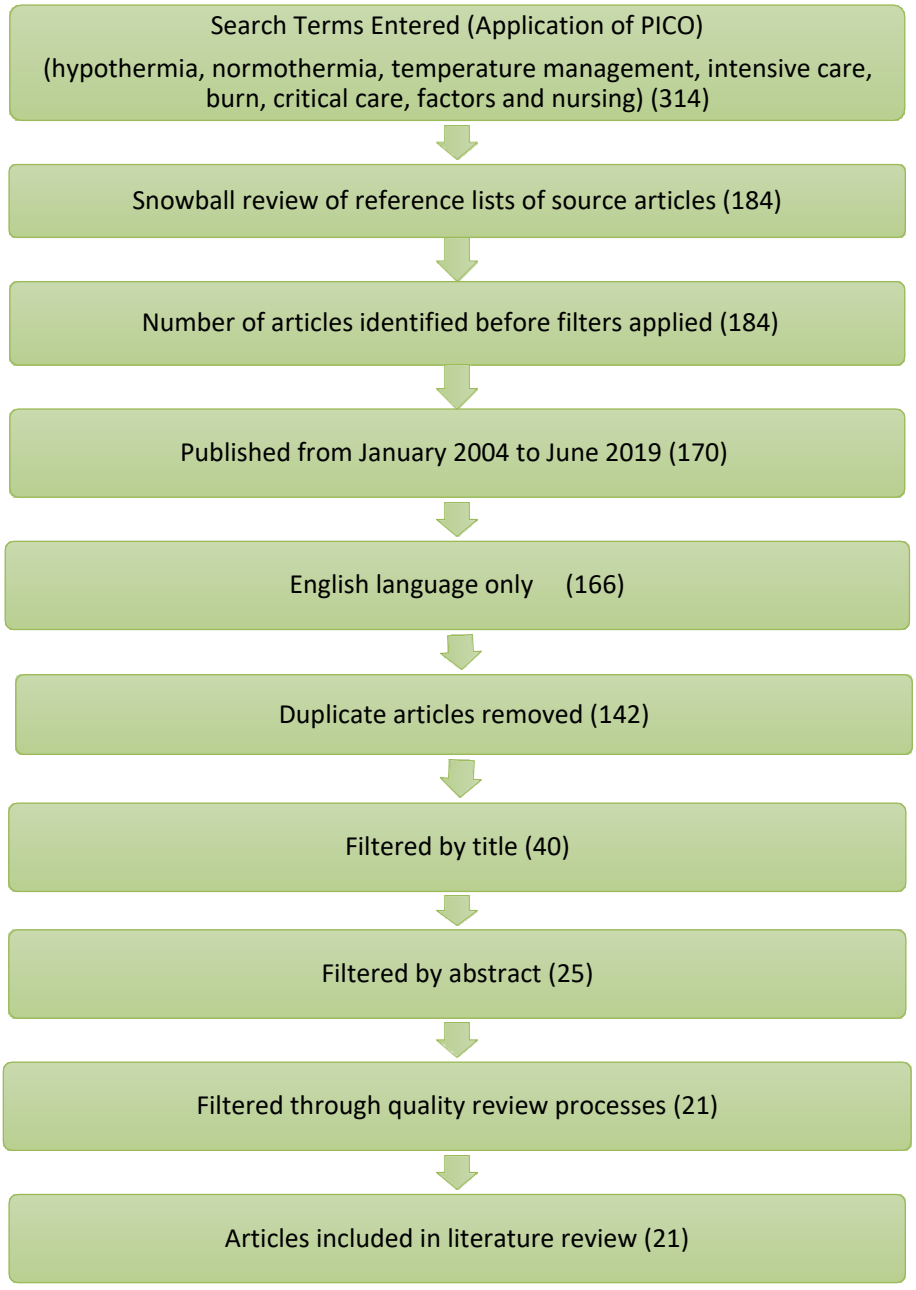


Figure 2.1 Selection process for literature review (adapted from Walker, Rossi, Anastasi, Gray-Ganter & Tennent, 2016).

2.2.3 Data Extraction and Analysis Processes for Reviewed Literature

Data was extracted during a further review of each article and tabulated in an excel spreadsheet. The extracted data included: author, year of publication, country study set, method, key findings, findings category and limitations. Data analysis followed a content analysis process in which the extracted data was analysed for key words and themes relevant to the research question (Schneider, Whitehead, Lobiondo-Wood, & Haber, 2014). These key words and themes were grouped and the final concepts to be included in the data abstraction instrument were able to be identified (See table 2.3).

2.3 Overview of the Included Journal Articles

The 21 journal articles included in the literature review utilised a variety of methodologies and revealed a diversity of findings related to the care of the burn injured person. All 21 journal articles were sourced from peer reviewed scholarly publications and were found by utilising the PICO search strategy described above. The studies originated from the following locations: Australasia (n =1), Europe (n =7), Middle East (n = 1), North America (n=11) and Africa (n= 1).

There was a variety of research methods utilised within the articles contained within this literature review. These included literature review (n= 4), randomised control trial (n=1), cross sectional analysis (n=1), case report (n=2) and cohort studies (n=13) (See Table 2.3). Most of the literature included in the review used retrospective chart audit methods to investigate potential factors related to a burn injured person's

ability to return to normothermia. Many of the research teams argued the benefits of this research design as being not only effective but also a cost efficient way of conducting research on this specific topic (Ehrl et al., 2018; Steele et al., 2016; Wearn et al., 2015; Bell, Simons, Hameed, Schuurman, & Wheeler, 2012; Moore, Pilcher, Bailey, & Cleland, 2014; Sherren et al., 2014; Hostler et al., 2013; Singer et al, 2010: Taira, Meng, Goodman, & Singer, 2009).

The studies included in the review of the literature were primary research articles and consisted of a range of sample sizes, from a case study of one participant (Corallo et al., 2008) through to a burn registry audit of 28,700 people (Karimi, Motevalian, Momeni & Ghadarjani, 2015). The case study by Corallo et al., (2008) explored an individual burn injured person's surgical experience and provided an expert opinion of the use of an intravascular warming device. The three literature reviews (Rizzo et al., 2017; Rani & Schwacha, 2011; Brusselaers, Monstrey, Vogelaers, Hoste, & Blot, 2010) analysed a total of 263 publications. A total of four studies had a sample size of less than 50 burn injured people as participants (Steele et al., 2016; Hardcastle et al., 2013; Prunet et al., 2012; Kjellman et al., 2011), while the largest sample was contained within the Iranian study conducted by Karimi, Motevalian, Momeni and Ghadarjani's (2015) who analysed 28,700 burn injured people over a 2-year period. All but one (Corallo et al., 2008) of the studies included in this literature review utilised quantitative data analysis techniques. The types of statistical analysis conducted was dependent upon the focus of each study and varied from descriptive statistics through to logistical regression analysis (See table 2.2 Summary of research studies reviewed.

Table 2.2 Summary of Research Studies Reviewed

Author	*Country*	*Sample*	*Method*	*Key Findings*	*Findings Category*	*Limitations*
Bell et al. (2012)	Canada	164 burn injured people from a trauma registry.	Retrospective chart review	Factors considered: distance, mode of transport, timing of transport. Average of one hour to get a burn injured person to a burn care hospital. Bell defined a severe burn as related to thermal injury being the most significant medical problem for the patient and not necessarily related to TBSA%. TBSA% will indicate different treatment options.	Pre-hospital factors	Identified missing data as an issue. Only considered severe burn injuries TBSA% was unable to be accurately assessed as there was variation in treatment between locations. Grouping of TBSA% into groups as per the registry accessed. Unable to measure reliability amongst referral diagnosis in the hospital records.

Brusselaers et al. (2010)	Germany	76 eligible studies.	Systematic literature review	The annual incidence of severe burns has decreased over time. 60% of burn injured people were male – Mortality post burn injury is decreasing over time. Risk factors for death were older age and a higher TBSA%, presence of chronic diseases.	Person factors	Absence of uniformity regarding definitions in the medical records. Issues with uniform definitions used to describe participants such as TBSA% recording were inconsistent. This study did not directly use the terms hypothermia or normothermia within the article but did discuss factors related to heat loss.
Corallo et al. (2008)	United States of America	1 participant 70% burn injury undergoing theatre.	Case Report	Intravenous warming devices are safe and effective intervention in maintaining normothermia during theatre procedures for burn injured people with large TBSA% burn.	In-hospital factors	Small sample size. Reliance on expert opinion.
Ehrl et al. (2018)	Germany	186 ICU burn injured people admitted	Retrospective chart review	Inappropriate temperature management may contribute to hypothermia	Pre-hospital factors	Sample only reviewed burn intensive care patients.

		between 2015-2017.		in the pre-hospital and transfer setting. Pre-hospital providers need to be familiar with current guidelines around preventing temperature management.		IV fluid warming guidelines were not standardised.
Hardcastle et al. (2013)	South Africa	36 research publications about burn injured people	Integrative review	Hypothermia is more likely in burn injured people who require resuscitation prior to admission to emergency department.	In-hospital factors	The review included trauma patients and burn injured people were considered in this group.
Hostler et al. (2013)	United States of America	During 2000-2011, 4479 burn injuries of 10% TBSA or greater.	Retrospective chart review	Nearly 40% of the sample presented mildly or moderately hypothermic on ED admission. Core body temperature is only weakly correlated with burn size. Low body temperature, age >50 years, and female sex	Pre-hospital factors	Risk for error in medical charts. Temperature measurements taken were not all direct core measurements. A variety of temperature methods were used including rectal, oral, tympanic, axilliary and other were listed in the publication.

				remain independent predictors of mortality in the burn injured person. Burn injured people are more likely to be admitted by ambulance, be severely burnt and have a Glasgow coma scale of eight or less compared to non burn injured people.		
Karimi et al. (2015)	Iran	28 700 burn injury cases	Cohort study	9.6 % of burn injuries require ICU admission. Length of hospital stay correlated with size of TBSA%.	In-hospital factors	Risk for error in recordings. Inconsistent definitions used were an issue due to multiple sites used and having inconsistency with data collection. Definitions may have be related to measuring scales of severity or medical conditions. This study although on the topic of burns discusses hypothermia in relation to systemic inflammatory response syndrome which

						occurs to some level in all burn injured persons.
Kjellman et al. (2011)	Sweden	Ten consecutive burned patients (> 20% total burned surface area and a core temperature < 36.0°C)	Non-Randomised controlled trial	Allon™2001 Thermowrap warming technique was able to warm the burn injured person by 1.4 degrees Celsius in two hours.	In-hospital factors	Application of warming method was limited to two hours at a time. Recruitment of participants was sporadic but were consecutive. Study occurred at a single site.
Klein, Nathens, Hiembach, and Gibran (2006)	United States of America	1853 burn injury people between 2000-2003	Retrospective cohort study	No difference if a burn injured person was transferred from another hospital or a direct admission. Length of stay, surgery and mortality were greater when burn injury occurred remotely. Burn injury persons were colder on arrival when a burn occurred in a remote location.	Pre-hospital factors	Risk for error in medical charts. Missing data.

				TBSA% was slightly higher in the direct admission group.		
Klein et al. (2009)	United States of America	128 self-reporting burn centres in the United States of America.	Cross sectional analysis	25.1% of Americans live within one hour of a burn centre by ground transport, 53.9 by air. If a person is directly transferred to a burn care hospital their function recovery is better. Burn injured people are found to be unsafe if 145 kilometers or more away from a burn care centre. Access and resources between burn care hospitals remains an ongoing issue.	Pre-hospital factors	Fixed wing aircraft are not available nationally Inaccuracy in medical centres reporting they take burn injuries. Risk for error in medical charts.
Moore et al. (2014)	Australia, New Zealand	1715 burns admissions over a 7-year period from Australia and New Zealand.	Retrospective chart review	Females were older and had more extensive burns when compared to males. Mortality was higher in women than in men	Person factors	There is risk for data error due to multiple sources and potential missing data. The study only looked at the intensive care setting.

				(p=0.001). Women spent longer in ICU than men		
Prunet et al. (2012)	France	4 patients, 11 surgeries in coolguard group. 3 pts and 10 surgeries in non-group.	Controlled non-randomised trial	Intravenous warming devices are effective at maintaining normothermia.	In-hospital factors	Single centre trial. Potential adverse effects to participants needs to be considered.
Rani and Schwacha (2012)	United States of America	115 burn injury publications reviewed	Integrative review	Inflammation contributes to the post burn hypermetabolic state. The aged experienced greater levels of inflammation and slower wound healing.	Person factors	Not a systematic literature review. Varied quality of resources reviewed.
Rizzo et al. (2017)	United States of America	72 burn injury publications reviewed	Integrative review	Minimal effective warming interventions and resources available for burn injured patients.	In-hospital factors	Focused only on peri operative period. Not a systematic literature review.

Sherren et al. (2014)	England	TBSA% greater 30%, 71-month period. 117 participants	Retrospective chart review	15 of 117 participants met lethal triad criteria who were burn injured. Burn injured people with low body temperature at admission had higher risk for burn severity index (p=0.001), inhalation injury, full thickness burns (p=0.027) and were older(p=0.033). Both groups had similar intravenous fluid volumes given.	In-hospital factors	Single centre. 28 participants with missing data sets. Investigative admissions despite having designated rooms could not be accounted for.
Singer et al. (2010)	United States of America	929 burn injured people admitted to a burn care Hospital between 1994-2007	Retrospective chart review.	Only 1.8% had a burn injury larger than 70% TBSA. That is 17 out 929 participants ($p < 0.001$). 1.6% of burn injured people had low temperature on arrival to ED and increased mortality risk. There were no association between sex, year, and presence of inhalation injury with low temperature. Burn injured persons who had	Person factors	Only prehospital therapies recorded. ED temperature measurements missing. Limited to single suburban medical centre.

				low temperatures were older, had high Injury Severity Score (ISS) when compared to normothermic burn injured people.		
Steele et al. (2016)	United Kingdom	31 burn injured people admitted between 2010-2013.	Retrospective chart review	42% of burn injured person had low temperature on arrival to hospital. Burn injured people were at significant risk during transfer to hospital. Low temperature is related to burn severity and patient physiological status. Burn injuries were more likely to occur at night. Temperature change was linked to length of time spent in transfer not the distance covered (p>0.001). Spring or summer (81%) were more likely to have a	Pre-hospital factors	Small sample size. Risk for error in medical charts. Low number of temperature measurements taken pre-hospital.

				burn admission compared to autumn or winter.		
Taira et al. (2009)	United States of America	700 trauma facilities admitting burn injured people between 2002 and 2006. n=25,572 burn injury admissions	Retrospective chart audit	68.9% of the sample arrived during off-hours. There was no difference in ICU length of stay between on and off hours arrival. Critically ill patient populations, off-hours admission were not predictive of worse outcomes.	In-hospital factors	Risk for documentation errors in medical charts. The study does not specifically use the words hypothermia or normothermia in its literature but does discuss heat loss and temperature management. Temperature measurements taken were not all direct core measurements. A variety of temperature methods were used including rectal, oral, tympanic, axillary and other were listed in the publication.
Wearn et al. (2015)	United Kingdom	Burn injured people aged 65 years and over. Either 1993-2003 admission or 2004-2012 admission	Retrospective chart audit	Mortality decreased over time due to improved burn injury care. TBSA% is decreasing over time. Burns to the head and buttocks have become more	Person factors	Risk for medical charts being in correct. One site location.

				common and the lower limb and perineum less common.		
Weaver et al. (2014)	United States of America	2,770 burn injury hospital admissions	Nested case control study	Aged burn injured people greater than 20% TBSA % were exposed to cooler pre-hospital environments. 42% of cohort had low temperature on arrival to the emergency department. Burns greater than 20% were associated with risk of low temperature, which was associated with age, winter season, if they were extricated, polytrauma, prehospital Glasgow coma scale and low body weight. Risk factors are readily identifiable by pre-hospital providers.	Person factors	Registry not designed to meet this specific question Although prospectively collected data were observational. Prehospital data were often missing Risk for error in medical charts Temperature measurements taken were not all direct core measurements. A variety of temperature methods were used including rectal, oral, tympanic, axilliary and other were listed in the publication.
Ziolkowski et al. (2017)	Canada	1111 consecutive burn surgery	Retrospective cohort study	Duration of operating time associated with incidence of low body temperature and	In-hospital factors	Risk for error in medical charts

	patients 2006-2011.	non-infectious complications.	

2.4 Review of Literature and Identification of Factors Affecting the Burn Injured Person's Return to Normothermia

2.4.1 Personal Factors

Research literature focusing on person- related factors relevant to people with a burn injury was the first factor explored in this literature review. Given each burn injured person is unique, their care will need to be tailored to address their individual needs (Ehrl et al., 2018). Person factors, within the context of this study, are considered to be the important unique individual elements that must be considered when planning and delivering medical and nursing care. Person factors identified in this literature review included: age, total burn surface area percentage, location of burn on the body, and sex of the person (Ehrl et al., 2018; Wearn et al., 2015; Karimi et al., 2014; Moore et al., 2014; Weaver et al., 2014; Rani & Schwacha, 2012; Brusselaers et al., 2010; Singer et al., 2010).

Previous research has shown age of the burn injured person to be a factor in their survival (Weaver et al., 2014; Rani & Schwacha, 2012; Brusselaers et al, 2010). Brusselaers et al. (2010) conducted a systematic review of the literature detailing the incidence, aetiology, morbidity and mortality of European burn injured people. These researchers noted that mortality in burn injured people is decreasing over time due to

better treatment. Although reviewing publications prior to 2010, Brusselaers et al. (2010), concluded that increasing age was a major predictor of mortality risk in the burn injured person. These researchers made no comment on the factors that may contribute to a burn injured person's ability to return to normothermia. In yet another integrative review, Rani and Schwacha, (2012) analysed 115 publications and concluded that despite the advances in burn management, the older person with a burn injury was more likely to have a high mortality rate due to deterioration in the immune system and pre-existing comorbidities, decreased strength, poor vision and reduced reaction time. Such conclusions are important and clearly show age to be a factor needing to be examined when considering the ability of a person with a burn injury to return to normothermia.

A North American research team led by Weaver et al. (2014) conducted a nested case control study on the trauma registry from Pennsylvania with details of 2770 burn injured people and their hospital visits. The study spanned a five-year period and focused on burn injured people 60 years of age and over, who had experienced a burn injury. One of the purposes of Weaver et al.'s (2014) study was to identify the incidence of older burn injured people sustaining hypothermia during the early hospital admission period. The study investigated if there was an association between body temperature of less than or equal to 36.5 degrees Celsius and total burn surface area. These researchers found 39% of the sample with a TBSA% of less than 20%, had a body temperature less than or equal to 36.5 degrees Celsius. Weaver et al. (2014) further found that a decreased core body temperature occurred in 48% of the sample with 20-39% TBSA. This finding was also found in 62% of people with TBSA % of 40% and

above (Weaver et al., 2014). The researchers further discovered that burn injured people over the age of 60 years were 50% more likely to present to the emergency department with a low body temperature. These results show a strong link between an increase in TBSA% and a decrease in temperature. Although this research adds valuable knowledge to what is known about TBSA% and body temperature, there was one limitation, which was that people were only included in the study if they were entered as a burn patient in the hospital data system (Weaver et al., 2014). Such limitations meant people who were not allocated a burn classification in the hospital data system may have been missed and not included in Weaver et al.'s (2014) study.

An earlier retrospective chart audit conducted by another North American research team (Singer, et al., 2010) found similar results to Weaver et al. (2014). Singer et al.'s (2010) analysed 929 medical charts of people who had experienced a burn injury between 1997 and 2010. They (2010) found pre-hospital cooling of the burn injury had no effect on the incidence of low body temperature in the burn injured person. Over a period of time these researchers concluded that people with larger sized burn injuries of 70% TBSA experienced low body temperature, with hypothermia being identified as a key factor leading to mortality in this group. Although adding valuable knowledge to the issues surrounding the care of the burn injured person, Singer et al.'s (2010), study was limited as the researchers only considered participants from one burn centre. In addition, the research was restricted by the definition of a large burn as being 70% or greater TBSA%. This was because the study recruited only seven participants with this TBSA% during the study period, thereby limiting the value of the conclusion with regards to people with large burn injuries.

Along with age and TBSA%, the location of the burn was also identified in the literature as being important in the management of the burn injured person in relation to hypothermia (Karimi et al., 2015: Wearn et al., 2015). According to the Australian Institute of Health and Welfare (2016), most reported burn injuries in Australia were to the wrist and hands. These were also the findings of an Iranian cohort study undertaken by Karimi et al (2015), with these researchers adding to the list other more densely fat areas of the body, such as with the perineum. Alternatively, in Wearn et al.'s (2015) study conducted in the United Kingdom, burn injuries to the head and buttocks were identified as more common than the perineum area. It was not clear in either study as to why this may be the case or if the location of the burn had an impact on the ability of the burn injured person experiencing hypothermia. Such omissions are important to this study and highlight the need for further research on the effects of the location of a burn on the body.

The Burns Evaluation and Mortality Study (BEAMS) (Moore Pilcher, Bailey, & Cleland, 2014) used a retrospective chart audit to examine outcomes of people (n= 1715) admitted with a burn injury to nine intensive care burn units from Australia and New Zealand. The aim of the study was to predict mortality in burn injured persons admitted to intensive care. This study unexpectedly found females (n=348) were older, had more extensive burns, had longer length of stays in both hospital and intensive care ($p < .001$), and were found to have double the risk for mortality when compared to males with similar injuries (21% vs 8.3%, $p<.001$). These researchers further found that

males were more likely to have burn injuries linked to occupation and working in high risk areas. Moore et al. (2014) concluded that for males, the severity of the burn injury and risk for mortality increased with age. Although these researchers recognised that the ability of the burn injured person to return to normothermia may vary between the males and females due to different hormone levels, body mass, or muscle mass they found no evidence for the sexes to be treated differently (Moore et al., 2014). Interestingly while the sex of the burn injured person is mentioned as a demographic characteristic in other studies (Ehrl et al., 2018; Steele et al., 2016), only the study by Moore et al. (2014) highlighted the link between the burn injured person's sex and mortality. As such the absence of information about the sex of the burn injured person and their ability to return to normothermia in most studies highlights the need for this factor to be considered in this study.

Of all the factors identified in this literature review, person factors are the most commonly discussed in the literature (Steele et al., 2016; Klein et al., 2009; Klein et al., 2006). Nevertheless, except for Singer et al. (2010), none of the studies explored person factors and their impact on the burn injured person's ability to return to normothermia. As such, person factors related to the burn injured person warrants further investigation.

2.4.2 Pre-Hospital Factors

Research literature focusing on the pre-hospital setting and pre-hospital care of the person with a burn injury was the second factor explored in this review of the literature. The pre-hospital setting includes: the geographical location of where the

burn occurred and the distance from a burn care hospital, along with the mode of transfer of the burn injured person to a burn care hospital (Klein et al., 2006). Most of the research surrounding the burn injured person has focused on the pre-hospital setting (Ehrl, et al., 2018; Weaver et al., 2014; Hostler et al., 2013; Klein et al., 2009: Klein et al., 2006). Researchers exploring the pre-hospital care of the burn injured person have identified distance from the setting where the burn injury occurred to the burn care hospital as a risk factor for maintaining temperature control in this group (Klein et al., 2006). Early research conducted in the United States of America by Klein et al. (2006) analysed 424 burn injury admissions that occurred between 2000-2003. Klein et al. (2006) explored whether burn injured people were admitted directly from the setting of the burn injury or secondary transfers to the burn care hospital. The research team defined secondary transfers as those in which the burn injured person received initial treatment at another hospital before being transferred to the burn care hospital (Klein, et al., 2006). These researchers found that the burn injured person was at greater risk of developing complications, including lower body temperature if the burn injury occurred in a remote location with limited ambulatory vehicle access or if the person required air ambulance retrieval (Klein et al., 2006). In 2009, Klein et al. added to their previous research by defining the distance that was considered unsafe for the burn injured person to travel. A total of 128 burn care centres participated in the study. Although Klein et al.'s (2009) study noted there would be variation in access due to geographical terrain between centres and states, the researchers found people with a burn injury who were retrieved from within 145km radius of a burn care hospital attained marginally better outcomes including shorter length of hospital stay, lower

number of operations and mortality when compared to those retrieved from distances further away. Hence, Klein et al.'s (2009) team concluded that burn injured people who were directly treated at a burn care hospital had overall better functional outcomes although the publication did not provide any statistical evidence to support this. The outcomes of Bell et al.'s (2012) retrospective chart audit concurred with Klein et al.'s (2009) findings. These researchers reviewed mortality rates and distance from linked census data and hospital data discharge information and concluded that people with a burn injury who were within around one hour from a burn care hospital when they experienced their burn injury did better than those who were further away and took an average of four hours to reach a burn care hospital. The information gathered in Klein et al.'s (2009) and Bell et al.'s (2012) studies emphasise the importance of resource allocation between burn care centres, along with access to the burn care centres as an ongoing issue that required further investigation. However, neither study considered whether either of these factors affected a burn injured person's ability to return to normothermia. Klein et al (2009) identified there were more self-verified burn centres than formally verified burn centres that met the strict criteria to be registered as a verified burn centre by the American Burns Association hence facilities maybe under resourced to adequately can for burn injured persons.

A later American study by Hostler et al. (2013) conflicted with the findings of both of Klein et al.'s (2009: 2006) studies, by reporting that burn injured people who were directly admitted to a burn care hospital had increased mortality rates and longer hospital length of stays when compared to those transferred from another care facility. This may been due to shorter travelling distance and mode of transport more like to be

road ambulance in Hostler et al's study. Hostler et al.'s (2013) study was a retrospective chart review which analysed the Pennsylvanian state-wide trauma registry between 2000 to 2011. This research team further found a burn injured person presenting directly to a burn care hospital was more likely to be admitted by ambulance, more likely to be severely burned and have a Glasgow coma scale of equal to or less than eight. These researchers also concluded that the burn injured person presenting to hospital with lower than normal body temperature had a high risk of mortality but was not found to be significant when the results were adjusted to include ISS score.

Although in agreement with previous research about mortality risk and low body temperature, the findings of a more recent chart audit review by a German research team headed by Ehrl et al. (2018) did not support Hostler et al. (2013) conclusions. Ehrl et al.'s (2018) team explored the outcomes of two cohorts of burn injured people and reported findings more consistent with those of Klein et al. (2009: 2006). To reach their conclusions Ehrl et al. (2018) examined the outcomes for 181 burn injured people, of which 121 were admitted directly to a burn care hospital and 60 admitted to a burn care hospital after first stopping at a regional health care facility. This study found that the group who were transferred to another hospital prior to being admitted to the burn care hospital were significantly more likely to have a longer length of hospital stay ($p<0.05$) when compared to those who were directly admitted. The study also highlighted the importance of the skills of the first responders and their ability to assess the burn injured person. Nevertheless, the findings from Ehrl et al.'s (2018) study should be considered within the context of the study limitations: data were obtained from a single study site; and the absence of comparable information such as the burn

injured person's initial temperature on admission to the emergency department and the time taken for the burn injured person to reach normothermia. Ehrl et al.'s (2018) study concluded that burn injured people often had low temperature measurements on admission to burn intensive care unit and suggested that this may be due to their delays in transfer to the hospital.

Extending the current knowledge around the pre-hospital factors impacting a burn injured person's ability to return to normothermia is a recent study conducted by an English research team conducted by Steele et al. (2016). This team investigated factors that affected burn injured people who had a lower than normal body temperature in the pre-hospital setting. Steele et al.'s (2016) study included a total of 31 burn injured people of whom the average age was 32 years. This retrospective chart audit found that burn injured people were more likely to present to hospital with lower than normal body temperature in spring or summer (81%, n=25) than in autumn or winter (19%, n=6). Four participants in Steele et al.'s (2016) study died on arrival to the emergency department, with three of the four being identified as having a body temperature of 36.0 degrees Celsius or less on arrival to hospital. No relationship was found in Steele et al.'s (2016) study between the distance travelled and body temperature however, a relationship was identified between the amount of time taken to transfer the burn injured person to the burn care hospital and lower than normal body temperature on arrival. In Steele et al.'s (2016) study 82% of the participants were transferred to the burn care hospital via road ambulance while the other 18% arrived by helicopter and road ambulance. These researchers reported that 80% of burn injured people transferred by helicopter arrived at the burn care hospital with lower

than normal body temperature. The outcomes of Steele et al.'s (2016) study indicated a relationship between length of time spent in transit and a change in body temperature when transferring between referring hospitals and burn care hospitals. Furthermore, these researchers highlighted the importance of the time taken to reach a burn care hospital as a crucial factor in the burn injured person's ability to return to normothermia.

In summary, contemporary research shows the geographical location of where the burn occurred and type of burn centre, distance travelled and the timing between a burn injury as pre-hospital factors that may contribute to normothermia in the person with a burn injury (Bell et al., 2012; Klein et al., 2009: Klein et al., 2006). Nevertheless, there was limited research available in relation to the distance from hospital to the time taken for the burn injured person to return to normothermia. Studies generally reported on the type of transport and distance travelled rather than on how this effected a burn injured person's ability to return to normothermia (Steele et al., 2016: Bell et al., 2012). Furthermore, none of the studies concentrating on the pre-hospital phase in the care of the burn injured person focused on the factors affecting the time taken to return to normothermia, thereby highlighting a gap in the knowledge with regards to an important component in the care of this group of people. Factors that contributed to the burn injured person's ability to return to normothermia have not been the focus of pre-hospital care literature and there has been limited recognition of normothermia as key to this group's survival.

2.4.3 In-Hospital Factors

Research focusing on the in-hospital factors and the care of the person with a burn injury was the final concept explored in this literature review. The in-hospital factors included the settings where burn injured people received treatment such as, the emergency department, operating theatre and intensive care unit. Most of the research surrounding the in-hospital factors and the care of the burn injured person has focused on body temperature on admission to the emergency department (Weaver et al., 2014; Hostler et al., 2013) and application of warming devices (Prunet et al, 2012; Kjellman et al., 2011: Corallo et al, 2009). These focuses are useful in determining there effectiveness for burn injured persons during other stages of their burn injury recovery.

In hospital factors were the focus of a retrospective analysis of 700 American trauma facilities that had admitted people with a burn injury between 2002 and 2006 (Taira et al., 2009). Taira et al, (2009) found that a total of 25,572 people with a burn injury of any size were admitted to the 700 trauma facilities during this time. These researchers compared the data of burn injured people who were admitted to the trauma facilities during off hours with those admitted during normal business hours. The study more focused on factors related to the effects of temperature changes than purely focussing on normothermia or hypothermia. These researchers defined off hours as being between 1800 hours and 0600 hours and over weekends. Taira et al, (2009) found that 68.9% of burn injured people arrived during off hours compared to business hours,

with 19% of these people less likely to have full thickness burns ($p < .0001$). These researchers discovered that Intensive Care Unit length of stay, hospital length of stay was longer and more incidences of mortality occurred during the 'off hours' compared to those admitted during weekdays which were found to be significant. Although this early research adds value and fills a gap in the knowledge, Taira et al, (2009) did not report on core body temperature but did include other methods of temperature measurement as per the summary table 2.2.

In 2013, Hardcastle et al. undertook a review of the literature to explore what was known about temperature control of burn injured people in emergency centres, trauma centres, intensive care units and operating theatres. The outcome of this activity was the highlighting of the importance of active resuscitation prior to hospital admission to the emergency department as it inversely correlated with occurrence of hypothermia, as the most likely factor to lead to hypothermia in the burn injured person. Although adding to knowledge on the topic area, Hardcastle et al. (2013) focused only on hypothermia and did not identify factors that may contribute to normothermia in people with a major burn injury. Around the same time, Sherren et al. (2014) undertook a retrospective chart audit of body temperatures of people with a burn injury of 30% or greater of their total body surface, who were admitted to a United Kingdom regional hospital between January 2006 and December 2011. Whereas these researchers found the admission temperature to be a poor predictor of mortality ($p = .009$) in the sample group, they did not explore factors that may lead to normothermia. Mortality is often linked to low core temperature on admission to hospital. Such omissions are important to this study as they highlight the need for more research on

emergency admission temperature on a burn injured person's ability to return to normothermia.

It is well documented in the literature that the operating room environment is an area where people with a burn injury are at risk of losing body heat (Rizzo et al., 2017; Ziolkowski et al., 2017; Prunet et al., 2012; Corallo, et al., 2008). Corallo et al. (2008) reported on a case study of a 53-year-old male who had sustained 70% burns to his body. Medical staff had inserted a central core warming device to assist the burn injured him to return to normothermia in the operating theatre environment. It was thought that the use of this device allowed for a longer surgery and a greater area to be excised and grafted. Corallo et al. (2008) argued that had traditional methods been used to warm the burn injured person, they may not have had such good outcomes post-surgery. Corallo et al. (2008) also suggest further studies need to be conducted to ensure safety and efficacy of the warming device in this population of burn injured persons. In a later study Prunet et al. (2012) explored the maintenance of normothermia in burn surgery when using an intravascular temperature control system in the operating theatre. This French study was a controlled non-randomised trial where four burn injured people required surgery. A total of 11 surgeries were conducted in the burn injury participant group. The study found if an intravenous warming device was insitu that no patient dropped their temperature below normothermic range.

In a recent study, Ziolkowski et al. (2017) examined 1111 consecutive burn surgery patients who required treatment between 2006 and 2011. This research team

found that burn injured people requiring surgeries that last longer than four hours were more likely to be hypothermic when compared with those who underwent shorter surgeries of less than 3 hours ($p < .05$) (Ziolkowski et al., 2017). Ziolkowski et al. (2017) concluded that protocols were needed to assist in the management of burn injured people requiring extensive surgery to prevent hypothermia. Contrasting conclusions were reached by Rizzo et al., (2017) who conducted a literature review that focused on hypothermia and burn care in the perioperative and intensive care environments. This research team concluded that warming the ambient temperature of the room should improve outcomes if the burn injured person needs to return to normothermia in these areas. Such conflicting findings highlight a need for further investigation into the factors that contribute to normothermia in burn injured people.

The only study available that addressed body temperature management of the burn injured person in the intensive care was a Swedish study conducted by Kjellman et al.'s (2011) who compared ambient, air-convection and fluid convection heating techniques in warming burn injured people. Kjellman et al. (2011) sample included 10 burn injured people who had sustained 20% TBSA burns or greater and had a core temperature below 36 degrees Celsius. The study participants were randomly exposed to the three heating methods. The study found only fluid convection was effective in continually warming a burn injured person. It was suggested by Kjellman et al. (2011) that the fluid convection method is underutilised in the management of burn injured people and warrants further exploration.

In summary, the literature is clear that consideration of in-hospital factors is important when planning and delivering care to burn injured people, however no study to date has explored how these factors impact the burn injured person's ability to return to normothermia. Such omissions are concerning and further highlight the need for this study.

2.5 Key Findings from the Literature Review

This review of the literature has shown the fundamental need of the burn injured person is to remain in or return to a normothermic state post burn injury to optimise recovery (Ehrl et al., 2018; Hostler et al., 2013: Singer et al., 2010). Furthermore, the factors that impact body temperature management of the burn injured person have been identified.

The key findings from the articles were analysed using content analysis process in which key words and themes relevant to the research question were identified in the literature (Schneider, Whitehead, Lobiondo-Wood & Haber, 2014). These key words and themes were grouped and the final concepts to be included in the data abstraction instrument identified.

Table 2.3 - Key Findings from the Literature

Factors	*Key findings of the literature review*
Person Factors	
Age	Young males are more susceptible to burn injury (Brusellaers et al., 2009). The older aged person takes longer to heal from burn injury (Rani and Schwacha., 2009) Burn injury mortality rates have stayed the same despite advances in health care (Wearn et al., 2015)
Total burn surface area% AND *Location of burn*	Burn injured people who have greater than 20% TBSA are at risk for systemic effects and more at risk for not returning to normothermia (Singer et al., 2010)
Sex	Males are more likely to be burnt than females (Moore et al., 2014) Females sustain larger sized burns on average (Moore et al., 2014)
Pre-hospital Factors	
Distance	Time to definitive treatment is more important than distance when a patient required burn injury care at a burn care hospital.

	Distance from the location where injury occurred to the location of the burn hospital are more at risk of developing complications and is impacted by geographical terrain (Klein et al., 2006) If a burn injured person is injured at a site further than 145km from a burn care hospital they will have a longer length of stay, more operations and higher risk for mortality (Klein et al., 2009). If a burn injured person is directly transferred to a burn care hospital, they will have better functional recovery (Klein et al., 2009). Burn injured people are more likely to be admitted by road ambulance, be severely burnt and have a Glasgow coma scale of 8 or below (Hostler et al., 2013). If a burn injured person is transferred to a stabilising hospital prior to admission to the burn care centre they will have a greater length of stay in hospital due to being more unwell (Ehrl et al., 2018).
Time of burn injury	Burn injured persons who were admitted between 1800 hrs and 0600hrs and weekend where minimal staffing compared to standard hours during the day were more likely to present with below normal body temperature (Taira et al., 2009). During Spring and Summer burn injured people are more likely to present with low temperatures to the emergency department (Steele et al., 2016). The majority of burn injured people arrive within 1 hour of the burn injury occurring (Bell et al, 2012).
In-hospital Factors	

Warming devices	Intravenous warming devices allow for management of larger burn areas and longer surgeries to be performed on burn injured people (Corallo et al, 2008). Warming devices in burn injured people have varied efficacy. The use of warming devices such as fluid convection and intravascular warming devices have been found to assist in returning to normothermia (Kjellman et al, 2011). Intravenous warming devices decrease risk for bleeding by maintaining core temperature (Prunet et al, 2012). Guidelines are needed for the use of warming devices in the theatre area (Ziolkowski et al, 2016). Warming the ambient temperature of the room should improve patient outcomes if the person needs to return to normothermia (Rizzo et al., 2017).
Temperature on arrival to ED	Burn injured people who have needed resuscitation prior to admission to hospital are more likely to have low temperature on admission (Hardcastle et al., 2013). If admission temperature is low on arrival, then the person is more at risk of mortality (Weaver et al., 2014). If the burn injured person is failing to reach normothermia on arrival to ED they are more at risk of mortality (Weaver et al., 2014). Low admission temperature is a strong indicator of mortality in burn injured people. Whilst, acidaemia and early coagulopathy is an indicator in burn injured people (Sherren et al., 2014).

2.6 Conclusion

Whilst there is extensive literature on the outcomes of burn injured people, there is at the same time limited evidence which relates to factors which effect an individual's return to normothermia. Gearing et al's (2006) framework was used to review the current literature. Studies have discovered a range of factors which will affect a burn injured person's morbidity and mortality, but there is limited research on a burn injured person's return to normothermia. To date, no studies have been conducted which explored the factors related to the ability of burn injured people with TBSA % greater than 10% to return to normothermia. In summary, the lack of evidence regarding factors that contribute to normothermia in the burn injured person limits the information available to guide the nursing care of this group of people and as such, has the potential to put lives at risk. Such omissions in the literature are troubling and thereby validate the need for the current study.

CHAPTER 3: Methodology and Study Methods

3.1 Introduction

This chapter presents the methods chosen to address the research question posed by this study. The research question addressed was: What are the factors that contribute to normothermia in the person with burn injury greater than 10% of their total body surface in the first 24 hours of admission to a burn care hospital? In addressing the research question the study utilised the Gearing Framework (2006) for retrospective chart audit as the methodology and chart audit as the research design (Gearing et al., 2006). The application of the nine steps of the Gearing Framework (2006) enabled the creation of a data abstraction instrument that was used to gather data to address the research question.

3.2 Methodology

This study was guided by the nine step Gearing Framework (2006) for retrospective chart audit (Gearing et al., 2006). This framework is a proven methodology for auditing charts containing medical records, patient information and has been successfully used in previous retrospective chart audit research studies. Gearing and Charach (2009) used this framework in the United States of America to investigate psychiatric medication adherence in children, while Canadian researchers Tang, Ansarian and Courtney (2017) successfully followed Gearing et al.'s (2006)

framework to design a data abstraction instrument that recorded information about participants use of cannabis and the medication clozapine at predetermined set timepoints.

Although developed in the United States of America, several research teams have successfully used the Gearing Framework (2006) to address research problems within the Australian health care context (Seckold, Walker, Dwyer & Signal, 2019; Tang et al., 2017; Manias et al., 2016; Massey, Aitken & Chaboyer, 2015: Varndell, Fry & Elliott, 2011). Varndell et al., (2011), used this framework in their retrospective chart audit that focused on intravenous sedation in critically ill patients. These authors found the Gearing Framework (2006) enhanced the integrity and validity of their study (Varndell, Fry & Elliott, 2011). Another Australian research team including Massey et al., (2015), successfully followed the Gearing Framework (2006) to address issues around the activation of the medical emergency team, while Manias et al., (2016) used it to review transfer handovers between rural to metropolitan health care facilities. A very recent Australian study undertaken by Seckold et al., (2019) used the Gearing Framework (2006) to investigate complication rates between different types of peripherally inserted central catheters. Although each of these studies had a different focus, all of the research teams found the Gearing Framework (2006) to be an effective methodology to guide and provide rigour to their research projects.

As outlined above, the selection of the Gearing Framework (2006) as the method for this study is well supported in the literature as it provides a systematic process for the development of a retrospective data abstraction instrument. In addition, the Gearing

Framework (2006) has proven to be an effective methodology for use in the Australian health care context. By using the Gearing Framework (2006) as the methodology for this research, all aspects related to the chart audit process were able to be considered prior to the study commencing (Jennings, Kansal, O'Reilly, Mitra, & Gardner, 2015). Using a fully tested model such as the Gearing Framework (2006) ensured a clear audit trail was evident for the decision-making processes followed throughout the study. In addition, the tested methodology provided by the Gearing Framework (2006) had the potential to minimise errors and improve reliability of outcomes (Gearing et al., 2006).

3.3 Research Design

The design of this research study was a retrospective chart audit. The adoption of a retrospective chart audit designed allowed for the analysis of data, which may not have been previously collected or tested as well as the identification of problems yet to be detected (Vassar & Holzmann, 2013). Retrospective chart audits have been successfully utilised in different health occupations including psychology (Gearing & Charach, 2009), nutrition (Johnson et al., 2018), midwifery (Lind, Richter, Craft, & Shapiro, 2017), medicine (Carr et al., 2016) and nursing (Seckold et al, 2019; Tang, et al., 2017; Manias et al., 2016; Massey et al., 2015: Varndell et al., 2011). Clearly, retrospective chart audits are a popular research design in the health environment, due to the ability of the researcher to generate findings directly from patient data, thereby enabling a more accurate picture of the topic to be uncovered (Vassar & Holzmann, 2013). In this study the use of the retrospective chart audit design enabled data needed

to address the research question to be gathered in an orderly, cost effective and timely fashion (Gearing et al., 2006).

When undertaking the retrospective chart audit, the researcher was required to follow a formal, objective and systematic approach (Vassar & Holzmann, 2013). This was achieved in this study using the nine steps of Gearing et al. (2006) framework for retrospective chart audit. The nine steps are labelled in order as follows: conception, literature review, proposal development, data abstraction instrument, develop protocols and guidelines for abstraction, data abstraction, sample, ethics and pilot. Figure 3.1 presents the research design for the study.

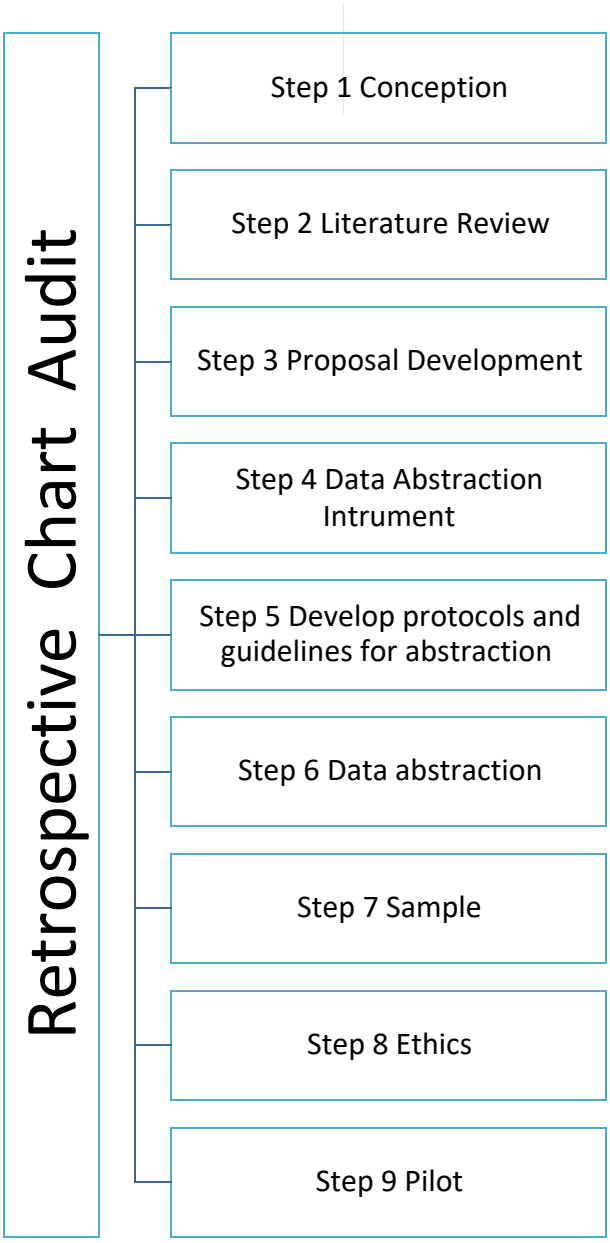


Figure 3.1 Research Design (adapted from Gearing et al, 2006)

3.4 The Development of the Data Abstraction Instrument

The nine steps in Gearing et al. (2006) Framework provided a comprehensive guide to conducting a retrospective chart audit, from conception through to the piloting of the data abstraction instrument. Having a set framework allowed clarity in the research approach and created a clear set of rules for the researcher to follow.

3.4.1 Step 1: Conception

According to Gearing et al., (2006) step one of the retrospective chart audit process is conception. The conception step involves two key parts, those being, research formulation and clinical scan. According to Gearing et al. (2006) research formulation is one of the key aspects of the process as it involves the creation of the research question. Formulation of the research question for this study had its roots in the clinical experience of the principle researcher, whose interest was spiked in the topic when caring for people with a burn injury in the first 24 hours of their hospitalisation. The researcher noted that it was not uncommon to receive burn injured persons into the intensive care unit during this period with low body temperature which was problematic for keeping the patient haemodynamically stable. The researcher further observed that many of these people required nursing intervention to increase their body temperature to normal range within the first 24 hours of hospital admission. This prompted the researcher to contact the hospital burns liaison nurse to query how people are kept normothermic in the intensive care environment. The answer received was that there is no evidence to suggest how best to warm people with a burn injury in

the intensive care setting. Knowledge of this situation ignited the researcher's interest in the topic and led to the foundations needed to formulate the research question.

The research question was further refined during the clinical scan, which involved the researcher exploring the issues around the management of body temperature of people with burn injuries in the first 24 hours of their hospital admission. The researcher sought input on the proposed research idea from four key people in the organisation, including the head burn surgeon, the burns ICU liaison nurse and two burns nurse educators located at the burn care hospital. The research supervisors were also consulted. Furthermore, the burn care hospital's nursing research committee was also asked for comment about the research design and research question. The outcome of the clinical scan indicated that there was a definite need for a study that explored the factors that affect body temperature in people with burn injury 10% or greater of their total body surface in the first 24 hours of their admission to the burn care hospital.

3.4.2 Step 2: Literature Review

The second step in the development of the retrospective data abstraction instrument was the literature review. The purpose of the literature review was to identify, synthesise and evaluate what was currently known about factors that contribute to normothermia in people with burn injuries and to identify key elements to be included in the data abstraction instrument. The literature selection process, quality analysis steps and review strategy are explained in Chapter 2. Table 2.3 presents the

initial concepts identified in the literature for inclusion in data abstraction instrument.

3.4 3 Step 3: Proposal Development

Step 3 involved the development of the research proposal, which essentially was the blue print of the methodology used to guide the study (Cresswel, 2015). The research proposal contained an abstract, introduction, literature review, research question, methodology, study methods, sample, study inclusion criteria (see Table 3.3).

Table 3.1 Study inclusion criteria

Item	***Description***
Age	Adult – 18 years of age and over
Burn injury	Greater than or equal to 10% of TBSA
Geographical location	Victoria, Australia
Hospital admission	Must be admitted to a burn care hospital ICU within 24 hours of hospital admission to ED.
Time period when burn injured persons were admitted to a burn care hospital	June 1st, 2013 to 31st of May, 2015

3.4.4 Step 4: Data Abstraction Instrument

Step 4 involved the creation of the data abstraction instrument to be used to collect the data for the study. The data abstraction instrument needed to include three

key components: organisation, simplicity and clarity (Zozus et al., 2015). An electronic version of the data abstraction instrument was favoured over alternatives due to the volume of variables listed and the ability to have data safely stored on a password protected computer (Chaboyer et al., 2008). Data were managed by entering the abstracted information directly on to the electronic data abstraction instrument (Zozus et al., 2015). An electronic version allowed for the information to be clearly identified during the data collection and data analysis process. Further benefits included cost effective data collection measures, reduced risk of input error due to clear documentation and easy access to data (Gearing et al., 2006).

Colour codes were used in the electronic data abstraction instrument to demonstrate different sections required in the audit process and to ensure the correct cell had the raw data entered in it. Having a table format made the data abstraction instrument easier to use and visually clear to the researcher when inserting data (Zozus et al., 2015). The key variables included: person factors, pre-hospital factors and in-hospital factors. These key themes were linked to the time when information would most likely be entered during the burn injured person's hospitalisation and followed in the order they appeared on the charts.

Vertically, the de-identified data of individual people were listed one at a time. When a burn injured person was admitted according to the set timeframe on the database, their electronic medical chart was be identified. Then, the potential participant was immediately screened for inclusion criteria as presented in Table 3.2. If the person met the inclusion criteria their details were coded and entered on the data

abstraction instrument. As well as initiating data collection, this process also provided confidentiality and privacy of the person. All data was collected from one medical record chart at a time. Once all information was gathered, the next person's data was identified and so forth. Information was only collected on people who met the inclusion criteria (see Table 3.2). Through creating the data abstraction instrument in this logical and standardised way meant the three key components, that being organisation, simplicity and clarity were addressed (Zozus et al., 2015).

3.4.5 Step 5: Data Abstraction Protocol and Guideline

Step 5 involved the development of guidelines and protocols for data abstraction. This step was important in the research process as Gearing et al. (2006) suggests that researchers undertaking chart audits need to have a working knowledge of how the information was recorded in the health records. Therefore, part of the preparation for the chart audit required the researcher to explore how the record keeping processes were applied by the burn care hospital, along with the type of information recorded in the charts (Zozus et al., 2015).

The burn care hospital has an archives department where health records are stored. As part of the ethical approval process the researcher was required to seek permission from the archives department for charts to be accessed. No physical paper hardcopies were accessed for this study. The researcher followed the burn care hospital's ethical approval processes (see 3.4.8 Step 8 – Ethics) and was granted to waiver participant consent and received permission to view the health record charts. An

important protocol involved the researcher accessing the burn care hospital's policies and procedures on data management. These were retrieved and reviewed prior to accessing the data. This ensured the principal researcher was not breaching any ethical, confidentiality or privacy components related to the research. Guidelines were also required with regards to the defining, capturing and the location of the data (Gearing et al., 2006). As such the researcher needed to know the expected location of the data in the health record chart. It was also important that each factor be clearly defined in the data abstraction instrument so that the researcher knew the data that was required to be collected. This information has been recorded in Table 3.2. The application of these protocols and guidelines ensured smooth access and processes were in place when the researcher undertook data abstraction from participants' medical record charts.

Table 3.2 Definition and expected location of factors in the data abstraction instrument

Factor /Variable	Definition	Expected location in health record chart
	Personal Factors	
Age on admission (years)	The age of the patient at admission (Steele et al., 2016).	Cerner Power chart
TBSA% on admission	Total burn surface area on admission relates to the size of burn injury expressed as a percentage by the rule of 9's assessment (Weaver et al., 2014).	Burn admission chart
Location of burn	The identified area on the body where the burn injury occurred (Steele et al., 2016).	Burn admission chart

Sex	The sex of the patient at admission (Steele et al., 2016; Singer et al., 2010).	Cerner Power chart
	Pre-Hospital Factors	
Pre-admission transfer	How the burn injured person was admitted to the burn care hospital such as ambulance (Steele et al., 2016).	Ambulance notes or emergency admission notes
Distance from hospital	The number of kilometres the burn injury occurred from the hospital (Weaver et al., 2014).	Ambulance or Emergency admission notes. Google Maps used to calculate distance from site hospital to burn injury site suburb.
Time of burn injury	Estimated time when the burn injury occurred (Weaver et al., 2014).	Ambulance notes or emergency admission notes
	In-hospital Factors	
Timing of admission and temperature non-admission	The initial temperature taken on arrival to the emergency department (Weaver et al., 2014).	Ambulance or Emergency admission chart
ICU arrival time and temperature	The initial temperature on arrival to the ICU (Mitra et al., 2013).	ICU observation chart

3.4.6 Step 6: Data Abstraction

Step 6 focused on planning how the data was to be extracted from the medical charts. Medical records were primarily electronically scanned but presented in paper format on screen. Although the data could be accessed on any computer within the hospital, consistent with ethical requirements, the researcher only accessed the data

from the burns liaison nurse's computer that was in a locked office space. This ensured the information viewed by the researcher on the burn care hospital computer system remained confidential. A regular appointment schedule was set with the burns liaison nurse to enable the access to required office facilities and collection of data.

Data were not able to be printed or photocopied from the participants medical record charts. Plans were made to ensure the spreadsheet containing the data abstraction instrument was locked, thereby ensuring security of the extracted data. The data abstraction instrument could only be access by the primary researcher, their supervisors and site hospital ethics committee who have not to date requested to see the data abstraction instrument. The data abstraction tool did not include participant names. These plans ensured the Privacy and Data Protection Act 2014 (Vic) and Health Records Act 2001 (Vic) were adhered to regarding data collection, retention and use. Other aspects of the data abstraction processes needing consideration included the time it took to gather the required data from each chart and the importance of the researcher ensuring selfcare by taking regular breaks from computer use.

3.4.7 Step 7: Sample

The setting for the study was a large tertiary referral hospital with burn care facilities situated in Melbourne, Australia. The hospital, which is referred to throughout this thesis as the burn care hospital, is responsible for servicing a population of 5,926,624 Victorians (Australian Bureau of Statistics, 2016). On average 10% of adults with a major burn injury require admission to a specialist intensive care unit. Only a

small number of people with a burn injury will require intensive care. Medical record charts of people 18 years of age and over, with a burn injury 10% or greater of the TBSA% that occurred in the state of Victoria, Australia during the set time period of June 1st, 2013 to 31st of May 2015 were considered for inclusion in the study. See Table 3.2 Study inclusion criteria.

3.4.7.1 Rationale for Inclusion Parameters

The burn size of greater than 10% was chosen as the majority of people admitted to hospital with burn injuries have between 10-20% TBSA (Burn Registry of Australia and New Zealand, 2018). Furthermore, the Australian and New Zealand Burn Association recommend that people with a burn injury of this size be referred to an adult burn care hospital (Burn Registry of Australia and New Zealand, 2018).

The original time period for the study was one year, however following the pilot test of the data abstraction instrument the time period was extended to two years (See 3.4.9 for details). The two-year time frame for the study was selected as no mass burn casualties occurred during this time in Victoria, Australia. According to Cameron et al. (2009) mass burn casualties have the potential to stress limited resources, resulting in the potential for data to be omitted or skewed. Only people with a burn injury that occurred in Victoria were included in the study as those transferred from other states may have passed through several health care facilities before arriving at the burn care hospital. Limiting the sample to participants from Victoria reduced the risk of temperature readings being skewed due to extensive travel time that may have occurred with out of state transfers.

3.4.7.2 Sample Size Determination

According to Gearing et al. (2006) every retrospective chart audit should have a statistical power analysis conducted prior to commencement of the study. The importance of this is to calculate the most appropriate sample size compared to the general population**.** Statistical power analysis establishes the required sample size to demonstrate significant results. In this research study, sample size was assessed by using an electronic calculator by Raosoft (2004). This estimate determined 41 cases were required when considering the average number of intensive care admissions to the burn care hospital (Raosoft, 2004).

3.4.8 Step 8: Ethics

This study followed and upheld the National Statement of Ethical Conduction of Research Involving Humans guidelines produced by the National Health and Medical Research Council of Australia (Australian Research Council, 2018). To achieve this simultaneous ethical clearance was sought from both Central Queensland University Human Research Ethics Committee and the burn care Hospital Ethics Committees prior to commencing the research. As part of this process the burn care hospital's nursing research coordinator was contacted, and a meeting arranged to ensure all components of the ethical process specific to the burn care hospital had been considered prior to submission of the ethics application. This was to assist in the process being smooth and to ensure the method of the research project was feasible. The burn care hospital nursing research coordinator was able to provide valuable and time saving assistance

such as informing about chart archive retrieval processes (Honari, Caceres, Romo, Gibran, & Gamelli, 2016).

The data collection section required access to electronic medical record charts of past patients of the burn care hospital. It is important to note that the past patients were unable to provide consent for their data to be accessed and were not aware their information was being used for this research. This was noted in the ethics applications and neither the university nor the burn care hospital required additional approvals. The ethical approval numbers were H16/01-006 (Central Queensland University) 639/15 (burn hospital ethical committee). Ethical approval certificates are available in Appendix A.

Data collection from participant's medical charts using the data abstraction instrument was able to proceed once the approval from both HREC's committees had occurred. The researcher was very aware of the ethical issues surrounding access to medical records and took steps to ensure all data was de-identified and privacy and confidentiality of the participants were always upheld to strict hospital and university ethical standards (Zeps, Lacopetta, Schofield, George, & Goldblatt, 2007). Furthermore, data storage processes required by both the university and burn care hospital have been followed. Data were stored on a password protected computer and will be stored in a secure locked server for the required length of time as per Central Queensland University data management policy.

3.4.9 Step 9: Pilot

The last step in Gearing et al.'s (2006) framework was the pilot testing of the data abstraction instrument. Despite the small available sample size, a pilot study was conducted. The first five medical charts that met the inclusion criteria were selected for the pilot. The pilot test was conducted to ensure the data were easily identifiable and information was smoothly transferable to the data abstraction instrument created (Gearing et al., 2006).

The pilot testing process identified that the sample size needed to be increased as there were insufficient number of burn injury admissions that met the inclusion criteria in the first timeframe. In addition, the small sample size often had variable descriptions in the paramedic notes about temperature recordings, for example; descriptions such as 'cold' or how temperature was measured. As such this variable was removed from the data abstraction instrument. Inconsistency in the documentation around the application of warming devices was noted in the pilot test. Inconsistencies were also noted with other factors such as temperature management in the critical care environment and application or removal of warming devices. Types of dressing applied, how temperature was assessed, as well as anaesthetics used were also removed due to inconsistencies recorded or simply not recorded about the burn injured person.

A minor amendment to the ethics applications for both the university and burn care hospital was needed after the pilot study was commenced. Findings suggested that the sample available in the initial time period of one year would be too small as not all

people with a burn injury were admitted to intensive care. Furthermore, the number of charts with missing data also reduced the available sample size during the original 12 month study period. By extending the date range by an additional 12 months the minimum sample number (n=41) needed for the study was reached. The amendments were approved by both the burn care hospital and university ethics committees – revised ethical approval letters can be found in Appendix B.

In addition to the pilot testing, a review of the data abstraction instrument was undertaken by experts in the area of burn injury nursing, including the burns liaison nurse of the burn care hospital. Adjustments were made to the data abstraction instrument following this peer review process. The expert team reviewed the data abstraction tool and made suggestions for change. and the final factors to be included in the study were identified. Table 3.3 presents the factors included in data abstraction instrument and the final data abstraction instrument is included in Appendix C.

Table 3.3 Factors included in data abstraction instrument

Person Factors
Age on admission years
TBSA% on admission
Location of burn
Sex
Pre-hospital factors
Season of burn injury
Distance from hospital

In-hospital factors
Arrival time to the burn care centre and temperature on arrival
Hours to return to normothermia
Duration (Hours) from ED to ICU admission
ICU arrival time and hour body temperature for first 24 hours

3.5 Data Collection

The medical charts of the study participants were accessed from March to July 2017 via the burn care hospital's intranet patient management program by the student primary researcher. This computer program was used to identify people with a burn injury who were treated at the burn care hospital within the study time frame. The patient management program was where the electronic patient medical records were housed at the burn care hospital. As the primary researcher had previously worked in the hospital, they were aware of the computer program and familiar with retrieving medical record charts from the electronic storage.

When the study commenced the researcher accessed one participant medical records chart at a time. This was to ensure that the information was accurately recorded in the correct places and data entry errors were minimised (Zozus et al., 2015). Strict privacy and confidentiality processes were carried out to ensure participants were de-identified during the selection process. People with a burn injury who met the inclusion

criteria for the study had their hospital identification number entered into a password protected word document. This was then coded with a number on the data abstraction instrument, which was also protected by a password. The reason for this process was to enable the researcher to revisit the chart should additional information be required. However, none of the participant data needed to be revisited.

The next step involved the researcher undertaking a detailed review of the medical records chart and searching for the required information. Data from the medical records chart was manually transcribed to the data abstraction instrument. When all data was abstracted and entered in the data abstraction instrument the data was stored as per Central Queensland Universities data management policy on a secure server. This includes storage of the de-identified data for seven years from time of publication and will be deleted after this time frame.

3.6 Data Analysis

The data was analysed using the statistical program SPSS 24 (IBM Corp, 2017). Descriptive statistics were used to determine the characteristics of the study sample. A mixture of parametric and non parametric analysis was used. Non parametric tests such as percentages, means, and standard deviations were used to determine distance from the burn care hospital, time of arrival, TBSA % and season. Parametric tests to detect differences between groups was determined by T- test with a *p* value of 0.05 being considered significant in this study (Chakkera, Schold, & Kaplan, 2016). T-tests were a

valuable statistic to use to determine the significant differences of different factors to assist in eliminating whether the factors occurred by chance (Pallant, 2016). A Levenes test was conducted to test the hypothesis where the variances in two groups may be considered unequal to determine if this was significant. Logistic regression was a suitable choice as it was used to predict categorical outcomes when considering return to normothermia in burn injured people. Further it was able to indicate the importance of each factor that was tested (Pallant, 2016).

3.7 Strengths and Limitations of the Study Methods

3.7.1 Strengths of the Study Methods

The adoption of a well-used and tested method such as the Gearing Framework (2006) to guide this study is a clear strength of this research. The Gearing Framework (2006) has a proven track record and has provided a systematic process for the researcher to follow. In addition, use of the Gearing Framework (2006) provides a clear pathway for replication of the findings as it outlines the steps followed by the researcher.

The retrospective chart audit research design was essential to the success of this study. The popularity of this research design in health sciences studies is well documented (Vassar & Holzmann, 2013) and it has been used many times to address important health focused research questions (Vassar & Holzmann, 2013; Gearing et al., 2006). For this study use of a chart audit design added strength to the research as it

enabled the data needed to address the research questions to be collected in an efficient and cost effective way (Vassar & Holzmann, 2013). Furthermore, by using one site for procurement of the electronic medical records, the researcher eliminated the risk of skewing the data with different data entry methods. Additionally, the process involved in conducting chart audit research is appealing as many clinical questions can be answered without invasive procedures. Such was the case in this study, as the researcher was able to access clinical data that had been entered previously in the clinical setting, without risk to participants' well-being (Vassar & Holzmann, 2013).

3.7.2 Limitations of the Study Methods

Although the study methods had several strengths, there were also some weaknesses. Previously it was argued that a single site for data collection was a strength of this research, it may also be viewed as a weakness as generalisability of findings may be limited. There is a possibility that the findings may be different if the research methods were applied in a different hospital or burn population. This limitation was identified prior to the commencement of the study when it was acknowledged there would potentially be limited numbers of subjects (Gearing et al., 2006). Limitation in the sample size was also highlighted and identified early when implementing step one of the Gearing Framework (2006). This allowed for the issue to be addressed in the development stage, which led to an expansion of the sample collection time range (Vassar & Holzmann, 2013).

Missing data is a clear weakness of retrospective chart audits as the data abstraction is only as good as the data originally entered (Varndell, Fry, & Elliot, 2011). Further to this is incomplete, unreadable or inaccurate documentation, making it difficult to assess the data accurately or accuracy. Additionally, there is a risk that a chart audit design can contribute to poor sample sizes and skewed data if not collected via a rigorous process (Chaboyer et al., 2008; Ireland et al., 2011). The research was also limited by the quality of documentation completed by the health practitioners caring for the participants at the time. On several occasions, data were not written or was unclear. In order to reduce this limitation and prevent missing data, the researcher reviewed all medical charts prior to enrolling the participants in the study to ensure required data was available.

3.8 Conclusion

In conclusion, the researcher has explained the pathway followed by the researcher in addressing the research question. The methodology and steps in the research design and method have been explained, along with the development of the data abstraction instrument, data analysis processes and ethical issues needing to be considered during the conduct of the research. The method chosen to address the research question has been justified and foundations laid for the next stage of the thesis, which is the presentation of the findings from the application the chart audit review process described in this chapter.

Chapter 4 Results

4.1 Introduction

This chapter presents the findings from the retrospective chart audit that was undertaken to address the research question: What are the factors that contribute to normothermia in the person with burn injury greater than 10% of their total body surface area (TBSA) in the first 24 hours of admission to a burn care hospital?

4.2 Demographic Characteristics

4.2.1 Sample Description

A total of 133 people with varying degrees of burn injury were admitted to the intensive care unit (ICU) of a large tertiary referral hospital able to provide burn care in Melbourne, Victoria during the two-year study period. A total of 50 people from this group met the study inclusion criteria. Of the potential sample, 83 were excluded. The reasons for exclusion can be found in Figure 4.1.

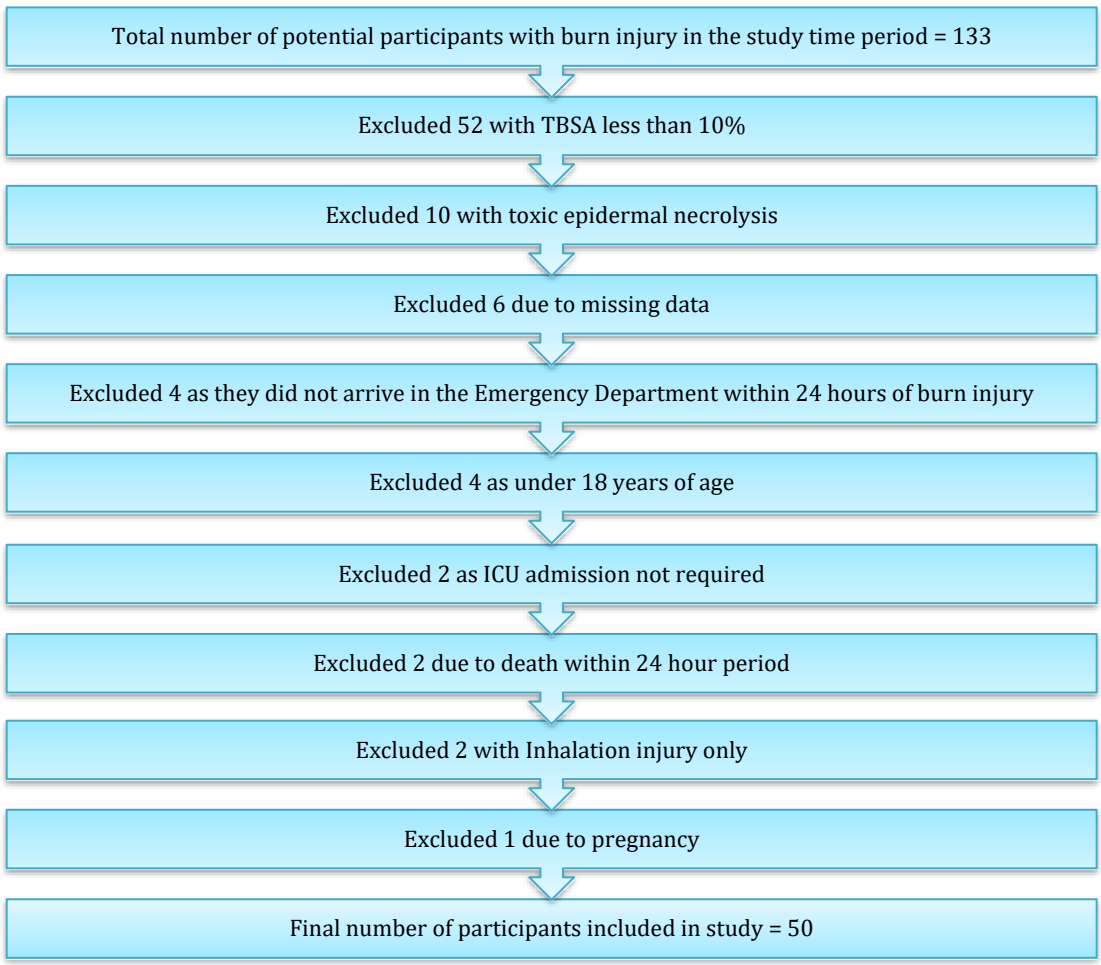


Figure 4.1 Reason for exclusion from study

The mean age of the burn injured persons was 42 years (SD 18.5; range 18-87 years). Two thirds (n=32; 64%) were under the age of 45 years. Of those included in the sample 40% (n=20) were aged between 18-34 years and 24% (n=12) between 35-44 years. Men accounted for 86% (n=43) of the total sample. See Figure 4.2 for age and sex distribution.

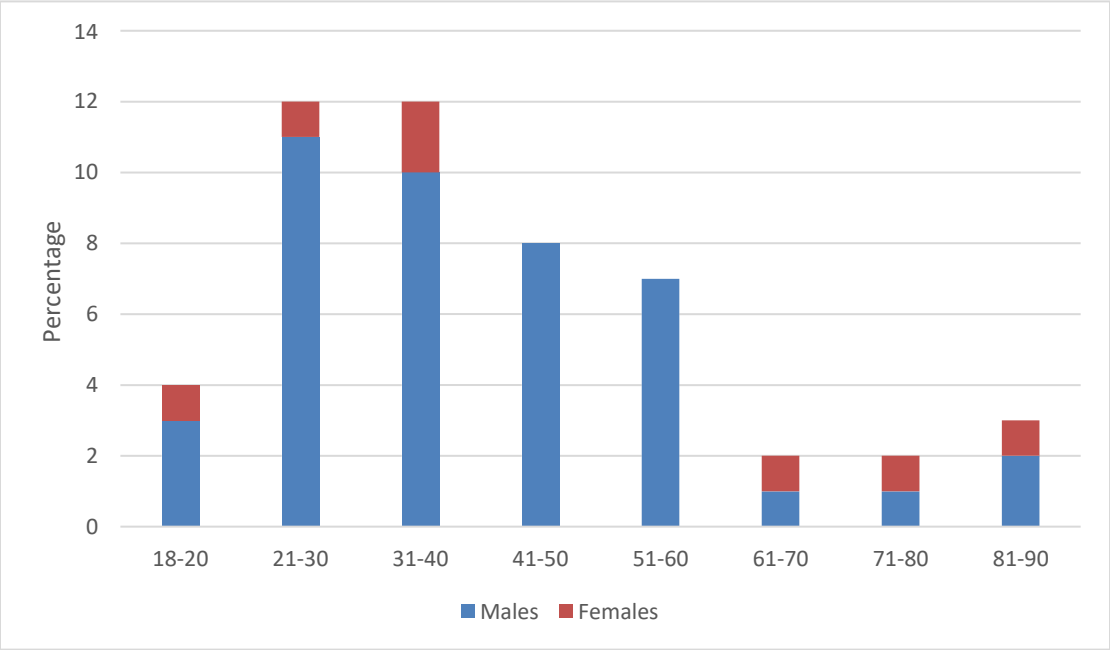


Figure 4.2 Age and sex distribution of sample (n=50)

4.2.2 Arrival at the Burn Care Hospital

Almost half the sample (48%; n = 24) were brought to the burn care hospital from further than 50km away (average 102.5 Km; SD 119.1), with the distribution of distance travelled to the burn care hospital heavily skewed toward shorter distances (Median = 42km, Range 3- 547km). The study participants were predominantly brought to the burn care hospital by ambulance (70%, n=35). Air ambulance (helicopter or fixed-wing plane) accounted for the second largest grouping, with nearly a quarter of the sample (22%, n=11) being transported by aircraft. Almost half the people who were more than 50km from the burn care hospital when their burn injury occurred were brought in by helicopter (46%, n=11). Additionally, a small number of people (8%, n=4) brought themselves to the burn care hospital or were brought in for treatment by a

family member or friend. See Table 4.1 for summary data and Figure 4.3 for graphical display of results.

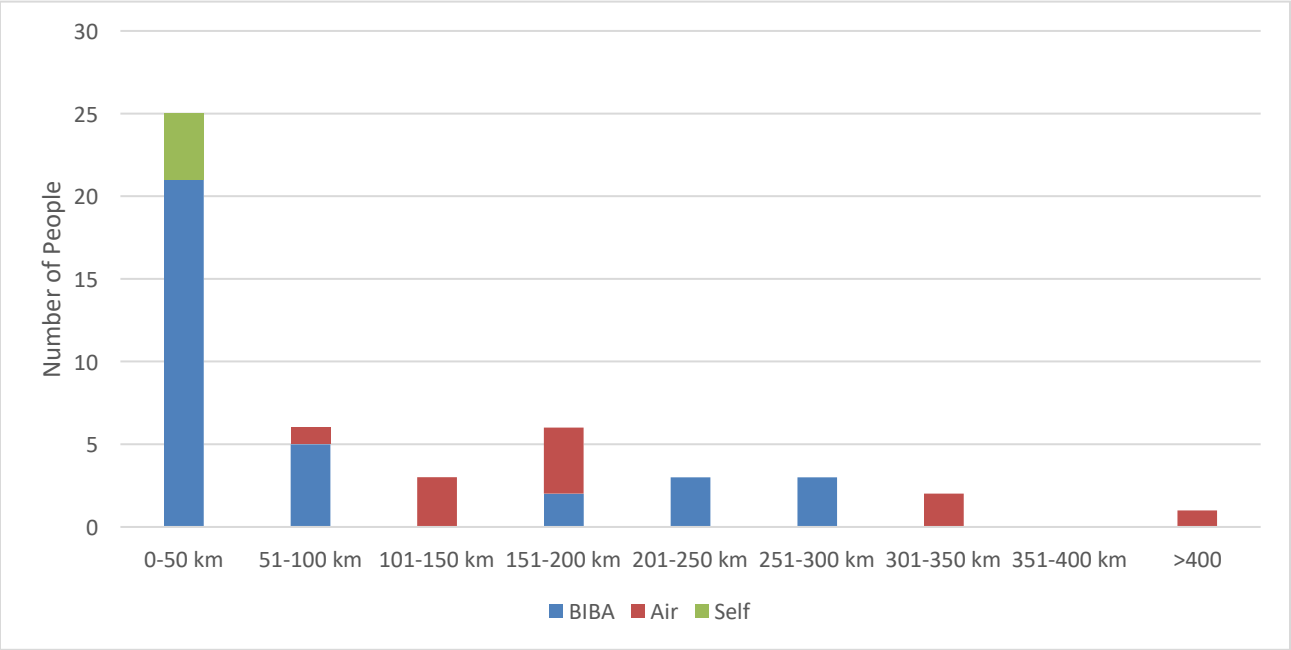


Figure 4.3 Mode of transport to hospital (n=50)

Table 4.1 Demographic information of sample

Participants' information	*Factors*	*% (n)*
Age	18-34	40.0 (20)
	35-44	24.0 (12)
	45+	36.0 (18)
	Total	100.0 (50)
Sex	Male	86.0 (43)
	Female	14.0 (7)
	Total	100.0 (50)

Mode of delivery to burn care hospital	Ambulance	70.0 (35)
	Air	22.0 (11)
	Self	8.0 (4)
	Total	100 (50)
Distance from burn care hospital	<49km	50.0 (25)
	50 or > km	48.0 (24)
	Total	98.0 (49)
	< 99 km	62.0 (31)
	100 or > km	36 (18)
	Total	98 (49)
Arrival time in Emergency Department (ED) at burn care hospital	7.00AM-7.00PM (Day)	62.0 (31)
	7.00PM-7.00AM (Night)	36.0 (18)
	Total	98.0 (49)
Total burn surface area (TBSA%)	10 - 20%	52.0 (26)
	21% – 40%	22.0 (11)
	> 40%	26.0 (13)
	Total	100.0 (50)
Season when burn injury occurred	Summer	16.0 (8)
	Autumn	34.0 (17)
	Winter	24.0 (12)
	Spring	26.0 (13)
	Total	100.0 (50)

There was a statistically significance difference in the initial temperature recorded on arrival at the burn care hospital for those people who travelled less than 99km (n= 28; M 35.1^{0}C; SD 1.33) compared to the arrival temperature of those that travel 100km and over (n= 18; M 35.8^{0}C; SD .609) (t (44)=-2.38, p = .022). Four participants arrived via personal transport. These results showed that participants who travelled over 100km to the burn care hospital were warmer than those who had less distance to travel. This may have been due to over 55% (n = 10) of those who had longer distances to travel having received initial treatment for their burn injury at another hospital prior to being transferred to the burn care hospital.

The time the burn injured person was admitted to the burn care hospital emergency department (ED) was recorded on the chart audit tool. “Day” was defined by the 12 hour window of 7.00AM-7.00PM. “Night” was defined as 7.00PM-7.00AM. These times reflected the 12 hour shift nursing rosters at the burn care hospital. The results showed that the time of arrival for the sample group was more frequent during the daylight hours (62%; n=31) compared to those who arrived during the night period (36%; n=18). One person was not included due to insufficient data recorded. See Table 4.1 for summary data.

4.2.3 Season when Burn Injury Occurred

The season a burn injured person was admitted to the burn care hospital was also recorded. The majority of the burn injured person admissions occurred in autumn (34%; n=17). This was closely followed by spring and winter, with 26% and 24 %

respectively (n = 13 and 12). Figure 4.4 demonstrates the seasons burn injured persons were admitted to the burn care hospital's Intensive Care Unit (ICU). The smallest admission rate as was during summer, with only 16% (n =8) of the sample being admitted at that time of the year.

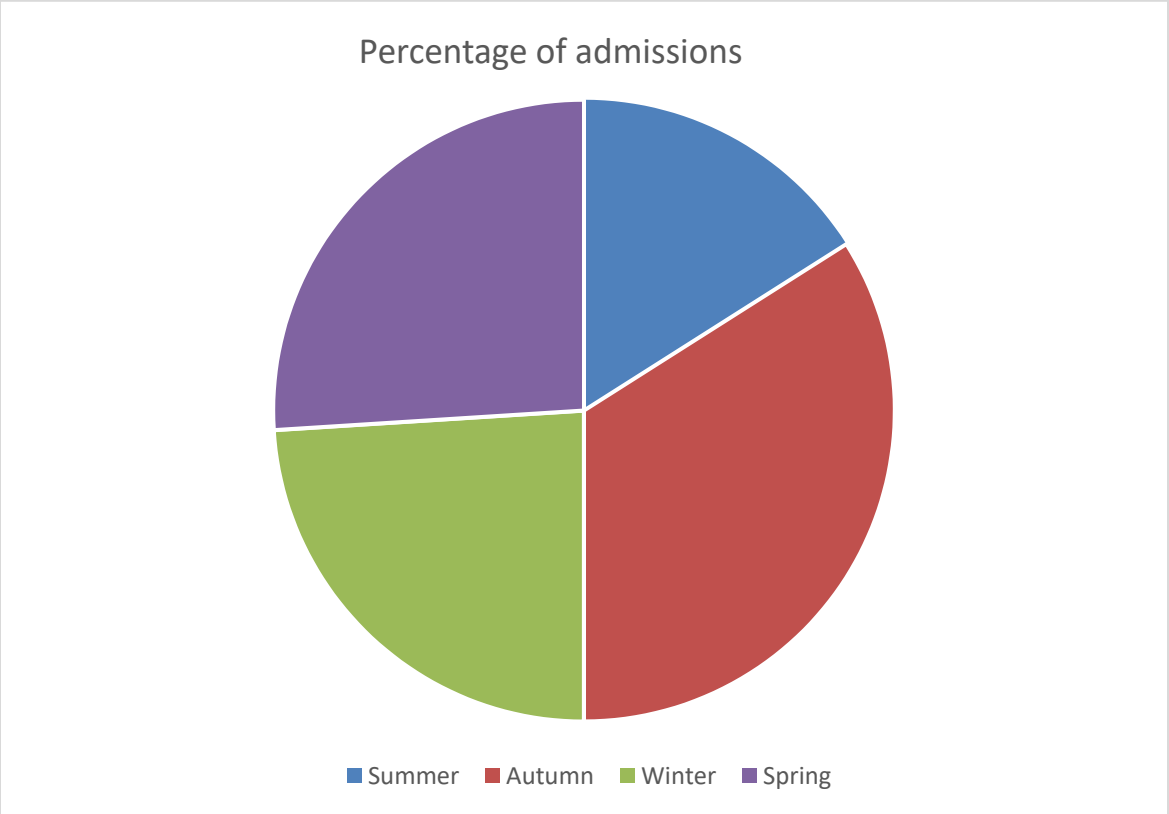


Figure 4.4 Seasonal admissions to ICU (n=50)

4.2.4 Total Body Surface Area Involvement

In line with referral recommendations from the Australia and New Zealand Burns Association (ANZBA, 2019), a minimum TBSA% threshold of 10% was set as a

key inclusion criteria for this study. Of those who met the inclusion criteria, just over half (52%; n=26) had documented TBSA% between 10 and 20% of their body. The remainder of the participants were relatively evenly split with 22% (n=11) having a TBSA% of between 20-39% and the remaining 26% (n=13) experiencing over 40% TBSA. The range for the study was 10-70% with the average total burn size being 19% (SD= 16.3). See Table 4.1 for summary data and Figure 4.5 for total body surface area distribution in the sample.

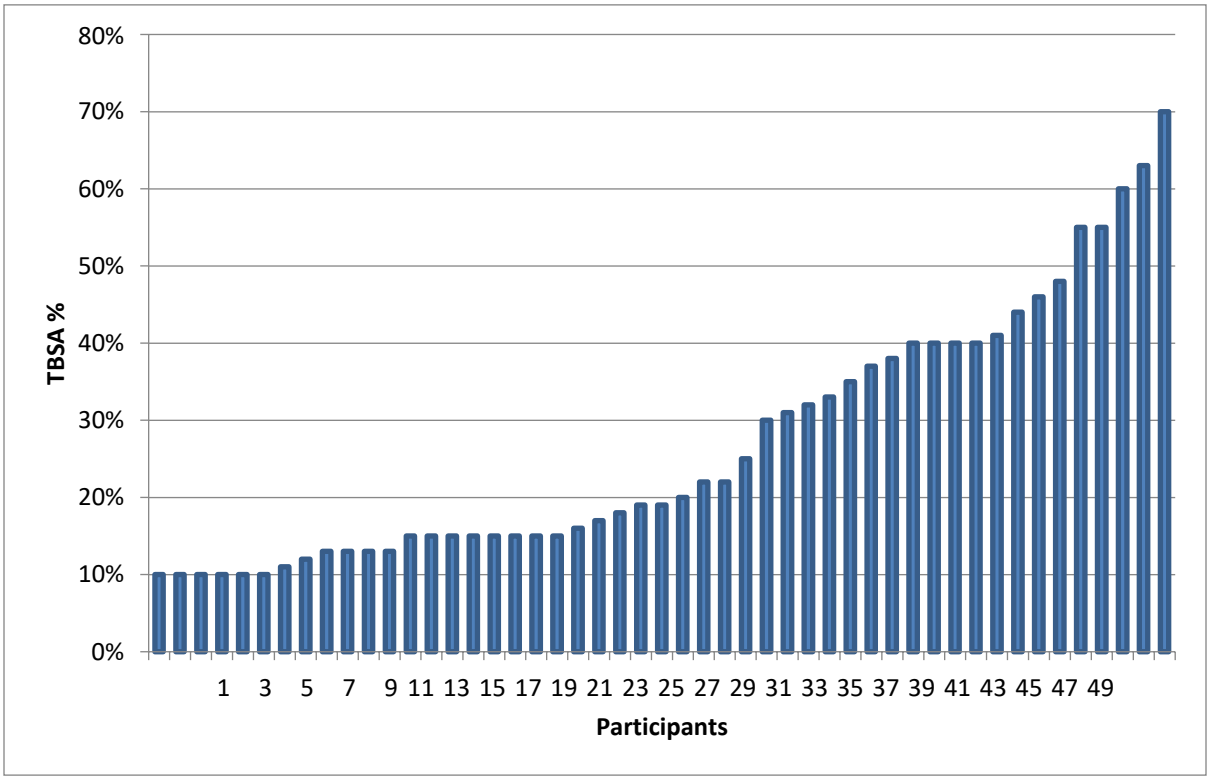


Figure 4.5 Total body surface area percentage burn distribution in the sample (mean26.4% SD 16.3%)

4.2.5 Percentage of Persons with Burn Injury to Specific Body Parts

The location of the burn. A total of 52% of burn injured persons (n=26) received burns to one or two areas of their body, 30% to three areas and the remaining 18% with burns to four or five body areas. The body areas involved are graphically represented in Figure 4.6, which shows that the genitalia and/or buttock areas were most commonly impacted.

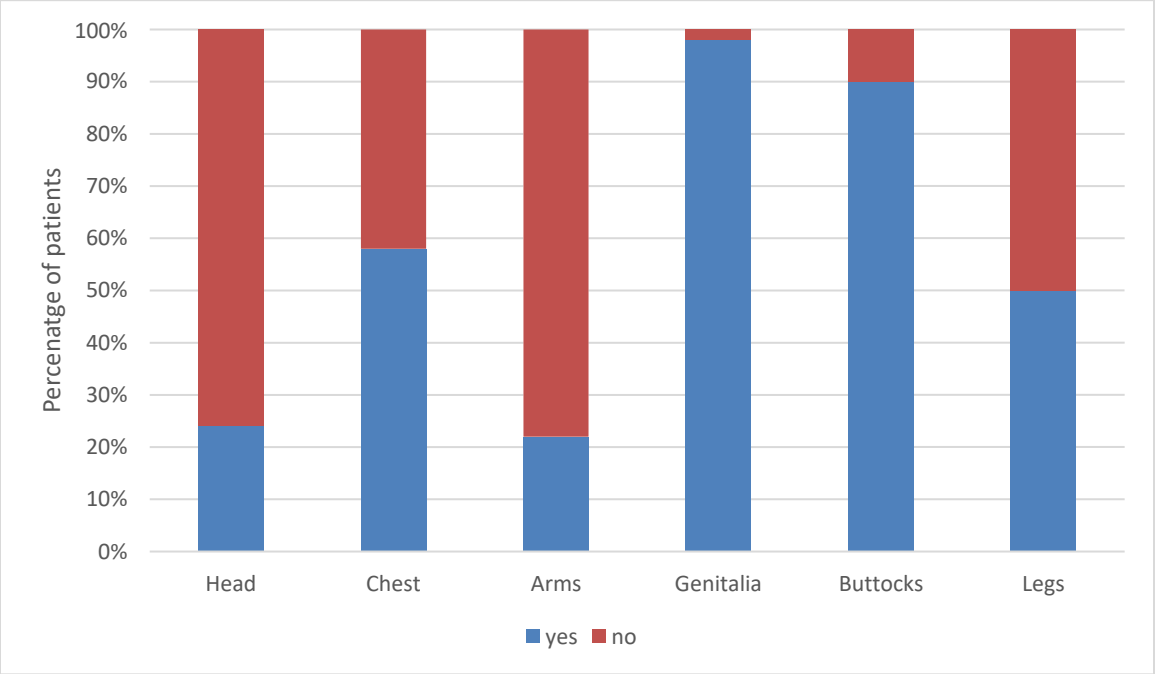


Figure 4.6 Burn injury specific to body area

4.2.6 Admission to Burn Care Hospital and Initial Treatment

All participants followed the burn care hospital admission process, which required them to be assessed and triaged in the emergency department (ED).

Depending on their triage category, participants were then admitted to either the operating theatre followed by transfer to ICU or directly to the ICU. Just over half (56%; n= 28) of the participants required transfer to the operating theatre during the first 24 hours of their admission at the burn care hospital with the majority (90%; n=45) requiring airway management with intubation and associated ventilatory support.

4.3 Data Analysis

A total of 44 participants had an initial body temperature documented by the paramedics in the pre-hospital environment. For the burn injured person with temperatures recorded the median initial temperature was 35.6 ^{o}C (range 30-37.2^{o}C). In comparison the initial median temperature recorded on admission to the emergency department was 35.4^{o}C (range 31.9-37.2 ^{o}C). According to this study's definition of what constitutes normothermia in the burned injured person, 84% (n = 37) of these burn injured persons recorded both a pre-admission and emergency department admission temperature below the desired temperature of 36.5 degrees Celsius.

Time taken to return to normothermia, varied greatly between those sampled and was treated as the dependent outcome variable. On average, participants took just over six hours to return to normothermia post admission to the emergency department (M=6.2 hours, SD=4.96). This distribution of return to normothermia for the sample is presented in Figure 4.7.

4.3.1 Correlations

A correlation matrix was used to investigate the dependence between multiple variables at the same time (Plitcha & Garzon, 2009). Table 4.2 was configured to demonstrate the relationship between the coefficients of each variable (O'Toole & Beckett, 2010). Significant correlations for several factors were observed. These were included in the model to assess the predictors of the number of hours taken to return to normothermia (36.5 ^{o}C) (HTN). These factors included: the distance from the burn care hospital (DFH) in kilometres, the percentage of TBSA, the hours between admission (HBA) to the burn care hospital emergency department and the ICU, and the initial temperature (INT) taken at the time of the burn injured person's arrival in the burn care hospital emergency department - See Table 4.2.

Table 4.2 Correlation matrix between the primary covariates in the study

	AFGE	*DFH*	*TBSA*	*INT*	*HBA*	*HTN*
Age	1.00					
Distance from burn care hospital (DFH)	-.024	1				
Total burns surface area (%) (TBSA)	.170	-.151	1			
Initial temperature (℃) at burn care hospital (INT)	.062	.224	-.207	1		
Hours admission to ED and ICU (HBA)	.074	-.018	.377**	-.033	1	
Hours to normothermia (HTN)	.242	-.236	.295*	-.545**	.077	1
Mean	42	102.4	26.4	35.9	5.53	6.20
SD	18.5	119.1	16.3	1.14	3.7	4.96

Note: Correlation is significant at *p < .05, **p < .01, 2-tailed

A positive correlation was detected between the burn injured person's TBSA% and the length of time between admission to the emergency department (ED) and the ICU (HBA) (r = 0.38, p < .01) as well as the hours taken to reach normothermia (r = 0.30, p < .05). A noteworthy significant negative correlation between the burn injured person's initial temperature (INT) in the emergency department of the burn care hospital and hours to normothermia (HTN) (r=-.545, p< .001) was found. When considering the predictor variable hours to normothermia (HTN), the hours between admission (HBA) was not significantly correlated with the HTN and was removed from further analysis (r = 0.08, p > .05, *ns*), along with age (r = 0.24, p > .05, *ns)* and distance from the burn care hospital (r = 0.24, p > 0.05, *ns).* Essentially, it was found that there

was an association between the larger TBSA percentage and the length of time the burn injured person spent in the emergency department and the length of time it took to return to normothermia. Likewise, there was an association between the lower initial body temperature recorded on arrival in the emergency department and the time taken to reach normothermia. The results showed that the lower the arrival temperature, the longer it took for the burn injured person's body temperature to return to normothermia.

Once admitted to the emergency department, the burn injured person had their temperature recorded an hourly basis. Figure 4.7 demonstrates the mean body temperature among the sample at each hour for 24 hours, the standard error of the means are displayed for each time point. The results of this study showed that burn injured persons reached normothermia (> 36.5°C) between 6.5 and 8 hours post-admission to the emergency department of the burn care hospital. Further, the biggest improvement in temperature occurred between four (M=35.4, SD=0.23) and five (M=35.83, SD=0.17) hours post-admission.

It is considered to be best practice is to transfer the burn injured person requiring surgery to the operating theatre within the early hospital admission period (Ziolkowski et al., 2017). There are currently no recommendations as to how quickly to warm a burn injured person. Potentially this may be the reason for the sudden increase in temperature at the 4-5 hours mark. The continued steady increase to the burn injured person's temperature during their time in the operating theatre may be the result of the application of warming devices to reduce further heat loss. Although

considered important in the literature (Ziolkowski et al., 2017) this information was not recorded in the charts audited for this study. A further spike in temperature was seen at the 10-11 hour mark where by this time the majority of burn injured persons have been admitted to ICU. The average number of hours it took a patient to return to normothermia in the sample was 6 hours. See Figure 4.7

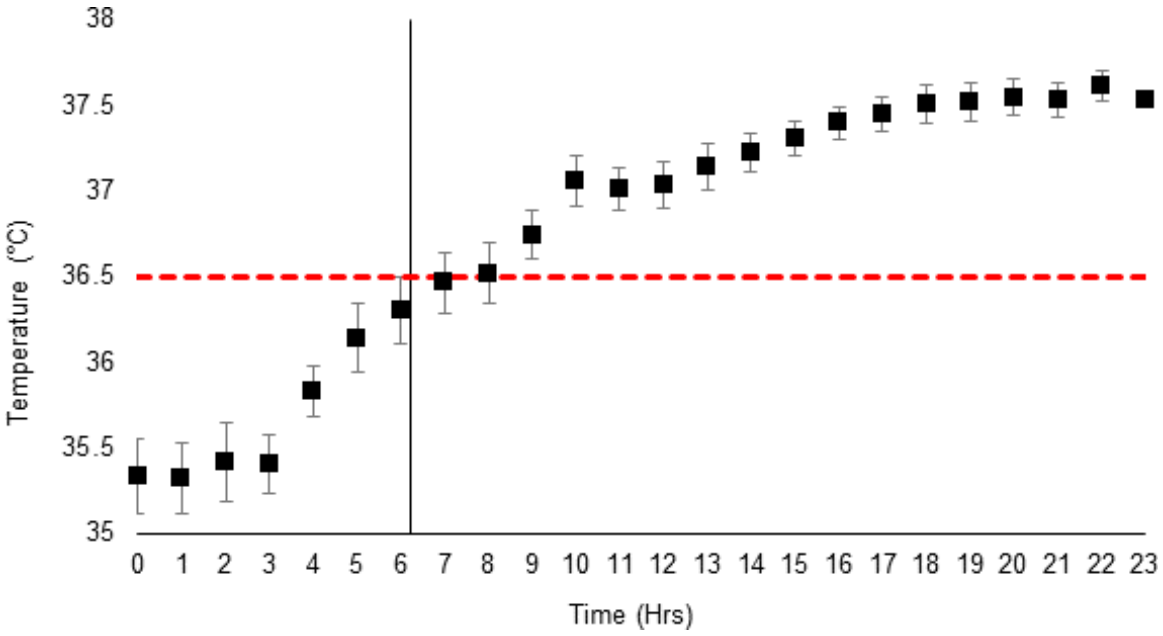


Figure 4.7 Average hourly temperature of all participants over a 24 hour period

4.3.2 Comparisons of Sex and Hours to Normothermia

The mean time for the total cohort to reach normothermia was 6.20 hours (SD= 4.962). A larger portion of the group sampled were males (See Figure 4.1) and the males in this sample were also significantly younger in age than the females. A t-test was conducted to determine whether there was a difference the time (hours) taken to

return to normothermia between the sexes. Females in the sample (M=11.14 hours, SD=5.58) took just under six hours longer to return to normothermia when compared to the males (M=5.38 hour, SD=4.41).

Males (n=43) had an average TBSA 25.5% (SD 15.3%) compared to females 32.1% TBSA (SD 22.0%). While the difference was not significant (t=-.766, DF 48 p= .469) this larger reported TBSA% demonstrated in females may have contributed to the differences noted in the longer time to reach normothermia between sexes. The time taken for each sex to return to normothermia after admission to the burn care hospital is graphically displayed in Figure 4.8. The horizontal bars in Figures 4.8 depict the median scores, edges of the boxes represent the interquartile range (25th and 75th percentile) and the tails representing the maximum scores with the exception of the outlier represented as a dot.

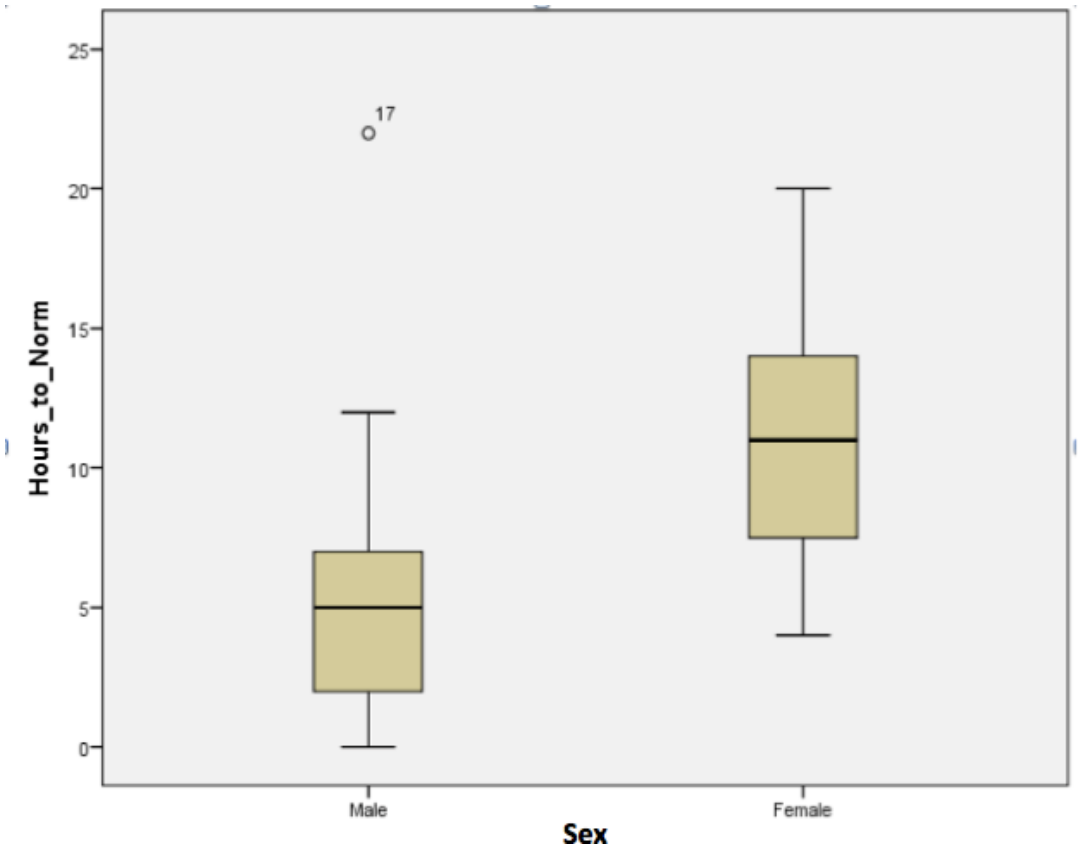


Figure 4.8 Difference in time to return to normothermia by sex

4.3.3 Comparisons Time of Day and Hours to Normothermia

A t-Test was conducted to determine if there is any difference in the time (hours) it takes for participants to return to normothermia (HTN) and the time of day they were admitted to the emergency department. People admitted to the emergency department during the night shift (7pm to 7am) on average took around two and a half hours (M=7.48 SD=5.3) longer to return to normothermia when compared to around five hours (M=5.25, SD = 4.53) for those admitted during the day (7am-7pm). This difference was not statistically significant (t (47)=1.54, p = .131).

4.4 Predictors of Return to Normothermia: Regression Analysis

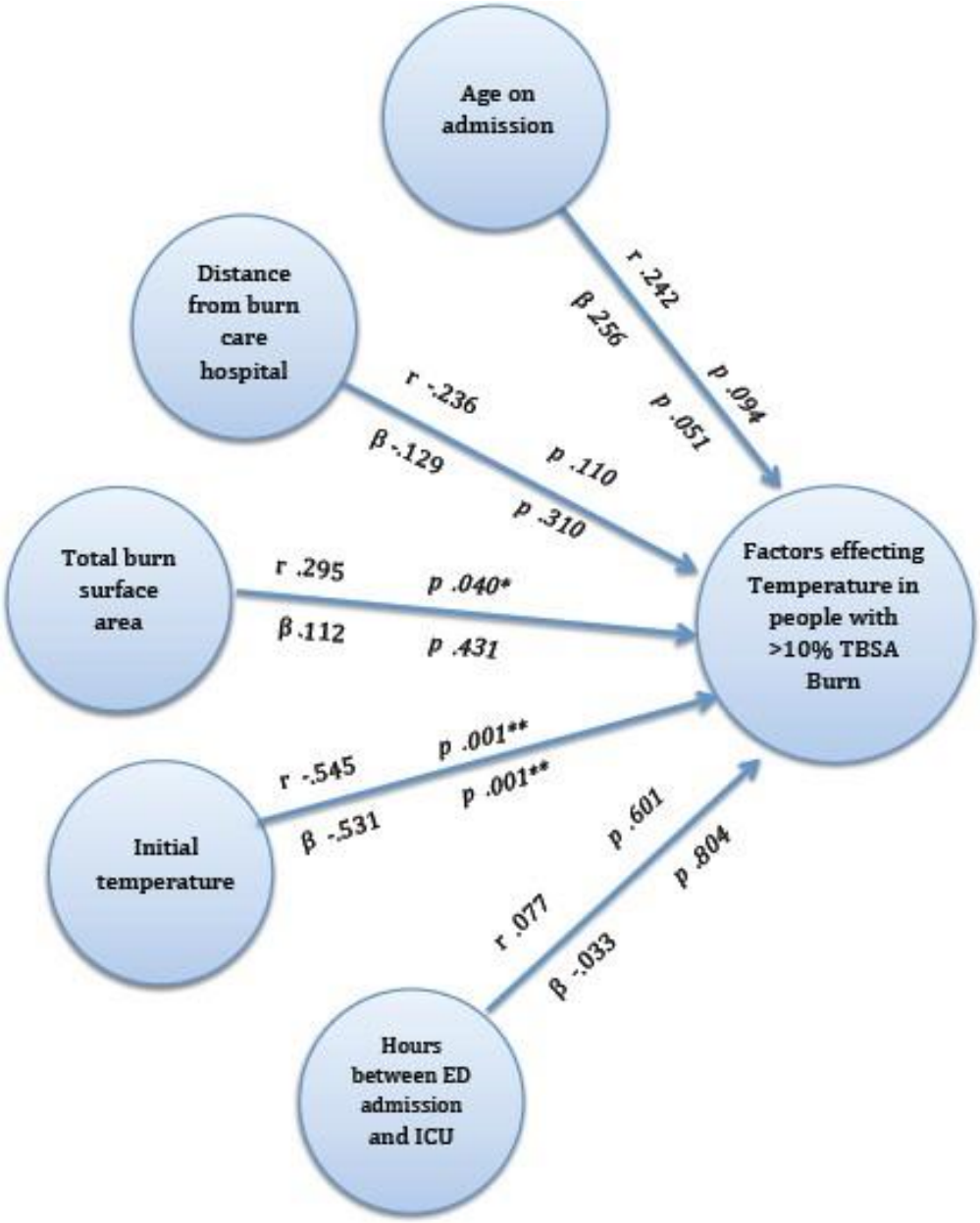
A two-step standard (simultaneous) regression analysis was conducted to examine the factors that are the greatest predictors of a body temperature of a burn injured person with greater than 10% of their body burned returning to normothermia in the initial 24 hours following admission to the burn care hospital (HTN). In the initial step only the significant correlations of the percentage of TBSA% and initial temperature (INT) on arrival in ED were entered. On the second step all five predictor variables were simultaneously entered including age, distance from the burn care hospital (DFH), the hours between admission (HBA) to the burn care hospital emergency department and the ICU, TBSA% and INT. The hours to normothermia HTN was the dependent variable for both steps. The results of the initial step of the regression indicated that the model explained approximately 29% of the variance in HTN ($F(2, 43)=10.38$, $p< .001$) with the initial temperature being the significant predictor ($\beta=-5.07$, $p< .001$). On the second-step of the regression, the model with all five variables, the explanation of the variance in HTN increased to approximately 34% (R^2) ($F(5,38)=5.46$, $p< .001$). The contribution of these five predictor variables are presented in Table 4.3.

Table 4.3 Predictor factors for hours to return to normothermia

Step 2	***Beta***	***T***	***Sig.***
(Constant)		4.113	.001
Age on admission	.256	2.014	.051
Distance from burn care hospital	-.129	-1.010	.310
Total burn surface area	.112	.796	.431
Initial temperature on arrival at burn care hospital ED	-.513	-3.961	.001**
Hours admission to ED and ICU	-.033	-.250	.804

Note: ** p<.001 Dependent Variable: Hours to normal temperature

When observing the coefficients in the model, the burn injured persons' recorded initial temperature on admission to the emergency department remained the only significant predictor of the time body temperature takes to return to normothermia (β=.513, $p < .001$). These results indicate the lower the burn injured person's initial temperature the longer it will take to return to normothermia. These findings are diagrammatically presented in Figure 4.9



Note: *p< .05 ** p< .001 Dependent Variable: Hours to normal temperature

Figure 4.9 Hours to normothermia

4.5 Conclusion

In conclusion, the findings of this research indicate that age, sex, distance from the burn care hospital when the burn injury occurred, percentage of total body surface area burned, and the time between emergency department and intensive care admission were factors that may affect a burn injured person's ability to return to normothermia. However, the finding that the burn injured person's body temperature on arrival to the emergency department was the key factor in their ability to return to normothermia is important and will have a significant impact upon the way care is delivered to this group of people.

Chapter 5 Discussion and Conclusions

5.1 Introduction

This final chapter contains the discussion of the findings from the retrospective chart audit. Throughout the chapter, the findings are compared to relevant research literature, conclusions are drawn, and recommendations are made for body temperature management in the person with a major burn injury. The strengths and limitations of the research are considered and a conclusion to the study is provided.

5.2 Brief Overview of Results

The aim of this study was to uncover the factors that contributed to normothermia in the person with a major burn injury during the first 24 hours of their admission to a burn care hospital. In order to address the aim and answer the research question, a retrospective chart audit guided by the Gearing framework (2006) (Gearing, et al., 2006) was conducted. Several factors related to participants and their burn injury were uncovered and investigated. These were grouped as person factors, pre-hospital factors, and in-hospital factors. Person factors focused on the age and sex of participants, percentage of body surface burned (TBSA%) and location of burn. Pre-hospital factors included the distance the person was from the burn care hospital when they experienced their burn injury, and whether they received treatment at another hospital prior to being transferred to the burn care hospital. In-hospital factors included

the time and body temperature recorded at the burn care hospital in the emergency department (ED) and intensive care unit (ICU) within the first 24 hours of the person's hospital admission. These temperature readings were assessed to determine trends and the time taken to reach normothermia.

The results of this study discovered normothermia generally occurred in most participants by 6-8 hours following admission to the burn care hospital, with the average time to normothermia being 6.4 hours. Furthermore, age on admission, distance from burn care treatment, total burn surface area, initial temperature on arrival at the burn care hospital ED, and hours between admission to ED and ICU were all shown to have an impact on the burn injured person's return to normothermia. Following application of simultaneous regression analysis techniques to these factors, the initial body temperature of the person with a major burn injury on arrival at the burn care hospital, emerged as the key indicator of the time it would take the person to achieve normothermia.

5.3 Predictors of Normothermia in the Person with a Major Burn Injury

Like many previous studies that have focused on the burn injured person (Ehrl et al., 2018; Moore et al., 2014; Steele et al., 2016; Weaver et al., 2014) this research had more males in the sample group than females. While males made up 86% (n=43) of participants in this study, these findings showed a significant difference between males

and females and the time taken to return to normothermia following a major burn injury. We found that females with a major burn injury took almost six hours longer than males to return to normothermia ($p = .034$). An earlier retrospective chart review conducted by Singer et al., (2010) that examined the outcomes for people who had experienced a burn injury, found 32% of female participants to have a temperature below 35.5 degrees Celsius on arrival at a burn care hospital. Unlike this study, Singer et al. (2010) did not offer any information with regards to the length of time it took females to warm when compared to males. A recent Canadian cohort study by Ziolkowski et al.'s (2017) found that when females experienced a burn injury, their burn tended to involve greater body surface area than when compared to males, but these researchers did not indicate why this may have been the case or how long it took females to reach normothermia. The finding that females took longer to reach normothermia than males with a major burn injury appears to be unique to this study. This study also provides information on the expected time it will take for females to warm compared to males. Such findings are important knowledge for nurses when planning the care of females with a major burn injury.

The average age of males in this study was 26 years with a range of between 21-30 years, in comparison to females who were more broadly spread over the entire age spectrum. This study demonstrated that as the age of the burn injured person increased, there was marginal trends upwards with the time taken for the person to reach normothermia following admission to the burn care hospital emergency department. Nevertheless, despite the positive correlation ($p= 0.469$) this study did not

find age to be a significant factor in the time it would take a burn injured person to achieve normothermia. Currently, there are no studies which report on whether a burn injured person's age effects the length of time it takes them to return to normothermia. That said, a study by Wearn et al. (2015) who reviewed the outcomes for older burn injured people in the United Kingdom, found that although burn injury management in the older population has improved, age continues to be highlighted as a risk factor for further complications in this cohort of people.

Previous studies suggests older people with a burn injury take longer to heal, are more at risk of morbidity (Albornoz et al., 2017; Bayuo & Botchway, 2017; Rani & Schwacha, 2011) and are likely to have high mortality rates due to deterioration in the immune system and pre-existing co morbidities, decreased strength, poor vision, and slower reaction time (Rani & Schwacha, 2011). Furthermore, frailty of the burn injured person has been identified as being more important than chronological age when considering outcomes following a burn injury (Bayuo & Botchworth, 2017), while a diagnosis of dementia was associated with a greater length of stay and more severe burns (Bayuo & Botchworth, 2017). Another recent study on outcomes for the burn injured older person found people over the age of 65 years to have more severe burns, deeper TBSA% wounds, and were more at risk of mortality being 1.9 times more likely to die (Albornoz et al., 2017). Although comorbidities have been shown in previous research to be important in the outcomes and management of the burn injured person (Albornoz et al., 2017; Bayuo & Botchway, 2017; Rani & Schwacha, 2011), this study did not investigate this area and had death in the first 24 hours of admission to the burn

care hospital as part of the exclusion criteria.

The focus of this study was on the factors that contribute to normothermia. To date, only one study has identified the older aged person with a burn injury as being more likely to have difficulty maintaining normothermia (Singer et al., 2010). Whilst not a significant finding, this research concurs with Singer et al.'s (2010) conclusions as the findings did show a positive correlation although not significant between the age of the burn injured person and the time taken to return to normothermia.

Although we demonstrated an upward trend with age and total burn surface area percentage (TBSA%) in this study, this was found to be not significant (p= .170). This concurs with previous research that also identified there was a trend, although not significant, with the size of the burn and incidence of low temperature when a burn injured person was admitted to the hospital emergency department (Hostler et al., 2013). In an earlier article, Muehlberger et al. (2010) argued that the size of the burn was insignificant in the pre-hospital setting and should only be of use for diagnosing a burn injury whilst the person was in the acute hospital environment (Muehlberger et al., 2010). Muehlberger et al. (2010) concluded that this was largely due to the inaccuracies in assessing the total burn surface area percentage, regardless of how experienced the assessor was. In this study, the size of the burn was identified to be significantly (p= .040) correlated with the number of hours to normothermia and increasing total burn surface area percentage. Although this does not indicate that one factor caused the other to occur, but when identified together may present a risk to the person with a major burn injury. This was unique to this study as no research to date

has explored these factors together.

Additionally, this study found an association between the length of time a burn injured person was in the emergency department of the burn care hospital, larger sized TBSA% (p=.377) and the time it took to return to normothermia (p= .295). Some studies (Weaver et al., 2014; Brusselaers et al., 2010; Singer et al., 2010) have considered these factors individually but to date no study has considered links between the return to normothermia and the length of time the burn injured person was in the emergency department of the burn care hospital or increases in TBSA% and return to normothermia. The closest finding is by Singer et al. (2010) who concluded the larger the TBSA % of the burn injury the greater the risk of hypothermia occurrence in the burn injured person. This study found a general positive trend when these two factors were correlated but was not found to be significant. Singer et al.'s (2010) study did not consider the length of time a burn injured person was in the emergency department. Weaver et al.'s (2014) study found burn injured people who had TBSA% of greater than 20% were more likely to have low body temperature. This study included burn injured people with 10% TBSA or greater and found a correlation with burn injured people with lower temperatures and increasing TBSA%. Weaver et al.'s (2014) study did not review the length of time the burn injured person spent in the emergency department.

The location of the burn on the person's body was also considered in this study, with more than half of the participants experiencing burns to more than one area of their body. The perineum or buttocks were the most commonly affected areas of the body in this study. It is difficult to assess why this may be the case as the mechanism

or

type of burn was not measured in this study. There is limited evidence in previous research about the location of the burn injury as the focus has tended to be on the impact of TBSA% rather than the actual location of the burn injury on the body (Hostler et al., 2013; Singer et al., 2010).

In this study, the season a burn injury occurred and subsequent admission to the burn care hospital was considered. Autumn was the season where most burn injuries occurred at 34%, followed by spring and winter, with 26% and 24% respectively. Lastly this study indicated summer was the least likely time a person would be admitted with a burn injury with 16% of the sample being admitted at that time. These findings differ from those of previous research with Steele et al. (2016) study concluding that burn injured people were more likely to present in Spring and Summer, though no reason was offered for this. Weaver et al.'s (2014) study went one step further and considered low temperature on admission and season. These researchers found similarly this study, summer had the least number of admissions with most being in spring, followed by autumn and winter (Weaver et al., 2014).

This study has identified that the distance from the geographical location the burn injury occurred to the burn care hospital did not contribute to the time taken for the person to return to normothermia ($p = .022$). Although distance has been considered by other researchers such as Chipp, Warner, McGill and Moiemen (2010), their focus was on distance, time and severity of the burn, rather than whether these factors contributed to normothermia in the burn injured person. Chipp et al.'s (2010) retrospective study of adult burn injured people found the more severely injured

required preference to be transferred by air ambulance to a burn care hospital and that guidelines were required to prevent unnecessary flights. 19% of the burn injured people in Chipp et al.'s (2010) study had a temperature of less than 35 degrees on admission to a regional burn care hospital. These researchers found that despite several burn injured people having a low body temperature in the pre-hospital setting, the distance, size of the burn injury and time taken to arrive at the burn care hospital were not contributing factors (Chipp, et al., 2010).

This study identified that the majority of burn injured people travelled short distances to a burn care hospital. We further found that nearly half of the participants travelled less than 50 km to attend the burn care hospital, with the average distance travelled being 42 km. Furthermore, 70% of the burn injured people in this study were bought to hospital via road ambulance. Moreover, this study concluded that burn injured people who attended a regional hospital to be stabilised prior to being transferred or who were flown directly from the geographical location of the burn injury by air ambulance were more likely to present as normothermic to the burn care hospital. This differs with the outcomes of previous research (Steele et al., 2016; Klein et al., 2009). Steele et al.'s (2016) study, for instance, found there was no significant difference between a person's body temperature on admission to the burn care hospital and whether they were moved by road ambulance or air ambulance. An earlier article by Muehlberger et al. (2010) that focused on prehospital care concurred with Steele, et al.'s (2016) findings. The views of Muehlberger et al. (2010) add to the debate as they conclude that emergency measures and resuscitation efforts for burn injured people in

the pre-hospital setting appeared to contribute little to improving the burn injured person's condition due to the physiological damage that may have occurred.

The researcher did not consider the physiological aspects of a person's response to a burn injury, we did explore the initial body temperature in the pre-hospital setting. In this study, the initial mean body temperature of the burn injured person in the pre-hospital setting was 35.6 degrees Celsius. On arrival at the burn care hospital the average body temperature recorded dropped down to 35.4 degrees Celsius. In this study normothermia was considered to be a body temperature of 36.5 degrees Celsius to 38.5 degrees Celsius (see chapter 1). This meant that 87.2% of these participants presented to the emergency department of the burn care hospital with a body temperature below the minimum range. Previous research found similar results to this study (Steele et al., 2016; Weaver et al., 2014). In Weaver et al.'s (2014) study, 42% of the sample were considered to have a body temperature below the required range of 36.5 degrees Celsius on arrival to the emergency department, while 42% of Steele et al.'s (2016) sample had a temperature below 36 degrees Celsius. The sample size in Steele et al.'s (2016) study was 31 burn injured people as opposed to Weaver et al.'s (2014) study who had a total of 2770 burn injured people in their sample. While low body temperature in the pre-hospital setting appears to be common, not all studies have found this to be the case. Singer et al. (2010) who reviewed body temperature of burn injured people, found only 1.6% of their sample had a body temperature below the required range on arrival to the emergency department of a burn care hospital.

Through analysis of the 87.2% of these participants who presented to the

emergency department of the burn care hospital with a body temperature below the minimum range, we were able to determine that body temperature on admission to the burn care hospital emergency department correlated to how quickly a person would return to normothermia ($p < .001$). Results from this study, although not significant, demonstrated that when the person's initial temperature was low, this correlated with the burn injured person having a prolonged return to normothermia ($p = 0.545$). These findings concur with those of Ziegler et al.'s (2019) retrospective chart audit who found 60.3% of their sample had a body temperature below normothermic range upon admission to the burn care hospital. In Ziegler et al.'s (2019) study a body temperature equal to or greater than 36 degrees Celsius was regarded as normothermic. Like this study, Ziegler et al. (2019) only reviewed body temperature in burn injured people in the first 24 hours of admission to the burn care hospital and found length of stay in hospital was longer in the severely hypothermic group but not significant. Nevertheless, in Ziegler et al. (2019) study, burn injured people who presented severely hypothermic had significantly longer length of stays in intensive care (29 days) compared to the normothermic group (9 days). This study did not investigate length of stay in intensive care or hospital as the focus was on the initial 24 hours of admission to the burn care hospital.

This study's finding that most people with a major burn injury had a temperature below normothermic range on presentation to the burn care hospital is consistent with findings of previous research. A German study by Ehrl et al. (2018) who had a similar

sample size to this study, that is, 54 burn injured people, found that 62.9% of their sample had not returned to normothermia on admission to the burn care hospital.

Importantly this study found that temperature on admission to the burn care hospital emergency department was correlated to how quickly a person would return to normothermia. No study to date has reported this identified factor. Results from this study demonstrated that when the person's initial temperature was low, this correlated with the burn injured person having a prolonged return to normothermia. These findings are unique to this study and significant as they highlight to nurses the importance of maintaining normothermia in the burn injured person. The study by Chalfin, Trzeciak, Likourezos, Baumann, and Dellinger (2007), which focused on why delays happen in treatment in the emergency department, found multiple reasons for this occurrence including: the need for additional specialty care, tests and procedures. Chalfin et al. (2007) concluded that people held for greater than six hours in the emergency department and then transferred to ICU had greater hospital length of stay and mortality rates. This early study does not specifically identify burn injured people and therefore the value of Chalfin et al. (2007) findings to this study are minimal.

The recent study by Ehrl et al. (2018) identified low temperature on admission to intensive care was common. The average ICU admission temperature of participants in Erhl et al.'s (2018) study was 35.9 degrees Celsius. Erhl et al.'s (2018) found that burn injured people who had been previously referred to another hospital prior to admission to the burn care hospital had marginally higher average ICU admission temperatures of 36.1 degrees Celsius. This study showed all burn injured persons had

returned to normothermia (36.5 degrees Celsius) by the time they were admitted to ICU.

Recognising the importance of ensuring the burn injured person receives treatment quickly, this study focused on the number of hours between arrival in the emergency department of the burn care hospital and admission to the intensive care unit (ICU). Furthermore, we considered whether the time taken for the burn injured person to arrive in ICU had any effect on their return to normothermia. No studies to date have focused on delays in transferring burn injured people once they have arrived in hospital and the impact this may have on their care. That said, Taira et al. (2014), did consider the time of the burn injured person's arrival at hospital and the impact of their needs on available resources. These researchers found 68.9% of the sample arrived during the off hours (6pm- 6am). This study also looked at time of arrival at the burn care hospital and, unlike Taira et al. (2014), we found 62% of burn injured people arrived in the daylight hours between 7am to 7pm. We found that there was no significant impact on the time or hospital arrival and the burn injured person's return to normothermia. During this time frame, more resources such as ICU Consultants, Surgeons and ICU Burn Liason Nurses are available to assess and assist the burn injured person (Ehrl et al., 2018; Taira et al., 2014; Klein et al., 2006).

In this study, we looked closely at the time between people being admitted to the emergency department and reaching intensive care. The results showed that most people with a major burn injury were admitted to ICU by the tenth or eleventh hour. This study's findings further revealed that it was at this time there was a notable spike in

recorded body temperature. These findings are unique to this research as no other study to date has explored how long it takes for burn injured people to be admitted to intensive care from the emergency department.

When the burn injured person is within the in-hospital setting (which includes ED) there is limited evidence available as to how to best manage their body temperature regulation needs (Hardcastle et al., 2013). The results of this study indicate that the time spent from the point of entry in the emergency department to the point of entry to intensive care is a significant factor in the burn injured person's ability to return to normothermia ($p < 0.05$). This factor has been under reported in the literature. As such, this study offers valuable findings on the importance of ensuring the person with a major burn injury receives immediate treatment. Delays in treatment can lead to further complications for the burn injured person (Schmauss et al., 2015) so it is imperative that burn resources are available to the person in a timely manner to assist a burn injured person return to normothermia.

5.3.1 Summary of Factors that Contribute to Normothermia in the Person with a Major Burn Injury.

In the context of this study, the outcomes do provide information for nurses and other health professionals about the factors that affect the ability of a person with a major burn injury to return to normothermia during the first 24 hours of their admission to a burn care hospital. This study has strengthened the understanding that, although not significant, the person's age, the distance they were from the burn care

hospital when the injury occurred, the percentage of their body burned, and the time between the emergency department admission and transfer to ICU are factors needing consideration when planning care for the person with a major burn injury. Importantly, the results of this study showed that the initial body temperature recorded for the person with a major burn injury on admission to the emergency department of the burn care hospital was the factor most likely to predict the number of hours it would take a person to achieve normothermia. This study indicates that ED nurses may need to do more to combat hypothermia in the initial hours of the hospital admission. The findings of this study further highlight the need to prevent early deterioration in the first 24 hours of hospital admission by directly preventing a drop-in body temperature in people with a major burn injury.

5.4 Strengths of the Study

The use of the Gearing et al.'s (2006) framework for chart audit is a strength of this study and enable the research question to be answered. The Gearing Framework (2006), which is based on nine sequential steps, provided a clear structure for the development of the data abstraction instrument that was used to collect the data required to address the research question. The retrospective chart audit design enabled the data to be collected in an efficient and cost-effective way. The study design further ensured data was able to be recorded across a range of seasons and within the required set time period. The use of the well-established Gearing et al., (2006) framework as the

methodology to guide the research design and data collection for this study added rigour and quality to the research process (Vassar & Holzmann, 2013).

A further strength of this study was the collection of data from a single site and the use of a sole data collector. Both these initiatives reduced the possibility of data corruption and interrater reliability errors that can occur with multiple data collectors. Furthermore, by collecting data from only one site, external factors that may impact results such as different protocols or levels of complexity in patient care were limited.

The literature review process applied to develop the data abstraction instrument was a further strength of this study. Step 2 of Gearing et al.'s (2006) framework involved a thorough investigation of the current literature available to ensure variables related to the topic were identified and included in the data abstraction instrument. The refinement of this instrument through a pilot test added strength to the study (see Chapter 3). The pilot test of the data abstraction instrument was undertaken to examine whether the number of variables or factors identified in the literature were present in the medical charts. Pilot tests of the data abstraction instrument were an added strength of this study as it ensured the tool contained the appropriate information to enable successful collection of the required data.

Finally, the results of this study are a strength as they have answered the research question, thereby filling the gap in burn injury literature with regards to the factors that impact upon the burn injured person's return to normothermia.

In summary, the strengths of the study from the selection of the methodology and design, through to the data collection methods and processes have enabled the research question to be answered. As such, the study has been able to provide important information for nurses and other health care professionals with regards to the factors that contribute to normothermia in the person with a burn injury during the first 24 hours of their admission to a burn care hospital.

5.5 Study Limitations

Whilst this study has strengths and the findings add to what is known about the ability of the person with a major burn injury to reach normothermia, there were some limitations that require consideration when interpreting the findings. One such limitation was the restricting of the study to burned injured people who received treatment in Victoria, Australia. As such the findings may not be transferable to other Australian states, territories or international settings. Nevertheless, the findings are specific to one location adding rigor to this study.

This sample included only adult people with a burn injury. This study did not investigate burn injured paediatric patients because different tools are used to assess burn injury in children. A further limitation was the inability of the data collector to confirm whether the TBSA% had been either underestimated or overestimated on initial assessment due to the retrospective nature of this study. Missing data was a common limitation encountered during the chart audit process (Varndell et al., 2011).

Nevertheless, the use of real time data to develop an accurate picture of the sample investigated is critical for this study. Furthermore, data recording errors were noted in many charts including the use of ambiguous or non-descript terms and illegible handwriting. To prevent missing data and ensure accuracy of the data, averages were not considered and any participant who had a five or more pieces of data missing were not included in this study. In the pilot stage, any factors that were being investigated that had no results were also eliminated from the data abstraction instrument. The identification of these limitations in the data resulted in the exclusion of several potential participants. According to Vassar and Holzmann (2013) this situation is not uncommon in the auditing of medical charts and is an area the researcher considered when planning the research using the chart audit design. It is important to note that throughout the research process these limitations were considered and steps were put in place to minimize the impact they may have on the research and outcomes.

5.6 Implications and Recommendations for Practice

This study has shown the initial body temperature of the burn injured person on arrival at the burn care hospital was the key factor with regards to the time it would take for them to achieve normothermia. This finding has implications for the management of the burn injured person and the education of nurses and other health professionals as to how to best manage this group of people. The increased ability of nurses and other health care professionals to manage people who have experienced a burn injury has the potential to reduce the risk of burn injury complications and save

lives. The information generated by this study will facilitate this process as it provides clear knowledge as to the factors that contribute to normothermia in the person with a burn injury during the first 24 hours of their admission to a burn care hospital.

Recommendations for practice arising from this study include the:

- Development of work place guidelines for best practice in nursing that incorporates both demographic factors as well as the recording of body temperature in the emergency department immediately upon arrival of the burn injured person.

- Implementation of guidelines for warming practices in the emergency department for the person with a major burn injury.

- Introduction of guidelines focusing on the sex of the person and specific consideration given to females who were identified by this study as being more at risk of a slow return to normothermia compared to males.

- Enactment of policies on specific documentation requirements surrounding temperature measurement of the person with a major burn injury during the first 24 hours of their admission to a burn care hospital.

- Increased focus on the education of nurses as to the risks faced by the person with a major burn injury, with an emphasis on the need to return a burn injured person to normothermia, including required documentation and the legal implications of missing data.

5.7 Areas for Further Research

Arising from this study are areas for further research into both the immediate care and policy development concerning the person with a major burn injury. When nurses and associated health professionals are better informed as to the contributing factors that hinder a burn injured person's ability to return to normothermia patient outcomes should be improved (Ehrl et al., 2018).

A key finding of this study related to the person's body temperature on arrival at the burn care hospital and its effect on their ability to return to normothermia. As such, further research is needed to explore the health professionals initial actions when caring for this group. More in depth research is needed to compare differences between the sexes with a major burn injury and the time taken to reach normothermia. In addition, further research is needed to explore whether a person's age and comorbidities affects the length of time it takes them to return to normothermia. It is recommended that a replication of this study be undertaken in the paediatric setting to explore whether the findings are transferable to children. Finally, research is needed to explore the long-term outcomes related to the time taken to reach normothermia in the person with a major burn injury. This study did not investigate how normothermia was achieved and this factor warrants further investigation. These findings highlight the need for more research to be conducted in relation to burn injury in the aged person as there is limited information available.

5.8 Conclusion to the Study

This study used a retrospective chart audit design, guided by the Gearing Framework (2006)(Gearing et al., 2006) to explore the factors that contribute to return to normothermia in the person with a burn injury within the first 24 hours of admission to a burn care hospital. Age, sex, distance from the burn care hospital when the burn injury occurred, the percentage of the total body burnt, and the time between the emergency department and ICU admission were flagged as factors that may impact upon the ability of the person to reach normothermia. This study found the key indicator was the body temperature of the person when they were admitted to the burn care hospital emergency department.

In conclusion, this research provides important information for nurses who care for people with a major burn injury during the first 24 hours of their hospital admission. Recommendations have been made for changes in practice and areas for further research have been identified. The outcomes of this research will assist nurses and associated healthcare providers improve the care delivered to people with a major burn injury during the first 24 hours of their hospitalization. Finally, the findings generated by this study provide information for use by nurses, nurse educators and policy makers to facilitate changes in practice that may contribute to saving lives.

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Appendices

Appendix A: Ethical Approval Certificates

Secretary, Human Research Ethics Committee
Ph: 07 4923 2603
Fax: 07 4923 2600
Email: ethics@cqu.edu.au

Dr Sandra Walker and
Ms Jessica Clack
School of Nursing and Midwifery
Rockhampton Campus

15 January 2016

Dear Dr Walker and Ms Clack

HUMAN RESEARCH ETHICS COMMITTEE ETHICAL APPROVAL PROJECT: H16/01-006 *BURN INJURIES AND HYPOTHERMIA: FACTORS CONTRIBUTING TO HYPOTHERMIA IN THE FIRST 24 HOURS OF ADMISSION TO INTENSIVE CARE UNIT*

The Human Research Ethics Committee is an approved institutional ethics committee constituted in accord with guidelines formulated by the National Health and Medical Research Council (NHMRC) and governed by policies and procedures consistent with principles as contained in publications such as the joint Universities Australia and NHMRC *Australian Code for the Responsible Conduct of Research*. This is available at http://www.nhmrc.gov.au/publications/synopses/_files/r39.pdf.

On 15 January 2016, the Acting Chair of the Human Research Ethics Committee acknowledged previous ethical approval for this project from the Alfred Hospital Ethics Committee (Approval 639/15), and has granted full approval as a CQUniversity project (H16/01-006) under chapter 5.3 of the National Statement, pending ratification by the full committee at its February 2016 meeting.

The period of ethics approval will be from 15 January 2016 to 30 December 2017. The approval number is H16/01-006; please quote this number in all dealings with the Committee. HREC wishes you well with the undertaking of the project and looks forward to receiving the final report.

The standard conditions of approval for this research project are that:

(a) you conduct the research project strictly in accordance with the proposal submitted and granted ethics approval, including any amendments required to be made to the proposal by the Human Research Ethics Committee;

(b) you advise the Human Research Ethics Committee (email ethics@cqu.edu.au) immediately if any complaints are made, or expressions of concern are raised, or any other issue in relation to the project which may warrant review of ethics approval of the project. *(A written report detailing the adverse occurrence or unforeseen event must be submitted to the Committee Chair within one working day after the event.)*

(c) you make submission to the Human Research Ethics Committee for approval of any proposed variations or modifications to the approved project before making any such changes;

(d) you provide the Human Research Ethics Committee with a written "Annual Report" on each anniversary date of approval (for projects of greater than 12 months) and "Final Report" by no later than one (1) month after the approval expiry date; *(Forms may be downloaded from the Office of Research Moodle site - http://moodle.cqu.edu.au/mod/book/view.php?id=334905&chapterid=17791.)*

(e) you accept that the Human Research Ethics Committee reserves the right to conduct scheduled or random inspections to confirm that the project is being conducted in accordance to its approval. Inspections may include asking questions of the research team, inspecting all consent documents and records and being guided through any physical experiments associated with the project

(f) if the research project is discontinued, you advise the Committee in writing within five (5) working days of the discontinuation;

(g) A copy of the Statement of Findings is provided to the Human Research Ethics Committee when it is forwarded to participants.

Please note that failure to comply with the conditions of approval and the *National Statement on Ethical Conduct in Human Research* may result in withdrawal of approval for the project.

You are required to advise the Secretary in writing within five (5) working days if this project does not proceed for any reason. In the event that you require an extension of ethics approval for this project, please make written application in advance of the end-date of this approval. The research cannot continue beyond the end date of approval unless the Committee has granted an extension of ethics approval. Extensions of approval cannot be granted retrospectively. Should you need an extension but not apply for this before the end-date of the approval then a full new application for approval must be submitted to the Secretary for the Committee to consider.

The Human Research Ethics Committee wishes to support researchers in achieving positive research outcomes. If you have issues where the Human Research Ethics Committee may be of assistance or have any queries in relation to this approval please do not hesitate to contact the Secretary, Sue Evans or myself.

Yours sincerely,

Mr Graham Fenlon
Acting Chair, Human Research Ethics Committee

Cc: A/Prof Trudy Dwyer (co-supervisor) Project file

Approved

ETHICS COMMITTEE CERTIFICATE OF APPROVAL

This is to certify that

Project No: 639/15

Project Title: Burn Injuries and Hypothermia: Factors contributing to hypothermia in the first 24 hours of admission to intensive care unit

Principal Researcher: Dr Sandra Walker

was considered for Low Risk Review and APPROVED on **11/01/2016**

It is the Principal Researcher's responsibility to ensure that all researchers associated with this project are aware of the conditions of approval and which documents have been approved.

The Principal Researcher is required to notify the Secretary of the Ethics Committee, via amendment or report, of

- Any significant change to the project and the reason for that change, including an indication of ethical implications (if any);
- Serious adverse effects on participants and the action taken to address those effects;
- Any other unforeseen events or unexpected developments that merit notification;
- The inability of the Principal Researcher to continue in that role, or any other change in research personnel involved in the project;
- A delay of more than 12 months in the commencement of the project; and,
- Termination or closure of the project.

Additionally, the Principal Researcher is required to submit

- A Final Report on completion of the project.

Approval covers the project as described in the application (including any modifications made prior to approval). Low Risk projects are subject to audit and ethical approval may be withdrawn if the project deviates from that proposed and approved.

SPECIAL CONDITIONS

None

SIGNED:

Professor John J. McNeil
Chair, Ethics Committee

Please quote project number and title in all correspondence

Appendix B: Revised Ethical Approval Letters

Secretary, Human Research Ethics Committee
Ph: 07 4923 2603
Fax: 07 4923 2600
Email: ethics@cqu.edu.au

Dr Sandra Walker and
Ms Jessica Clack
School of Nursing and Midwifery
Rockhampton Campus

19 April 2016

Dear Dr Walker and Ms Clack

HUMAN RESEARCH ETHICS COMMITTEE ETHICAL APPROVAL PROJECT: H16/01-006
BURN INJURIES AND HYPOTHERMIA: FACTORS CONTRIBUTING TO HYPOTHERMIA IN THE FIRST 24 HOURS OF ADMISSION TO INTENSIVE CARE UNIT

The Human Research Ethics Committee is an approved institutional ethics committee constituted in accord with guidelines formulated by the National Health and Medical Research Council (NHMRC) and governed by policies and procedures consistent with principles as contained in publications such as the joint Universities Australia and NHMRC *Australian Code for the Responsible Conduct of Research*. This is available at http://www.nhmrc.gov.au/publications/synopses/_files/r39.pdf.

On 15 January 2016, the Acting Chair of the Human Research Ethics Committee acknowledged previous ethical approval for this project from the Alfred Hospital Ethics Committee (Approval 639/15), and has granted full approval as a CQUniversity project (H16/01-006) under chapter 5.3 of the National Statement, pending ratification by the full committee at its February 2016 meeting. On 19 April 2016, the Chair approved your request to amend the protocol for this project, by widening the date range for data extraction to include the period 1 June 2013 to 31st May 2015.

The period of ethics approval will be from 15 January 2016 to 30 December 2017. The approval number is H16/01-006; please quote this number in all dealings with the Committee. HREC wishes you well with the undertaking of the project and looks forward to receiving the final report.

The standard conditions of approval for this research project are that:

(a) you conduct the research project strictly in accordance with the proposal submitted and granted ethics approval, including any amendments required to be made to the proposal by the Human Research Ethics Committee;

(b) you advise the Human Research Ethics Committee (email ethics@cqu.edu.au) immediately if any complaints are made, or expressions of concern are raised, or any other issue in relation to the project which may warrant review of ethics approval of the project. *(A written report detailing the adverse occurrence or unforeseen event must be submitted to the Committee Chair within one working day after the event.)*

(c) you make submission to the Human Research Ethics Committee for approval of any proposed variations or modifications to the approved project before making any such changes;

(d) you provide the Human Research Ethics Committee with a written "Annual Report" on each anniversary date of approval (for projects of greater than 12 months) and "Final

Report" by no later than one (1) month after the approval expiry date; *(Forms may be downloaded from the Office of Research Moodle site - http://moodle.cqu.edu.au/mod/book/view.php?id=334905&chapterid=17791.)*

(e) you accept that the Human Research Ethics Committee reserves the right to conduct scheduled or random inspections to confirm that the project is being conducted in accordance to its approval. Inspections may include asking questions of the research team, inspecting all consent documents and records and being guided through any physical experiments associated with the project

(f) if the research project is discontinued, you advise the Committee in writing within five (5) working days of the discontinuation;

(g) A copy of the Statement of Findings is provided to the Human Research Ethics Committee when it is forwarded to participants.

Please note that failure to comply with the conditions of approval and the *National Statement on Ethical Conduct in Human Research* may result in withdrawal of approval for the project.

You are required to advise the Secretary in writing within five (5) working days if this project does not proceed for any reason. In the event that you require an extension of ethics approval for this project, please make written application in advance of the end-date of this approval. The research cannot continue beyond the end date of approval unless the Committee has granted an extension of ethics approval. Extensions of approval cannot be granted retrospectively. Should you need an extension but not apply for this before the end-date of the approval then a full new application for approval must be submitted to the Secretary for the Committee to consider.

The Human Research Ethics Committee wishes to support researchers in achieving positive research outcomes. If you have issues where the Human Research Ethics Committee may be of assistance or have any queries in relation to this approval please do not hesitate to contact the Secretary, Sue Evans or myself.

Yours sincerely,

A/Prof Tania Signal
Chair, Human Research Ethics Committee

Cc: A/Prof Trudy Dwyer (co-supervisor) Project file

Approved

From: "research@alfred.org.au" <research@alfred.org.au>

Date: Monday, 20 June 2016 8:55 AM

To: Jessica Clack <jclack@cqu.edu.au

Subject: Project 639/15 – Amendment approved

Dear Jessica Clack (cqu),

Your amendment submitted for project 639/15 has been reviewed and ethics approval is granted.

The approval certificate/letter is available for downloading in the 'Amendments' tab of project 639/15.

Please be aware that any research conducted must comply with the National Statement on Ethical Conduct in Human Research and the Australian Code for Responsible Research Conduct.

An audit may be conducted at any time.

Best wishes,
Emily Bingle

Appendix C: Data Abstraction Instrument

ID			Person Factors					Pre hospital Factors						
SPSS ID	PID	UR	Suitability: Meets inclusion criteria	Age in years	Sex	TBSA% (rule of 9s)	Location of burn on the body	Geographical location where burn injury occurred	Transport type to got to hospital	km from burn care hospital.	Date of admission to burn care hospital	Initial Temperature measurement in Ambulance - ambulance code Cold /Normal/Warm	Ambulance called to person time (hrs) following burn	Transfer to other hospital first Yes 0r No

In-Hospital Factors														
ED Admission			TEMP (0 - 4 H)						TEMP (5 - 24 H)					
Time of arrival in burn care hospital ED following burn	Day / Night	Admission temperature in burn care hospital ED	Time of admission to burn care hospital ICU	Body temperature on admission to burn care hospital ICU	Timing of initial temp in burn care hospital ED	2nd hr temp after admission to burn care hospital	3rd hr temp after admission to burn care hospital	4th hr temp after admission to burn care hospital	5th hr temp after admission to burn care hospital	6th hr temp after admission to burn care hospital	7th hr temp after admission to burn care hospital	8th hr temp after admission to burn care hospital	9th hr temp after admission to burn care hospital	10th hr temp after admission to burn care hospital

In-Hospital Factors													
TEMP (5 - 24 H)													
11th hr temp after admission to burn care hospital	12th hr temp after admission to burn care hospital	13th hr temp after admission to burn care hospital	14th hr temp after admission to burn care hospital	15th hr temp after admission to burn care hospital	16th hr temp after admission to burn care hospital	17th hr temp after admission to burn care hospital	18th hr temp after admission to burn care hospital	19th hr temp after admission to burn care hospital	20th hr temp after admission to burn care hospital	21st hr temp after admission to burn care hospital	22nd hr temp after admission to burn care hospital	23rd hr temp after admission to burn care hospital	24th hr temp after admission to burn care hospital