School of Public Health

Development and evaluation of a new model of minor burn care

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Abstract

As the majority of all burns result in survival, the goal of burn care is for a patient to return to pre-injury quality of life with minimal functional deficit. A high proportion of burn patients (95%) presenting to Royal Perth Hospital (RPH) have sustained minor burns, defined here as those with burns to 15% of the total body surface area or less. These patients in particular, should have a relatively straightforward treatment and recovery pathway. However, this cannot be assumed as the response to minor burn injury can vary and there is a relatively high volume of patients requiring specialised care.

The Burn Service of Western Australia at RPH provides acute management of the burn wound and outpatient clinic review for the majority of patients based on clinical judgement. Hospital based review provides screening for potential complications and can minimise the likelihood of adverse outcomes in selected cases. For those with minor burns whose recovery is smooth and swift, the benefit of hospital review to confirm recovery does not always outweigh the inconvenience of attending. Large numbers of minor burn patients have been known to self-select, opting out of returning to hospital for scheduled outcome review. Previous research conducted at RPH shows that those who failed to attend follow-up appointments reported a good quality of life when re-surveyed.

This body of work comprises three studies presented as journal publications. The first two studies have been accepted for publication while the third is being prepared for submission. Separate methods and discussion sections have been added for further elucidation. Review of the current published knowledge surrounding minor burns and their outcomes covered an extensive range of topics from epidemiology to the prediction of outcome from burn injury. The synthesis of the literature revealed that few contributions to the literature describing minor burn management have been made over the past 20 years. For example, much work has been done examining the use of the Burn Specific Health Scale – Brief for measuring outcome after major burns, but none so far have demonstrated its use in a mostly minor burn cohort. Interestingly, in spite of the paucity of publications on minor burns, review of the research uncovered recent work advocating efficiency in the management of minor burns.

The three studies were devised in response to exploration of the literature which revealed deficiencies in the efficient management of minor burns. Thus the major objective of this work was to provide a data driven standardised, efficient model of care for minor burns. Self-report survey of patients with minor burns that heal quickly is a potentially efficient, cost-effective monitoring alternative to hospital-based review. This method can provide self-reported confirmation of outcome or highlight areas of concern with the benefit of reduced patient and health care burden. This thesis provides evidence for a new streamlined model of minor burn care which uses a mailed injury-specific quality of life survey in place of hospital review to establish outcome in patients with burns of 15% TBSA or less, who heal in 14 days or less and who have not had skin graft surgery. Further, as all studies utilised the self-report survey, the Burn Specific Health Scale – Brief as a measure of recovery post-injury it was imperative to investigate its effectiveness as a tool for tracking and predicting outcome after minor burn.

The first study involved a sample of 107 minor burn patients who were administered a novel model of care which involved administration of a burn care education manual and discharge as soon as their wounds healed, if within 14 days. Instead of attending the burn outpatient clinic at one month post-burn for follow-up as per standard care, these patients completed and returned postal BSHS-B and Satisfaction surveys at one month. As a safety net for potential misidentification of participants, a nomogram that estimates likelihood of a good score at six months post-burn from one month survey results was used to predict recovery trajectory of patients receiving the new model of care. The cohort comparison study demonstrated that participants' one month BSHS-B survey results were not significantly different from the results of the patients who received standard care ($n=62$, $p=0.05$). Participants unanimously reported high levels of satisfaction with the service.

In the second study the BSHS-B responses of a sample of 927 patients, 90% with minor burns (mean TBSA 6.7%, SD 10.0%), were analysed to determine reliability and validity of the scale for measuring quality of life after minor burn. Reliability, as expressed by internal consistency, was high with a Chronbach's alpha of 0.95. The scale was found to have the same factor structure as previously described in the literature, using data from major burn patients. The four factors described by the analysis reflected combinations of the nine historical domains of Simple Abilities and Hand Function; Interpersonal Relations and Sexuality; Heat Sensitivity; and Work.

BSHS-B responses obtained up to three months post injury were significantly associated with severity markers; TBSA, LOS and Surgery ($p<0.001$, $p<0.001$, $p=0.03$ respectively) demonstrating construct validity. The BSHS-B total and domain scores ($p<0.01$) displayed a significant change over two years since injury indicating criterion validity.

The final study involved the development and validation of the nomogram used in the first study to predict likelihood of good quality of life six months after burn as measured by the BSHS-B. The nomogram was developed by producing a multivariate logistic regression model which combined burn patients' personal, injury and BSHS-B responses. A cut-off value of 150/160 was selected as the point at which good quality of life for a minor burn patient was obtained. The nomogram was validated using Receiver Operating Curve analysis to determine the sensitivity and specificity of each percentage probability of attaining the cut-off score. The analysis determined that an 8% error was associated with a 70% probability of scoring 150 points on the BSHS-B at six months. This error rate was deemed to be an acceptable risk of miss identifying potential patients to receive the new model of minor burn care.

In conclusion, the three studies demonstrate that the new data driven model of care is a safe and efficient strategy for minor burn management. The new model saves one clinic visit for suitable minor burn patients that heal quickly and is advantageous for both patients and busy burn services. The BSHB-B is as valid and reliable a measure of quality of life after minor burn as after major burn and therefore can be used to demonstrate effectiveness of case specific as well as service wide interventions. The RPH burn nomogram is a valid tool for justifying minor burn patient selection into an alternative management stream and for identifying those whose recovery pathway is worse than expected, within a tolerance of 8%. The model of care and nomogram studies were somewhat limited by small sample sizes as a consequence of a nine month study period imposed by the grant that funded the research.

There is extensive potential for application of this work in developed burn centres across the world. The burn population managed by the BSWA at RPH is over-represented by minor burns, hence the focus, in this thesis, on efficient management of this low-severity burn category. This research should be relevant to the case mix seen in developed countries that have a similar distribution of severity.

Though the proportion of minor burns in developing countries is less, application to appropriate patients may also have potential benefit. The advantage of using the new model of care is the increased likelihood of sustainability in the provision of quality outcomes for all burn patients.

Statement of Originality

This thesis is comprises three original studies presented as two peer reviewed publications and one draft manuscript. The main body of work, the '*Streamlined model of care for minor burns',* arose from research submitted for funding from the West Australian Department of Health with myself as an Associate Investigator. Winthrop Professor Fiona Wood was named as Chief Investigator and Dr Dale Edgar the Primary Investigator. Ms Delia Hendrie was also one of the Associate Investigator on the grant application. A State Health Research Advisory Council grant was obtained for my salary and that of a part-time research assistant.

I coordinated the supported research project which provided the data for the first study with guidance from W/Prof Wood and Dr Edgar. All study materials were produced, sourced or compiled by me through collaboration with staff of the Burn Service of Western Australia (BSWA). The multidisciplinary burn care manual *'Caring for your burn'* was designed and developed with assistance from Nursing, Physiotherapy and Occupational Therapy staff members. Ms Joy Fong, Ms Sharon Rowe, in particular provided valuable input to the patient education materials and to the implementation of the intervention in the clinical setting. Data collection and entry was provided by research assistants, Emma Kretchmer and Sarah Stearne under my supervision.

The second two studies; the validation of the Burn Specific Health Scale – Brief in minor burns and the validation of a nomogram for predicting burn outcome, were conceptualised through necessity for further investigation of these essential components of the minor burn model of care. The majority of the data were gathered through routine data collection instigated via the Burn Clinical Outcome Research Project, supported by a grant from LotteryWest, obtained by W/Prof Fiona Wood as Director of the BSWA. Data were collected and entered by clinical and support staff which was then extracted and collated by myself.

All data analysis for the minor burn model of care study and for a proportion of the following two studies was conducted by me. Mr Michael Phillips, biostatistician at the Western Australian Institute for Medical Research provided significant statistical output for the second two studies.

The two published manuscripts and the draft manuscript were written with editing assistance from Mr Michael Phillips and my supervisors Dr Dale Edgar, W/Prof Fiona Wood, Prof Garry Allison and Ms Delia Hendrie.

I declare that all the information presented in this thesis is original and my own work.

Acknowledgements

'To be conscious that you are ignorant is a great step to knowledge.'
Benjamin Disraeli

Much time, effort and support from colleagues, friends and family have contributed greatly to the production of this thesis and the research it describes. I could not have completed this work without all of their help and I am grateful to them all.

My family, especially my husband Mark and my parents Victoria and Edward, have provided endless encouragement as well as practical support to allow me to juggle study, work and the care of our children. Thankfully, Alesha, Charlie and Seamus have remained largely oblivious to the extra burden this degree has posed except for, at times, the loss of my attention. To my statement that I was taking a day off Alesha once responded '*it's about time*' However, they have all stepped up, helped out, grown up and become more self-sufficient; an added bonus.

Heartfelt thanks go to my main supporter and clinical supervisor, Dr Dale Edgar who has been my guide from start to finish, not the least because he is in my direct line of fire, sitting next to me at work. His contribution is incalculable.

Thanks go to Ms Delia Hendrie and Professor Garry Allison, my Curtin academic supervisors for their valuable input at each stage of this process. I have always felt calmer and more in control after speaking with them. Their feedback has shaped and lifted this work to a much higher level.

I feel incredibly fortunate to be working for and with Winthrop Professor Fiona Wood, who is also a supervisor on this Masters. I am constantly challenged and inspired by her leadership and vision. I thank her for the opportunity to be involved in the progression of burn care and knowledge.

My colleagues at the Fiona Wood Foundation and the Burn Service of Western Australia have helped me in more ways than I can describe. In particular, Aaron Berghuber, Sharon Rowe, Joy Fong, Professor Suzanne Rea and Nicole Latham have all been there when I needed them.

I thank my good friends who have helped me through this process. Dr Noula Gibson has been my constant cheerleader and confidante on our regular early morning runs

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Finally, I would like to acknowledge the support of the Physiotherapy Department at RPH, namely Professor John Buchanan and Carol Watson in allowing me to combine my clinical and research roles.

Activity arising from this research

Publications

During the course of my thesis candidature the work undertaken has contributed to following the peer review publications.

1. **Finlay V**, Hendrie D, Allison GT, Phillips M, Wood FM, Edgar DE. Expanding the clinical utility of the Burn Specific Health Scale – Brief across the spectrum of burn size. Accepted to Burns, June 2013.

2. **Finlay V**, Hendrie D, Allison GT, Phillips M, Wood FM, Edgar DE. Evaluation of a streamlined model of care for minor burn patients. Accepted to the Journal of Burn Care and Research, June 2013.

The following published papers were a result of parallel studies that arose from the Masters research or contributed conceptually to the thesis studies.

3. **Finlay V**, Davidoss N, Lei C, Huangfu J, Burrows S, Edgar DW, Rea S, Wood FM. Development and evaluation of a DVD for the education of burn patients who were not admitted to hospital. J Burn Care Res 2012; 33(2): e70-8.

4. Kvannli L, **Finlay V,** Edgar DW, Wu A, Wood FM. Using the BSHS-B as a measure of quality of life after burns- what score should clinicians expect? Burns 2011; 37 (1): 54-60.

5. **Finlay V,** Phillips M, Wood F, Edgar D. A reliable and valid outcome battery for measuring recovery of lower limb function and balance after burn injury. Burns. 2010; 36(6): 780-86.

6. **Finlay V,** Burke K, van de Ruit C, Lapuz R, Phillips M, Wood F, Edgar D. Assessing the impact of missing data in evaluating the recovery of minor burns. Burns 2009; 35(8): 1086-91.

Platform Presentations

Abstracts of two studies from this work have been accepted for oral presentations at conferences. The first study in this thesis; *Implementation and evaluation of a new model of minor burn care: Focus on sustainability, efficiencies and cost reduction while maintaining optimal patient outcomes*, was presented at the WA Health Symposium in Fremantle in 2009. In the same year, the third study titled *Validation of a nomogram for predicting outcome from burn injury* was presented at the Australian and New Zealand Burn Association Scientific Meeting in Wellington, New Zealand in 2009.

Awards

A Julian Burton Burns Trust travel grant was awarded to assist attendance and presentation of study one of the thesis at the 2009 ANZBA Annual Scientific Meeting

The major study arising from this thesis: *A streamlined model of care for minor burns* has been selected as a finalist for a WA Health Award, to be presented at the 2013 WA Health Conference.

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CHAPTER ONE INTRODUCTION

1.1 Introduction

The majority of burns in developed nations such as Australia involve a small surface area (Duke, Wood et al. 2011, van der Wal, Vloemans et al. 2012). Minor burns, in adults, have been defined by the American Burn Association as burns that involve 15% or less than the total body surface area (TBSA) (Heimbach, Engrav et al. 1981). At Royal Perth Hospital (RPH) and in many other burn centres worldwide, this definition of a minor burn is used to direct treatment (Alsbjorn, Gilbert et al. 2007). Minor burns using this threshold account for up to 90% of all burn injuries requiring specialist medical attention (Morgan, Bledsoe et al. 2000, Chipp, Walton et al. 2008, Duke, Wood et al. 2011).

Current research advocates that minor burn patients can be successfully managed on an outpatient basis at dedicated burn centres (Alsbjorn, Gilbert et al. 2007). There is evidence that the numbers of patients being treated as outpatients have increased significantly in recent years (Moss 2004). This has occurred as a result of several factors. The establishment of specialised burn outpatient clinics in tertiary hospitals, fewer patients with small burns admitted to hospital and earlier discharge of major burn patients in the final stages of wound healing have all contributed to the increased flow of outpatients. In spite of the large volume of minor burns patients presenting to tertiary burn centres, less than 1% of all burn publications within the scientific literature focuses on this patient population (PubMed 2013). This suggests that there is need for research in the area of minor burns to improve the management of this ubiquitous injury with the goal of providing efficient care resulting in quality outcomes for the benefit of the whole burn population.

The objective of the management of all forms of burns (major and minor) is to reduce mortality and disability. Since the 1950's there has been a sustained contribution by health services, burn clinicians and researchers that have resulted in considerable improvements in burn morbidity and mortality. In particular, improvements in fluid resuscitation, early surgical excision and burn wound closure and infection management have led to much higher rates of survival (Feller and Jones 1987, Palmieri 2009). In Western Australia there has been a 2% annual decrease in burn deaths in the years from 1983 to 2008, (Duke, Wood et al. 2011).

As the numbers of burn survivors have increased, adding to the already considerable minor burn population, significant health care resources throughout the acute management and recovery phases after the burn are required (Wheeler, Van Harrison et al. 1983). In a system of finite resources, there is a need to manage both the severity of the injury and the volume of clients and therefore strategies need to be developed to optimise resource utilisation across this heterogenic burns population.

With improved mortality outcomes, burns management and research is directed to improving long-term function and quality of life outcomes for burn patients (van Loey, van Beeck et al. 2011, Pereira, Murphy et al. 2004, Falder, Browne et al. 2009). With little minor burn outcome data available, management to date appears to be based on clinical judgement and experience and therefore may reflect unique practices specific to individual burn care facilities (Dries 2009, Alsbjorn, Gilbert et al. 2007). The status quo with regard to guidelines on the efficient management of minor burns has been maintained for several years (Morgan, Bledsoe et al. 2000, Tenenhaus and Rennekampff 2007). In the past decade Brandt and colleagues (Brandt, Yurko et al. 1998, Brandt, Coffee et al. 2000) have examined the clinical benefit of establishing outpatient facilities for minor burn care and this has been reflected in renewed interest for new minor burn management protocols (Sagraves, Phade et al. 2007, Vercruysse, Ingram et al. 2011). Economic rationalisation of health services including outpatient services has led to the increased demand for alternative burn service strategies focussing on utility and service efficiency. To date, few studies have described changes to existing minor burn management models with an emphasis on relieving the burden of care of specialist burn centres (Sagraves, Phade et al. 2007, Vercruysse, Ingram et al. 2011).

Clinical decision-making in burn care is often based on research that indicates that early wound healing minimizes the likelihood of abnormal scar formation (Deitch, Wheelaham et al. 1983, Cubison, Pape et al. 2006). Burns that are slower to heal have an increased risk of abnormal scarring (Deitch, Wheelaham et al. 1983). Surgical excision and skin replacement is often prescribed if wound closure is slow and is deemed unlikely to occur within 14 days post injury (Greenhalgh 2010). Those who heal outside the optimal time frame should be reviewed routinely over 24 months until the scar maturation process is finalized (Stella, Castagnoli et al. 2008, Wang, Zhang et al. 2008). In contrast, minor burns that heal within 14 days are least likely to result in a poor outcome and may need little follow-up care (Deitch,

Wheelaham et al. 1983). Therefore, minor burns may be an appropriate severity category to act as a candidate patient cohort for a streamlining protocol with minimal risk of adversely affecting outcome.

Burn severity is a major determinant of physical and psychological outcome and can vary significantly. Size of the burn combined with other injury and patient characteristics is a major factor in determination of severity (Tobiasen, Hiebert et al. 1982, Macedo and Santos 2007). Burn progression can be measured by wound healing time, skin replacement surgery and hospital length of stay. The majority of minor burns often recover quickly with few complications and minimal impact on patients' function, work and social activities (Brandt, Coffee et al. 2000, Alsbjorn, Gilbert et al. 2007, Sagraves, Phade et al. 2007). However, even within the category of minor burn, severity can be varied. Thus good outcome after minor burn based on size of burn alone cannot always be assumed (Shakespeare 1998). In developed countries like Australia, the vast majority of burns are designated as minor based on the extent of the injury (Rea and Wood 2005). In spite of injuries being classified as such, not all minor burns are trivial with some having the potential to impact negatively on patients, families and communities (Casaer, Kums et al. 2008). Factors other than size of burn can influence quality of outcome from burn injury. Age, treatment and healing time can impact patient physiological and psychological recovery. Dissatisfaction with scar outcome was reported by 43% of patients with burns 20% TBSA or smaller (Shakespeare 1998).

The context for this research is the health care profile seen in Australia and similar developed nations where the aim of health services is to provide sustainable high quality burn care. In view of reducing large numbers of minor burns, the goal of modern burn services like RPH is to provide burn patients with a care pathway that enables them to achieve their pre-injury quality of life as quickly as possible. This goal requires an ongoing investment in improving surgical and therapeutic techniques; research and infrastructure. Expert clinical care from dedicated burn facilities should provide burn care pathways and processes involving continuous quality improvement aimed at producing good outcomes for all burn patients. Best practice in health care may now be achieved by streamlining management of minor injuries (Mathews, Supple et al. 1997). New models of minor burn care that involve assessing a patient's propensity for good outcome based on personal characteristics, injury severity factors and early functional outcome may provide important information for improving efficiency of clinical care.

In the absence of published alternatives, traditional models of minor burn care employed provide general strategies for facilitation of early wound healing with risk management provided by clinical review on a case by case basis. These models advocate routine wound management and follow-up to assess potential post-acute complications for all but the most superficial of burn injuries (Morgan, Bledsoe et al. 2000). Implementation of these models is associated with inefficiency related to missed appointments along with increased burden on patients and the health service given that they provides similar follow-up to patients across the spectrum of burn injury severity (Finlay, Burke et al. 2009). Selecting patients for more efficient management can be problematic as a good outcome from minor burn cannot be guaranteed (Shakespeare 1998). Further, the classification of minor burn encompasses a heterogeneous cohort. To provide a safe platform to change standard of care, the target group should be selected according to several factors that impact minor burn outcome and not only the extent of burn. Using minor burn outcome data may assist the development of more efficient methods of minor burn care and is currently hampered by the lack of published data.

1.2 Outcome after minor burn

With the decline in mortality, over the last four decades, the challenge for burn care teams has been to produce good results in scar, function and quality of life (Pereira, Murphy et al. 2004). Efforts are now being directed across the burn continuum to minimise the incidence and impact of burn. The focus in recent years is shifting toward areas such as prevention, first aid and patient education in an attempt to influence outcomes (Rea 2005, Finlay, Davidoss et al. 2012, Muller, Dulhunty et al. 2013). Routine outcome data collection throughout the recovery phase has become a priority for many burn centres for benchmarking progress and adapting treatment strategies (Falder, Browne et al. 2009). Temporal assessment of outcome should start early in the post-acute period so that necessary interventions can be implemented or modified to aid good long-term recovery (Morgan, Bledsoe et al. 2000, Edgar, Dawson et al. 2010).

Measurement of long-term quality of life is becoming one of the most important indicators of recovery from burn injury (Jaskille, Jeffrey et al. 2009). The burn patient's perspective on their ability to function in their normal surroundings provides the burn care team with insights that can facilitate improvements in clinical practice (Brasel, deRoon-Cassini et al. 2010). Despite the commencement of physical and

psychological functional assessment in the 1970s following increasing numbers of burn survivors, there are still few validated burn specific tools available (Munster, Fauerbach et al. 1996). This is most apparent in minor burns as examination of the properties of measurement tools has previously centred on major burns (Yoder, Nayback et al. 2010). van Baar et al advocate the development and validation of outcome measures that accurately chart progress after burn injury as a necessary part of quantifying recovery and as imperative for the successful management of burns into the future (van Baar, Essink-Bot et al. 2006).

Minor burns and their outcome can vary greatly depending on patient and injury factors (location, depth, pre-existing medical status). The level of morbidity of each minor burn is relatively small when compared to major burns. The vast majority of the hundreds of thousands of presentations to dedicated burn centres worldwide are minor burns posing a significant burden to health services. Despite this there is a limited amount of published information on the impact of minor burn burden on the health care system compounded by insufficient levels of evidence and description of scientific method to allow for translation to the clinical setting. For example, Al-Benna and colleagues (2010) reviewed the two leading burns journals and found that less than 50% of studies included comparative data (Al-Benna, Alzoubaidi et al. 2010). Most of the research on minor burns describes clinical care strategies with minimal information on outcomes. The early published information on minor burns describes acute management with some post-acute burn care (Morgan, Bledsoe et al. 2000, Kagan and Warden 2001). Instead, papers reporting outcomes after changing minor burn management strategies have mostly referred to incidence of complications or need for surgical involvement (Vercruysse, Ingram et al. 2011). Failure to employ standardised outcome measures to demonstrate effectiveness of an intervention is a limitation as the absence of complications or further surgery does not mean that functional outcomes were achieved.

In fact, there is limited literature on minor burn outcomes using valid and reliable tools. Quality of life scales are highly regarded in injury recovery research. However, as burns have features unlike any other injury group, scales with burn related detail are possibly the most informative measure of outcome. This limits the availability of tools for minor burn research as all burn specific measures have currently only been validated in the major burn population (Fauerbach, Lezotte et al. 2005, Finlay, Edgar et al. 2010, Kvannli, Finlay et al. 2010). The Burn Specific Health Scale-Brief is the most popular outcome instrument in burn research and contains more health

concepts linked to the International Classification of Function than almost all other burn outcome scales (Wasiak, McMahon et al. 2011). In spite of having been extensively tested in major burns, exploration of the BSHS-B in the minor burn population is lacking (Willebrand and Kildal 2008). Investigation of the BSHS-B in the minor burns population is an area that warrants further research. Specifically, no studies have used the BSHS-B to benchmark outcomes from minor burn. Additionally, there are no studies that have used burn specific QoL outcomes in minor burns to predict factors that underpin outcome at six months. It is only with this data that prognostic models can be developed and from these optimal models of service delivery can be trialled. Establishing the validity of using the BSHS-B in minor burns would be useful in demonstrating effectiveness of new and existing interventions to assist the provision of best practice in a minor burn population.

Using the BSHS-B to measure recovery from minor burn necessitates placing a value on what is an acceptable outcome from this category of injury severity and at which point. Referring to the target group receiving the new model of care; minor burns that heal within 14 days with conservative management are not expected to scar and recovery should be reached by six months post-injury. Research into the target for good recovery from minor burn as measured by the BSHS-B is planned. The study aims to collect responses to a modified BSHS-B survey from sample of the non-burned West Australians to determine a 'normal' score on the scale. On conclusion of this research, a conservative definition of a good outcome or good recovery from minor burn in terms of the BSHS-B at six months post-burn will be determined.

Measuring outcome from minor burn using standardised methods can confirm clinical predictions of recovery made in the early stages of injury or, in some cases flag those who are not progressing as expected (Pereira, Murphy et al. 2004). This can reinforce the appropriateness of past treatment choices and guide future clinical decisions. Whilst most are expected to recover quickly with good outcomes, close monitoring of progress in the early stages can guide the prescription of additional services to those whose recovery is compromised. Conversely, fast-tracking of routine care may be appropriate for minor burn patients who follow the expected recovery pathways and demonstrate good early recovery (Cooke, Wilson et al. 2002). Further, at RPH, many patients who recover early choose to miss follow-up review, provided so that clinicians can be assured of the patient's good outcome (Finlay, Burke et al. 2009). This leads to inefficient use of staff time, spent in

preparation for large numbers of outpatient clinic appointments. In addition, the large numbers of minor burn patients who attend burn outpatient clinics for the purpose of having their recovery confirmed use up resources that could be allocated to more severe burn patients. Thus, the need for follow-up and treatment should be assessed using standardised outcome data.

A fast-track discharge protocol for patients with minor burn that heal quickly, may improve the efficiency of burn care and provide benefits to patients, the burn service and the health care system.

CHAPTER TWO REVIEW OF THE LITERATURE

This review of the literature aims to encompass the depth and breadth of published knowledge as it pertains to the studies described in this thesis. It focuses on sources referring to minor burns with some contrasting information on major burns. This literature review examines firstly, the scope of the problem that minor burns poses to burn services in developed nations, in particular, Australia. As the definition of a minor burn varies between publications, the middle section of this review seeks to clarify the definition, classification and pathology of minor burns as the population of interest in this research series. Outcomes from burn injury including those related to scar quality, physical function and self-reported quality of life are an important factor in assessment of progress and response to treatment. Relevant tools used in this process and information gleaned from previous outcome measurement is presented. Education of the burn patient facilitates patient involvement in the management of the burn to minimise the risk of complication and aids the attainment of a good outcome. This is particularly important when streamlining care and reducing hospital based management. Burn patient educational tools investigated in previous research are described to provide context for the use of a similar tool in this research. Next, prediction of outcome will be explored. The ability to predict outcome can provide justification for selection of patients that receive alternatives to the standard care. Finally, the costs associated with current burn care provision are examined in order to demonstrate the benefit to the health service of streamlining care to patients who are likely to recover well.

2.1 Burn Epidemiology

2.1.1 Minor Burn Mortality and Morbidity

In contrast to major burns, death is rare in minor burns. Many papers have presented information on the proportion of burn deaths occurring in various areas around the world and it is important to understand the size and nature of this issue to provide a context to the problem of minor burn management. The consensus is that while mortality from burn injury has been in steady decline over the past 60 years, in Australia and other developed nations, burns are still one of the leading causes of death and disability from traumatic injury. In the United States, from over

181000 burn injuries sustained from 1998 to 2007, the mortality rate was 4.4% (Miller, Bessey et al. 2008).

Long term epidemiological studies suggest that the burn mortality rate in Western Australian of 1% (233 deaths) over 26 years is among the lowest in the world (Duke, Wood et al. 2011). Similarly, across Australia, death was the result for 0.8% of burn injured in the period between 1st July 2010 and 30th June 2011 (Cameron, Gabbe et al. 2012). The more recent national figures are an improvement on those reported by an earlier study of 4094 patients admitted to a Brisbane burn centre between 1972 and 1996 which described a 3.6% burn death rate (Pegg 2005). The reported mortality rate for Australia is well below the 5% for all burn injury patients admitted to a tertiary hospital burn facility in the developed world in 2007 (Evans, van Wessem et al. 20, Miller, Bessey et al. 2008, Evans, van Wessem et al. 2010). This figure is similar to that based on Swedish burn patients for a 16 year period from 1987 to 2003 (Akerlund, Huss et al. 2007). This profile contrasts with that of burns in developing countries where mortality rates ranging from 30%-61% of all burn injuries remains similar to those of developed nations in the 1950's. (Kalayi 2006, Rajabian, Aghaei et al. 2007, Ganesamoni, Kate et al. 2010). This may be related to the differences in access to resources and injury severity.

Minor burn mortality is rare but is more likely to occur in specific subsets of the burn population. Death from burns is more likely to occur in older age (over 60 years), larger burns (>40% TBSA) and inhalation injury (Ryan, Schoenfeld et al. 1998, Jaskille, Jeffrey et al. 2009). A US study involving patients with minor injuries found an increased risk of death in patients over 65 years when associated with the presence of a chronic medical condition (McGwin, MacLennan et al. 2002). The Australian and New Zealand Burn Association Bi-National Burn Registry Annual Report 2010-11 describes the mortality rate for burns less than 10% TBSA to be 0.3% (Cameron, Gabbe et al. 2012).

Morbidity can be a long term consequence of burns and is related to severity of the initial injury. Burns can be classified as a chronic condition due to the permanent nature of some injuries (Engrav, Heimbach et al. 1986). In England and Wales, burns accounted for 5.4% of serious hospital admissions due to traumatic injury (Kalson, Jenks et al. 2012). Injury, including burns, was the seventh highest source of health burden in Australia in 2003, representing 185, 100 Disability-Adjusted Life Years (Cripps and Harrison, 2008). There is limited information on disability in minor

burns which refers to patients with burns under 10% TBSA. Those affected have disability mostly related to hand dysfunction, with a physical burden of injury after 12 months significantly worse than the general population (Fauerbach, Lezotte et al. 2005).

2.1.2 Minor Burn Prevalence and Trends

In Australia, like many developed countries, the trend in burn injuries sustained appears to be decreasing over time (Duke, Wood et al. 2011). The rate of hospitalisation from burns in Western Australia (WA) has almost halved in the 26 year period between 1983 and 2008 from 64 to 36 per 100, 000 (Duke, Wood et al. 2011). In recent years, the number of hospital admissions in WA due to burns is on average close to 1000 annually (Duke, Wood et al. 2011). There appears to be inconsistency in the rates of hospitalisations due to burns reported around the world. While WA burn hospitalisations have declined, other studies of similar burn populations have described an increased or stable trend (Sales, Plomondon et al. 2004, Burton, Sharma et al. 2009, Duke, Wood et al. 2011).

Although the numbers of burn injured have reduced in the last 20 years, the increase in survival rates has resulted in a greater proportion of burn patients requiring management in dedicated burn centres, including those with minor burns (Gibran, Klein et al. 2005). During 1993-94 hospitalisations due to burns in Australia incurred a cost of AUS$65.6 million (Harrison and Steele 2006).

Minor burns, defined here in terms of extent of burn, as those affecting 15% of the body's total surface area or less, constitute the majority of all burn injuries sustained in the developed world. Burns up to 15% TBSA are still considered minor injuries as they are too small to require fluid resuscitation but may be admitted for pain management, wound care and surgical treatment (Fong et al. Burn Service of WA, Annual Report. 2009). Of 1550 new burn cases aged 16 years and older 68% were males and 80% of admitted patients underwent a burn related surgical procedure (Duke, Wood et al. 2011). In the US, annually, 95% of the 1.25 million burn injuries treated are minor (Kagan and Warden 2001). A similar pattern is seen in Australia using data from eleven burn facilities across Australia and New Zealand collected over a period from July 1st 2010 to June 30th 2011 and presented in second Bi-National Burn Registry report (Cameron, Gabbe et al. 2012).

With regard to hospital admission, the majority have sustained wounds classified by size as minor and include injuries up to 20% TBSA. The American Burn Association has reported that 62% of burn patients admitted to hospital have burns less than 10% TBSA (Dries 2009). In Australia, the prevalence of minor burns requiring hospitalisation is reported as significantly less. Of the 10% of patients with a burn injury admitted to Australian hospitals over the period between 1983 and 2008, 80% sustained small to moderate sized burns (20% TBSA or less) (Greenwood, Tee et al. 2007). At RPH, the figure is higher still with more than 90% of the burn population sustaining burns to less than 15% of the body's surface area, as extrapolated from the data presented in a recent WA epidemiological paper by Duke et al (Duke, Wood et al. 2011).

Over the last 50 years burn patients have experienced a reduction in hospital length of stay from 11 to seven days with minor burn patients tending to have shorter periods of hospitalisation, calculated as approximately one day per percentage TBSA up to 50% (Miller, Bessey et al. 2008, Cameron, Gabbe et al. 2012). Improvements in burn care and non-hospital burn management strategies may have had an effect on reduced hospitalisation times (Warden 1987, Sagraves, Phade et al. 2007, Vercruysse, Ingram et al. 2011). Implementation these practices at RPH and elsewhere have resulted in a considerable and ongoing demand for outpatient burn services (Al-Mousawi, Mecott-Rivera et al. 2009). The majority of the 1000 patients managed annually by the ambulatory burn service at RPH have injuries that can be classed as minor with 60% of these receiving burns to 1% of their body or less (Rea and Wood 2005).

It is evident that the volume of minor burns requiring expert burn care is still substantial, requiring considerable resources to ensure sustainability. Adding to the significant health care burden posed by large numbers of minor burns, the availability of high quality burn care has improved the rate of survival after major burns. Thus the impact on patients, society and the health system is pronounced.

2.2 Definition of a Minor Burn

At RPH as in other burn centers worldwide, a minor burn is defined as a 15% TBSA or less partial thickness injury (Alsbjorn, Gilbert et al. 2007). However, there is no clear consensus in the literature regarding the definition of a minor burn in terms of wound area or size. Burns are often termed minor due to their size, depth and

propensity for good recovery (Johnson and Richard 2003). Some define a minor burn as a partial thickness burn that is up to and including 10% TBSA (Gomez and Cancio 2007), others as 5% or less (Singer, Brebbia et al. 2007). The American Burn Association modified their Injury Severity Grading System to define the group of patients suitable for outpatient management as those with a partial thickness burn less than 15% (Edlich, Larkham et al. 1978). Further, some authors have advocated outpatient management for burns up to 20% TBSA (Jansen, Hynes et al. 2012). The BSWA defines a minor burn on the basis of a need for hospital admission for administration of fluid resuscitation. Most agree that burns 15% or less do not require fluid resuscitation (Greenhalgh 2010). Based on this criterion, it has been recommended that minor burns can be treated initially in non-burn centers or on an ambulatory basis, providing no inhalation injury has occurred (Vercruysse, Ingram et al. 2011).

A major factor in the classification of burn severity is time to healing, as it is linked to size and depth of burn. Visual estimation of size of burn is an accepted part of clinical practice in spite of a 65% average systematic positive bias. However the same method of burn depth assessment is widely recognized as unreliable. Thus, time to healing is the indicator of depth most often used by clinicians (Monstrey, Hoeksema et al. 2008). Time to healing is also possibly the most significant influence on outcome in small area burns though this variable is rarely included in studies in favour of other traditional predictive factors such as burn depth, TBSA and surgery (Deitch, Wheelaham et al. 1983, Gangemi, Gregori et al. 2008, van der Wal, Vloemans et al. 2012). In the absence of a definitive clinical assessment of burn depth, a minor burn can be described as a small burn (15% TBSA or less), that heals in 14 days or less with conservative management.

The majority of minor burns are small, superficial and heal quickly with few long term complications (Singer, Brebbia et al. 2007). A caveat to this is the variance in the seriousness of minor burns as defined by %TBSA (Fauerbach, Lezotte et al. 2005). Minor burn wounds that do not show signs of early healing, and have a high chance of requiring surgical closure should be evaluated and managed by burn specialists and may need hospital admission (Johnson and Richard 2003). Small deep burns, particularly those in cosmetically significant areas such as the face or chest have the potential for a poor aesthetic and psychological outcome (Gangemi, Gregori et al. 2008). Guided wound care and close monitoring of patients while the burn is healing

along with the provision of early scar management and psychosocial support as necessary may improve long-term outcome.

2.3 Burn Pathophysiology

2.3.1 Effect of Burns on the Skin

The skin is the largest organ in the human body and has sensory, protective and cosmetic roles. Skin has several layers with only the more superficial layers, the epidermis and papillary dermis having regenerative capabilities (Kao and Garner 2000).

Burns are thermal or chemical injuries that result in destruction of the various components of the skin**.** Tissues in the burned area are often affected in varying degrees with the amount of skin damage proportional to the temperature of the burning agent and the length of time the skin remains at an elevated temperature (Gomez and Cancio 2007). Burns cause ischemic damage to the microcirculation and tissue necrosis resulting in the immediate and dangerous outpouring of serous fluid and blood from damaged cells and blood vessels forming a collection of oedema and proteins (Jackson 1953). Uncontrolled oedema can prevent vital nutrition reaching cells resulting in ongoing tissue death (Kao and Garner 2000). This potentially creates unsalvageable tissue resulting in a greater likelihood of skin replacement surgery (Atiyeh, Gunn et al. 2005). Early cooling of the skin through removal of the heat source and application of first aid such as water can minimize the amount of tissue loss and limit the severity of the wound and subsequent systemic responses (Jeng, Bridgeman et al. 2003). Good early management of the burn wound aimed at limiting oedema and preventing infection provides the greatest chance of a good long-term outcome (Jackson, 1991).

2.3.2 Assessment of Burn Severity

Prompt accurate assessment of a burn severity is necessary to determine the most appropriate treatment to facilitate the best possible outcome for the patient (Atiyeh, Gunn et al. 2005). In recent times, cosmetic and functional outcome has replaced survival as the main indicator of successful management for burn services in the developed world (Pereira, Murphy et al. 2004). Burn severity can be measured by establishing the extent and depth of a burn wound.

Determination of burn severity is used as clinical reasoning for treatment choices (Atiyeh, Gunn et al. 2005). Superficial and full thickness burns are relatively easy to recognise; identifying partial thickness burns is problematic, particularly in the first week post injury. As subjective assessment of partial thickness burns can be inaccurate, early monitoring of rate of wound healing can minimise risk of unnecessary surgery (Monstrey, Hoeksema et al. 2008). Burn wound healing prior to 21 days post injury is associated with a lower rates of hypertrophic scarring (Deitch, Wheelaham et al. 1983). According to the traditional classification of burn depth, superficial burns are those that heal quickly and have little likelihood of leaving a noticeable scar (Pape, Skouras et al. 2001). Deep burns take longer to heal and often need surgical intervention resulting in greater potential for pathological scar formation (Gangemi, Gregori et al. 2008). Although anecdotally, it has been observed that the earlier wounds heal, the better the scar outcome, at this point, the literature is unclear on the optimal maximum time to healing after burn injury in humans. A resolution may to be close as a recent porcine study has found that wounds that healed on day three post-burn had the best scar outcome compared to day 14 or 21 (Chan, Harvey et al. 2012).

Extent of burn is measured in size, expressed as a percentage of the body's total surface area. The body is sectioned according to a system devised in the 1940's by Pulaski and Tennison known as the 'rule of nines' (Knaysi, Crikelair et al. 1968). Each area of the body is assigned a percentage which adds up to a total of 100. As burns can vary in size and shape, the palmar surface of the patient's hand with fingers adducted, deemed to be 1% is often used in clinical practice (Sheridan, Petras et al. 1995, Yu, Hsu et al. 2008). However, overestimation of burn size is common as the actual palmar surface area of the hand approximates 0.89% as revealed by recent studies (Yu, Hsu et al. 2008).

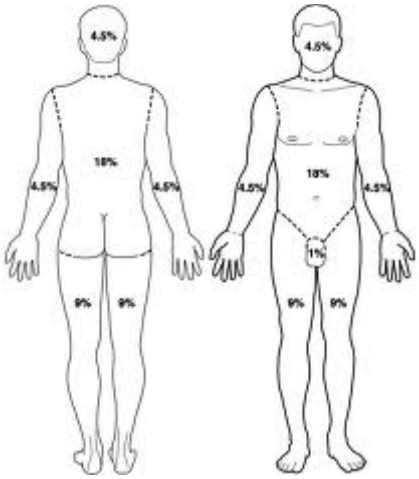

Figure 2.1 Lund and Browder body chart depicting rules of nines

2.3.3 Healing of the Burn Wound

Accurate determination of burn wound healing and prognosis of wound outcome is essential in many treatment decisions (Shakespeare 2003). This is because timely healing of burn wounds is recognised as a major factor in avoiding abnormal scarring (Deitch, Wheelaham et al. 1983). However, time to healing is rarely included in research investigating predictors of scarring possibly due to the difficulty in establishing an end point (van der Wal, Vloemans et al. 2012). Further, early healing by conservative means has been shown to be superior to surgical treatment in a study of children with scald burns (Cubison, Pape et al. 2006). Thus the main aim of minor burn care is to facilitate early wound healing, preferably by conservative rather than surgical means.

It is clear that regular assessment of diminishing wound size provides crucial information on rate of healing up to 10 to 14 days post injury. This is generally the watershed period where important treatment decisions such as the need for surgery are made, based on prognosis of wound healing (Engrav, Heimbach et al. 1986). However, there is uncertainty in the international burn arena around the most appropriate time to decide on excision and grafting (Hop, Hoogewerf et al. 2012). Some burn specialists prefer to operate within five days of injury to minimise risk of infection while others review wound progression close to 10 days with a view to preservation of dermis (van der Wal, Vloemans et al. 2012). Currently, at RPH the former is the usual practice. A wound that closes within 21 days without requiring

skin grafting suggests less damage to deeper skin structures, particularly the dermis with its collagen stores, and has less chance of hypertrophic scarring (Deitch, Wheelaham et al. 1983, Tenenhaus and Rennekampff 2007). Wounds that heal in an even shorter time frame, within 14 days for instance, are therefore likely to be shallower wounds and less likely to scar (Cubison, Pape et al. 2006). Monitoring of burn wounds of indeterminate depth within this period is therefore crucial in determining when, if at all, to provide surgical closure of the wound (Kao and Garner 2000).

If epithelialisation of wound margins occurs at a rapid rate resulting in complete healing well within two weeks, wound management can be judged a success (Cubison, Pape et al. 2006). However, with some wounds, progression is unpredictable such that it is difficult to determine with confidence the approximate day of closure. Tracking wound healing by measuring of decreasing wound size is also problematic as some of the most effective methods are invasive, time-consuming and/or costly (Jeng, Bridgeman et al. 2003, Monstrey, Hoeksema et al. 2008). Skin biopsy, trans-epidermal water loss and Laser Doppler imaging (LDI) are scientific measure of wound healing all found to be superior to subjective clinical assessment (Surinchak, Malinowski et al. 1983, Jeng, Bridgeman et al. 2003). However, visual estimation of wound progression is the current standard of care at RPH and many other burn centres around the world (Monstrey, Hoeksema et al. 2008). A recent study has found that this method is as accurate as LDI on the eighth day post-burn and is therefore an effective way of determining whether to continue with conservative care or proceed to surgery (Hoeksema, Van de Sijpe et al. 2009).

The international burn community lacks consensus regarding the definition of a fully healed burn. Total epithelialisation is generally cited as the final end-point to burn wound healing (Morgan, Bledsoe et al. 2000). However, this necessitates that treatment and monitoring continue even when only very small wounds remain. At RPH, a wound that has 98.5% re-epithelialised, with the remaining area partial thickness or less and therefore not requiring surgery, is considered fully healed. Discontinuation of dressings may be viewed as a marker of final healing (Cubison, Pape et al. 2006). Some authors recommend surgical review for remaining full thickness wounds greater than 2cm diameter (Morgan, Bledsoe et al. 2000). This suggests that, smaller wounds, particularly if located in non-significant areas of the body such as the leg or back, may have a low risk of abnormal scarring if allowed to continue to heal by contraction.

2.3.4 Complications of Minor Burn

The literature indicates that progression of minor burns can vary significantly depending on the nature of the injury, healing time, early management and co-morbidities (Warden 1987, Johnson and Richard 2003). Most minor burns heal quickly without long-term adverse effects as described by a study of 269 paediatric upper limb burn patients, of whom only five suffered complications (Ewings and Pollack 2008). Another study of adults with minor burns reported that 13.4% of patients suffered scarring, chronic pain or contractures (Sagraves, Phade et al. 2007). In these studies, no information on the factors associated with complications was presented.

Minor burns with partial thickness injuries should progress quickly to complete healing within 21 days and have little chance of long term complications (Deitch, Wheelaham et al. 1983). Recent research by Vercruysse et al shows that older patients with pre-existing medical conditions can do well. That study described the outcomes of a cohort of 64 patients who sustained burns related to home oxygen use. The majority of the group, described as having a mean age of 62.5 years, 4% TBSA and five co-morbidities, recovered well, with a mean length of stay (LOS) of 2 days and one follow-up visit. This was mostly related to the low severity of the injuries with most being small partial thickness or superficial (Vercruysse and Ingram 2012).

However, delayed healing due to infection or pre-existing medical conditions can produce long-term complications such as scarring and contracture in minor burns with partial thickness involvement (Schwartz, Rothrock et al. 2011, Chan, Harvey et al. 2012). Anti-microbial dressings and education of patients to ensure their co-operation with aseptic care are essential in minimising this risk. Diabetes as a co-morbid condition has been found to impair healing time in a sample of 68 burn patients with a mean TBSA of 4.2%, where the mean LOS was 15 days and 62 complications occurred (Barsun, Sen et al. 2013).

Studies have shown that complications occur more commonly in deeper burns due to greater loss of non-regenerating dermis (Stewart, Ball et al. 2012). Deep partial or full thickness burns that result in delayed healing or excision and split skin grafting are likely to result in an abnormal scar or contracture (Gangemi, Gregori et al. 2008, van der Wal, Vloemans et al. 2012). The combination of deep, small area burns with

body location is also a major factor that can affect patient outcome. Deep burns on anatomically significant areas such as the face and hands can have significant long term negative consequences (Fauerbach, Lezotte et al. 2005). In contrast, another study has found that, good long-term quality of life and a high return to work rate is demonstrated by patients sustaining high voltage electrical injury, 50% of whom suffered amputations (Cochran, Edelman et al. 2004).

Local complications such as pruritis are common sequelae of minor burns, occurring from one week post-burn and lasting for years. A study of 270 patients with a median TBSA of 2% found that 49% suffered from pruritis (Casaer, Kums et al. 2008).

Minor burns can also have systemic effects. Physical dysfunction can persist up to 12 weeks after a minor burn as evidenced by abnormal gait in a patient following a 3% bilateral calf burn (Grisbrook, Reid et al. 2010). A murine study conducted at the Burn Injury Research Unit at the University of Western Australia demonstrated a reduction in muscle bulk in the unaffected limb following a 4% leg burn (O'Neill et al, unpublished data). Neural changes have also occurred in unburned areas following a small burn injury (Anderson, Zorbas et al. 2010). Case studies have reported bacterial endocarditis and cardiomyopathy following minor burn injury (Paterson and Dunn 1999, Wikiel, Gemma et al. 2011).

These findings need to be considered in the effective management of minor burns. Generally, long-term complications from minor burn are related to severity as measured by burn depth, long healing times and increased length of stay (Shakespeare 1998). Preventative strategies and careful monitoring of minor burn wounds in the early stages of healing may minimise or promptly identify complications should they arise.

2.3.5 Scarring After Minor Burn

Pathological scarring is a common negative consequence of burns that involve damage to the deeper dermal structures of the skin (Stewart, Ball et al. 2012). It can seriously affect the quality of life of burn patients and its minimization and prevention are major goals for clinicians (Bloemen, van der Veer et al. 2009). Hypertrophic scarring (HS) is the most common type of pathological scar seen after burn injury (Stella, Castagnoli et al. 2008). HS can appear as soon as one month after injury and has been linked to age, size of burn, ethnicity, delayed wound healing and

multiple skin graft procedures (Brissett and Sherris 2001). Further, 5% of burns that result in pathological scar formation develop contractures (Gangemi, Gregori et al. 2008). Length of stay, extent of burn (TBSA) and history of skin grafting have been identified as factors associated with a higher incidence of contractures (Schneider, Holavanahalli et al. 2006).

Little is known of the proportion minor burns affected by pathological scarring (Matsumura, Engrav et al. 2001). A study that reported scarring after burns was limited by 60% loss to follow-up at 12 months that potentially biased the outcome in favour of more severe burns. Further the study did not describe the time to healing of the subset that had partial thickness burns nor what proportion had surgery (van der Wal, Vloemans et al. 2012). Studies have reported incidences of between 0% and 77% of abnormal scarring in samples where the mean TBSA was either unreported or greater than 15% (Deitch, Wheelaham et al. 1983, Oliveira 2005, Gangemi, Gregori et al. 2008, Bombaro, Engrav et al. 2003). Most have not described the injury severity and healing times of the included sample in detail (Bloemen, van der Veer et al. 2009). Lower incidence was found in superficial and moderate partial thickness burns, treated conservatively and relative to healing time (Deitch, Wheelaham et al. 1983). An early study described an 80% incidence of visible scarring up to four months post-burn in a cohort with a mean TBSA of 3.6% (Shakespeare 1998). This contrasts with a study of children, with average TBSA burns of 5.5% that were treated conservatively where the incidence of HS was 2% if healing occurred within 14 days of injury (Cubison, Pape et al. 2006). Higher incidence is related to burns over 10% TBSA, reflecting the association between burn severity and scar outcome as demonstrated by the largest published epidemiological scar study to date (Gangemi, Gregori et al. 2008).

Scar outcome is associated with burn size, depth and healing rate and surgical treatment (Bombaro, Engrav et al. 2003, Gangemi, Gregori et al. 2008, van der Wal, Vloemans et al. 2012). Studies in adult and child burn cohorts have demonstrated that burns that heal within 21 days result in a better scar and functional outcome (Deitch, Wheelaham et al. 1983, Kildal, Andersson et al. 2002, Cubison, Pape et al. 2006). In contrast, large, deep burns with wounds that take longer than three weeks to heal can develop hypertrophic or keloid scars (Bloemen, van der Veer et al. 2009).

Small burns have a lower risk of abnormal scarring. An investigation into the predictors of scar outcome in a cohort of 703 patients with 2440 burn sites found that those who did not receive a HS had a median TBSA of 18% (Gangemi, Gregori et al. 2008). Further, a small proportion (8%) of the group with a good scar outcome was comprised of those with full thickness injuries. Conservative healing is linked with a better outcome as those that had skin graft surgery were found to have 0.25 times the risk of abnormal scarring (95% CI 0.2-0.31). A limitation of the study was the absence of a standardised scar assessment tool to provide a more involved description of the scar outcome.

It is clear that little information on the incidence or quality of abnormal scar in the minor burn population is available. The research shows that scar outcome is related to increased severity and there is less likelihood of hypertrophic scarring in minor burns that heal within two weeks. Thus, most burn clinicians work on the premise that a burn under 15% that heals quickly by conservative means is unlikely to scar (Johnson and Richard 2003, Alsbjorn, Gilbert et al. 2007).

2.4 Outcome from Minor Burn Injury

Information on outcome from minor burn available to guide clinicians comes mostly from expert opinion, is limited to specific patient groups such as children or describes injuries to a single body location (Sheridan 2000, Ewings and Pollack 2008, Finlay, Burke et al. 2009). It has been known for some time that minor burns that heal quickly recover well with few if any long-term complications (Heimbach, Engrav et al. 1981). Significant numbers of people sustain minor burns each day that, with effective wound care, early movement and preventative scar management, heal within two weeks resulting in a speedy return to normal function (Morgan, Bledsoe et al. 2000, Sheridan 2000, Alsbjorn, Gilbert et al. 2007). At the other end of the severity scale, major burns can result in significant distress, an increased hospital length of stay and long-term problems (Thombs, Singh et al. 2007).

Because of the potential variability in outcome after minor burn, careful screening of patients for the factors that influence recovery can facilitate appropriate treatment selection. While it appears that the majority of minor burns heal with early conservative wound care, more involved treatment cannot be excluded from the outset and early assessment of outcome is important in judging potential for full recovery. Hospitals with a burn outpatient facility can provide specialised wound

management and assessment of progress to minimise potential for poor outcome (Brandt, Coffee et al. 2000, Morgan, Bledsoe et al. 2000). RPH provides a dedicated ambulatory burn service to minor burn patients the majority of whom recover without long-term consequences (Rea and Wood 2005, Finlay, Burke et al. 2009).

From the literature, it is difficult to determine the incidence of poor outcome from minor burn with much of it referring to the necessity for increased services as a measure of response to treatment (Jansen, Hynes et al. 2012). In addition, comparison of data between studies is complicated by lack of homogeneity of the sample populations, particularly with respect to severity. In a cohort of 49 patients with a mean TBSA of 3.6%, 33% reported physical and social dysfunction up to four months. However, all were hospitalised with a mean LOS of 7.8 days indicating greater severity than is apparent from extent of burn alone (Shakespeare 1998). In contrast, another study of 178 patients with a mean TBSA of 2.9%, only 23.7% needed hospitalisation with fewer still having long-term complications (13.5%) (Sagraves, Phade et al. 2007). One US study of 776 patients describing a new minor burn management strategy reported that 93% of the sample healed without requiring hospitalisation or surgical intervention (Vercruysse, Ingram et al. 2011). This finding is supported by a study reporting that 8% of minor burn patients who attended a United Kingdom hospital emergency department in 2003-4 required plastic surgery (Khan, Rawlins et al. 2007).

Patient self-assessment of post-burn recovery is possibly the most important gauge of outcome following injury and success of a particular intervention (Garratt, Schmidt et al. 2002). In particular, evaluation of patient quality of life (QoL) can be a strong indicator of recovery from burn injury. Measurement of QoL after major burn using standardized self-report survey has been a feature of outcome assessment for the last 30 years but appears to be uncommon after minor burn. Compared to major burns, little objective data on quality of life is available to evaluate the success of minor burn management. In addition, there is inconsistency in the use of self-reported outcome tools used to measure recovery after minor burn. Further, none of the tools available to date, have been validated for use in this population.

Only a few studies reporting patient self-evaluation of recovery post-burn using a variety of tools have been published. A study of electrical and thermal burn patients with mean TBSA <10% found that the sample group reported similar or better well-being than the general population up to seven years post-injury as measured by the

Short-Form 36 (Cochran, Edelman et al. 2004). Another study used the Impact of Event Scale (IES) and the Hospital Anxiety and Depression Scale (HAD) to measure short term outcome in patients with burns up to 20% TBSA (Shakespeare 1998).

Despite having been developed in major burn patients, the Burn Specific Health Scale-Brief (BSHS-B) has been used to describe quality of life of patients after minor burns (Fauerbach, Lezotte et al. 2005, Finlay, Edgar et al. 2010). A study of patients with electrical burns reported relatively high BSHS-B domain scores for patients with burns under 10% TBSA (Noble, Gomez et al. 2006). However, at present, a definitive demonstration of the performance of the BSHS-B in minor burns is lacking in the literature.

2.4.1 Measures of Recovery from Burn Injury

Collection of outcome data over time assists in the establishment of the recovery pathway, direction of intervention strategies and the measurement of service performance (Falder, Browne et al. 2009).The measurement of recovery after minor burn as indicated by QoL is hampered by a lack of validated assessment tools. Several tools have been previously used to measure outcome after major burn but none to date have demonstrated to be valid measures of minor burn recovery. The BSHS-B is a tool that has been developed specifically for measuring recovery after burn injury and has been extensively investigated using major burn cohorts. Its validity for use in the minor burn population is yet to be demonstrated. Other more generic assessment tools have been used to describe recovery after major and minor burns without demonstrating their validity in both injury sub groups. One study reported Brief Symptom Inventory Global Severity Index and Short Form 36 survey scores in burns stratified according to size. Comparison of patients, stratified according to TBSA, using chi-square tests found those with smaller burns (<10% TBSA) were noted to have better physical function and make a faster recovery than those with significantly larger burns (Fauerbach, Lezotte et al. 2005).

The BSWA at RPH has routinely collected outcome data to assess recovery of burn patients since January 2006. Standardised outcome measures employed include the BSHS-B; the Short Form -36; the shortened Disabilities of the Arm, Shoulder and Hand (QuickDASH); Range of Motion (ROM) using Goniometry; Grip Strength using a hand dynamometry; and the Timed Up and Go test (TUG) (Blades 1982, Blalock, Bunker et al. 1994, Kildal, Andersson et al. 2001, Bennie, Bruner et al.

2003, Wu, Edgar et al. 2007, Edgar, Dawson et al. 2010, Finlay, Edgar et al. 2010, Clifford, Hamer et al. 2013). All measures were chosen for their validity in burns and other patient populations. At RPH, in January 2006, a programme of validation titled the Burns Clinical Outcomes Research Project (BCORP) was instigated to investigate the tests within the local burn population. The BCORP established the accuracy of burn outcome measurement tools and set benchmarks of recovery from burn injury (Wu, Edgar et al. 2007, Edgar, Finlay et al. 2009, Falder, Browne et al. 2009, Finlay, Burke et al. 2009, Finlay, Edgar et al. 2010).

2.4.2 Describing the Burn Specific Health Scale- Brief (BSHS-B)

Routinely employed at RPH and around the world to measure QoL after burn injury, The BSHS-B is an injury specific self-report outcome tool that features often in burns publications (van Baar, Essink-Bot et al. 2006, Finlay, Edgar et al. 2010). It encompasses a variety of responses to burn injury and has been studied extensively (Noble, Gomez et al. 2006, Wu, Edgar et al. 2007, Finlay, Edgar et al. 2010, Zhang, Cao et al. 2012). Its psychometric properties have been well established (Willebrand and Kildal 2011). An expert panel from the Johns Hopkins School of Medicine in Maryland, USA developed the instrument to measure quality of life in major burn survivors and first came to the attention of the international burns community in 1982 (Blades, Mellis et al. 1982). The scale initially consisted of 80 items determined to be important in assessing the performance of patients post-burn (Munster, Fauerbach et al. 1996).

The 40-item BSHS-B has been found to be reliable, valid and sensitive in several major burn patient samples (Kildal, Andersson et al. 2001, Willebrand and Kildal 2008, Edgar, Dawson et al. 2010, Finlay, Edgar et al. 2010). The BSHS-B measures the subjective responses of burn patients regarding their injury across a number of areas including physical, psychosocial and sexual functioning and scar outcome. It is scored on a Likert scale of 0 to 4 with higher scores indicative of better function after burn injury (Cromes, Holavanahalli et al. 2002). Initial factor analysis resulted in nine subscales with related items (Kildal, Andersson et al. 2001). The nine subscales first identified include Affect, Interpersonal Relations, Sexuality, Simple Abilities, Hand Function, Work, Heat Sensitivity, Treatment Regimens and Body Image. Repeated factor analysis of the subscales of the BSHS-B further reduced the scale into three major clinically meaningful health domains comprising Function,

Skin Involvement and Affect and Relations (Willebrand and Kildal 2008). Further, it has been shown to have 43 health related concepts in common with the International Classification of Functioning, Disability and Health (Wasiak, McMahon et al. 2011). The tool is currently limited in its application as it was developed using large burn data and its performance in measuring outcome from minor burn has not been fully demonstrated.

Self-assessment of scar outcome is critical to the post-burn review process (Martin 2003, Rea, Goodwin-Walters et al. 2006). Information on patient response to scar quality post-burn is afforded by the Body Image subscale of the BHSH-B (Kildal, Andersson et al. 2001). This is useful as objective measurement of scar outcome is made difficult by the lack of a reliable and valid assessment tool. The Vancouver Scale is a widely used but subjective scar assessment tool which has been found to lack inter-rater reliability demonstrated by intraclass correlation coefficient values below 0.50 (Nedelec, Correa et al. 2008). Further, scar ratings by clinicians are mostly subjective, being dependent on the training and experience of the rater. Standardised tools such as the Vancouver Scar Scale and the Patient and Observer Scar Assessment Scale are commonly used in scar assessment but have limitations also (Nedelec, Correa et al. 2008, Vercelli, Ferriero et al. 2009).

Tracking of burn patient progress, including the use of data on health status is useful in guiding clinical judgement. An attempt is made by the BSWA at RPH to routinely collect BSHS-B scores at one, three, six and 12 months post-injury. Preliminary analysis of BSWA clinical data shows that self-reporting of scores on the BSHS-B at one month displays a strong association (98%) with six month scores (Finlay et al, unpublished data). This is due to a ceiling effect evident from one month post-injury (Edgar, Dawson et al. 2010). Thus, it can be inferred that a patient who reports a good outcome as measured by the BSHS-B at one month, will maintain their burn related QoL long term.

Classification of QoL as measured by the BSHS-B has not been extensively explored. For instance, what score constitutes good or poor quality of life? It is understandable that the standard for good recovery after major burn is lower than for a minor burn. A previous study has suggested that 80% of a full score or 128/160 is an indication of good recovery in a major burn population (Cromes, Holavanahalli et al. 2002). Conversely it can be argued that as minor burns are likely to have little long term negative impact, return to pre-injury level of quality of life should be

expected. Obtaining reference values for good QoL as defined by a normal population occurs through survey of a representative sample of the population. In the case of the BSHS-B, collection of population norms is complicated due to the presence of a proportion of burn related questions. This requires the scale to be modified, removing or rewording questions relating to burns as was recently done by our group which applied a modified version of the BSHS-B to a sample of 124 non-burned residents of Perth, WA. The study found that participants scored an average of 145/160 points (Kvannli, Finlay et al. 2010). Therefore, in this research, a score of 146 points on the BSHS-B was used to define adequate recovery from burn injury. Thus the target for a good recovery after minor burn, as defined by the BSHS-B, if attempting to approximate a normal score, is notably higher than for a major burn.

2.4.3 Psychological Outcome after Minor Burn

The psychological effects following burn are linked with pre-morbid psychological illness, personality traits, body image, injury trauma and distress experienced in hospital, physical function and scar outcome post injury (Patterson, Ptacek et al. 2000, Fauerbach, Lezotte et al. 2005). Up to two years from injury, patients with reduced physical ability also report increased levels of psychological dysfunction (Van Loey, Faber et al. 2001). While it is well known that major burn survivors have reportedly higher levels of emotional distress and reduced quality of life than the normal population at discharge from hospital and six months from injury, less is known of the mental health of minor burn patients (Patterson, Ptacek et al. 2000). In one study, 33% of patients with burns under 20% percent TBSA have also reported experiencing psychological distress four months after injury (Kalson, Jenks et al. 2012). The study group had spent at least one day in hospital and 80% reported visible burn scarring. Thus, it may be inferred that a significant proportion of patients sustain small to moderate burns with a significant negative physical and psychological result. The psychosocial impact of patients with minor burns who were not admitted to hospital is not known.

2.4.4 Burn Patient Satisfaction with Care

A few published studies describing burn patient satisfaction with care and outcome after burn injury are available (Wikehult, Ekselius et al. 2009). Assessment of patient experience following contact with health care has been used extensively in other injury populations as a measure of service delivery (Berke, Fergason et al. 2010).

Patient satisfaction is useful in determining the effect of changing standard of care and implementation of early discharge strategies as demonstrated by research cardiovascular medicine (Glaser, Gertz et al. 2009). In burns, studies on the patient's experience of pain management suggest that meeting patient expectations is strongly predictive of satisfaction with treatment regardless of burn size, age, sex or perceived improvement (Browne, Andrews et al. 2011). Further, research has shown that patient satisfaction has been shown to be unaffected by improvements in efficiency (Wood, Spahr et al. 2009).

The only tool measuring burn-specific patient satisfaction that appears in the literature is the Burn Patient Satisfaction Scale (BPSS), developed at RPH (Finlay, Burke et al. 2009, Finlay, Davidoss et al. 2012). Previous studies have used generic measures such as the Norwegian Patient Satisfaction - Results and Quality instrument for evaluating satisfaction with surgical intervention (Wikehult, Ekselius et al. 2009) and the Pain Treatment Satisfaction Scale (Andrews, Browne et al. 2012). The BPSS is limited by lack of studies investigating its validity or reliability in the burn population, however its advantage is that it has questions relating specifically to burn a patient's satisfaction with care and other burn related outcomes including scar.

2.5 Management of Minor Burns

Burns are usually managed according to severity (Kessides and Skelsey 2010). Patients presenting to community medical services and hospital emergency departments are often directed to specialist treatment on the basis of wound size, depth and the patient's response to the injury (Monstrey, Hoeksema et al. 2008). Depending on accurate assessment of severity and potential outcome, minor burns can be managed on an ambulatory basis by emergency departments of hospitals, general practitioners or burns outpatient clinics without complications of infection or immobility (Heimbach, Engrav et al. 1981, Warden 1987, Alsbjorn, Gilbert et al. 2007). RPH has a dedicated burns outpatient clinic staffed with a specialized multidisciplinary team that accepts referrals from other health care workers as well as managing the ongoing care of patients discharged from the inpatient burn unit (Rea and Wood 2005). Outpatient care of minor burns can be more cost-effective and convenient for the patients, clinicians and the health service involved than hospital admission as demonstrated by several studies (Vercruysse, Ingram et al. 2011, Brandt, Yurko et al. 1998, Brandt, Coffee et al. 2000).

2.6.1 Educating the Burn Patient

Education of burn patients aids in minimising potential complications and the facilitation of a good outcome (Yurko and Fratianne 1988). Education of the burn patient through the transfer of specialist information is beneficial in improving burn patients' knowledge of the recovery process, improving compliance with therapeutic regimes and reducing anxiety regarding their condition (Jenkins, Blank et al. 1996, Lo, Hayter et al. 2010). Multidisciplinary education based on current literature assists patients to effectively self-manage their post-acute burn care, recognize problems and know when to seek help (Moss 2004). Patient education can also be useful in preventative scar management over the scar maturation process which can take up to 24 months to complete (Johnson and Richard 2003). This may help to combat the tendency of some burn injuries to result in a chronic condition. Several authors describe the dispensation of wound care and scar management advice to patients (Jordan, Daher et al. 2000, Johnson and Richard 2003, Moss 2004). To date, a handful of scientific studies demonstrating the importance of educating patients in self care of their burns have been published. One such study utilising computer based education demonstrated reduced anxiety and increased compliance with use of pressure garments in burns over 5% (Lo, Hayter et al. 2010). In another study, provision of a handout and instructional video was found to improve compliance with scar management (So, Umraw et al. 2003).

The research on burn patient education regarding the management of burn injury encompasses the spectrum of burn injury (Finlay, Davidoss et al. 2012). Thus, minor burn patients also benefit from up-to-date, expert information to provide the best opportunity for full recovery from injury. Prevention of complications and early scar management are necessary to facilitate good quality outcomes minor burn injury, particularly in those managed on a solely outpatient basis (Moss 2004). A recent study conducted among minor burn patients at RPH who had not been admitted to hospital found that viewing a burn care DVD improved patient confidence in burn self management activities like washing and dressing the burn (Finlay, Davidoss et al. 2012). Education in these areas along with pain management, and functional mobility, among others, needs to be instigated upon presentation of the patient to the burn service and continue until no further action is deemed useful. It follows that specialised burn patient self-care information provided in a visual format that can be taken home for repeated reference is a useful tool in the minor burn outpatient management.

2.6.2 Loss to Follow-up and Missing Data in Burn Research

At RPH, initial follow-up appointments for minor burns between four and six weeks post injury provide patient feedback, assessment of response to treatment and risk management. This assists clinicians in screening patients for future intervention which may include functional rehabilitation, psychological support and scar management.

Other burn centres have different review protocols with one advocating routine follow-up for all burn patients at two months from injury for identification of patients who may have developed hypertrophic scar (Hudspith 2004). However, lack of attendance at outpatient clinic review appointments is common at RPH and burn centres in developed nations such as the United Kingdom (Hull, Alexander et al. 2002). Unpublished data on outpatient attendances to RPH burn clinics in 2008 indicated that more than 25% of all scheduled appointments were unattended (Fong, unpublished, 2008). This is supported by data from a study of 311 burn patients in the United States, 28% of whom failed to attend follow-up clinic appointments (Sagraves, Phade et al. 2007).

As can be seen in Figure 2 below, this is more noticeable in the minor burn population in particular, with an RPH study noting approximately 45% patient attrition at one month post-injury and increasing over time (Finlay, Burke et al. 2009). The study involved a cohort of upper limb minor burn patients who missed scheduled hospital review appointments. Patients were contacted several times, an average of one year later to obtain BSHS-B survey results. Of the 67% who responded to postal or telephone requests to return completed BSHS-B surveys, the majority had good quality of life and were satisfied with the burns service provided. The non-responders were young males who are established non-attendees at hospital appointments and are also known to have the best recovery from injury (Finlay, Burke et al. 2009). This finding is supported by another study that attempted to retrieve quality of life survey information from burn patients. The authors reported a 42% response rate with non-responders most likely to be young males, with smaller burns, short inpatient stays and less invasive treatment (Cochran, Edelman et al. 2004). Thus it appears that failure to present for follow-up after minor burn is associated with increased likelihood of good recovery.

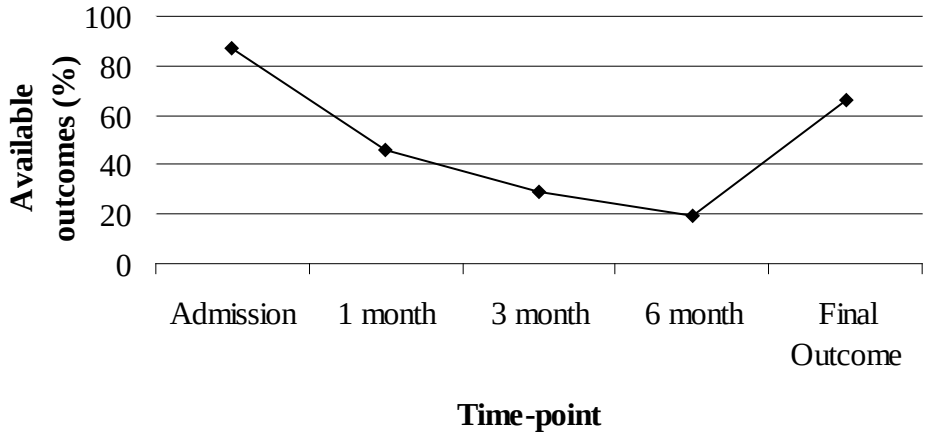

Figure 2.2 Available outcome data throughout recovery (with intensive data retrieval attempts after six months)

Loss to follow-up can also hamper the translation of outcome research to clinical practice by affecting the development and implementation of data driven patient management programs. Missing data can bias interpretation of results of outcome analysis used to provide feedback on clinical care and response to treatment (Sales, Plomondon et al. 2004, Holavanahalli, Lezotte et al. 2006). In burn patients, as discussed previously, longitudinal outcome data collection is impeded by poor patient attendance at outcome review clinics. Following up burn patients is increasingly difficult as time from injury increases (McKeown, Mackey et al. 2008). Routine attempts to collect data from BSWA minor burn patients at six months from injury have previously resulted in 80% loss to follow-up (Finlay, Burke et al. 2009). In some clinical trials loss to follow-up can indicate a poor outcome such as death or lack of adherence to trial protocol (Streiner 2008). However as the above study indicates, in minor burns, patient non-attendance is associated with likelihood of a good outcome.

Missed follow-up appointments also result in financial burden to government health services as was noted in a Scottish study (Hull, Alexander et al. 2002). In addition, anecdotal evidence suggests that staff time is misdirected by collecting and organising patient notes, time that could be spent on attendees.

Most importantly, this may delay treatment for other patients. Appointments may be deferred if the full quota of patients for the clinic in question has been reached. The

resultant increased risk of a potentially adverse outcome might be minimised by providing alternate methods of follow-up that may be more convenient to those reluctant to attend hospital for review. Instead of presenting to a hospital, patients can be reviewed by their local doctor, via tele-health, by telephone or self-report health survey to determine response to treatment and early outcome post-injury (Holt, Faraklas et al. 2012).

Clinical studies are often plagued by missing data (Houck, Mazumdar et al. 2004). Missing data is related to location such as busy clinical environments, inexperienced data collectors and enterers, busy clinicians, patient attrition and longitudinal studies. Further, studies with data collection that occurs over a long period involving a large sample with many variables are more prone to missing values.

Loss to follow-up is a major source of missing data in longitudinal outcome studies. Capturing maximum data captured to avoid bias of results bias can be difficult to achieve, particularly in routine follow-up data collection. A recent study of 637 multi-trauma patients using simulated loss of follow-up has found that study results are unaffected by up to 20% missing data (Zelle, Bhandari et al. 2013). Investigation of large amounts of missing data can aid understanding of results and any potential bias (Molenberghs, Thijs et al. 2004). Statistical techniques such as multiple imputation are available to deal with missing data necessary to determine if whether the missing data records are associated with a particular characteristic of the subset of the initial sample group or the unknown outcome (Streiner 2008). For instance a significant proportion of those with incomplete data may be female or may have provided low scores. This suggests that the data is not randomly missing. There are three categories of missing data: Missing Completely At Random (MCAR), Missing At Random (MAR) and Missing Not At Random (MNAR) (Enders 2011). Establishing which category describes the missing data in a study assists the application of techniques to manage the dataset, maximise the sample and minimise bias.

2.6.3 Costs of Minor Burn Care

Burns are an expensive injury to manage. Increasing numbers of burn injuries and burn survivors add to increasing costs borne by health services. The management costs for burn patients in economically advanced countries like Australia, are double that of non-burned hospital patients (Takayanagi, Kawai et al. 1999). Further most of

the research into cost of burn care is related to major burns. A recent economic analysis has found that the average cost of managing an adult burn patient with a mean TBSA of 20% in an Australian burn care facility is AU$71,056 (Ahn and Maitz 2012). The cost of inpatient burn care in a Canadian Burn Unit has recently been reported as CAD$1,663 per day (Jansen, Hynes et al. 2012). This figure is almost double that of the average major burn inpatient daily rate from 1997-2001 for a Spanish Burn Centre, quoted as US$917 (Sanchez, Pereperez et al. 2007).

Cost analysis in minor burns seems to be limited to in-patient care leaving little data available for comparing cost-minimisation strategies for out-patients as the majority are managed on an ambulatory basis (Rea and Wood 2005). Sanchez et al recently reported two Spanish hospitals' health care costs for burns classified according to diagnosis-related groups. Between 1997 and 2001, a sample of 411 patients with non-extensive burns without an operating room procedure who had mean LOS of 12 days cost US$303.30 per day (Sanchez, Pereperez et al. 2007).

In recent times, increasing numbers of publications have reflected the need for burn services to provide more sustainable care while providing good patient outcomes (Jansen, Hynes et al. 2012). Minor burns are seen to be a practical and low-risk target for improving efficiency by streamlining care (Vercruysse, Ingram et al. 2011). However, for dedicated burn units with associated outpatient services there are few guidelines available to efficiently manage the large numbers of minor burn patients that are not admitted to hospital.

It has been determined that staff resources comprise a greater proportion of total treatment costs in the management of minor burns compared to major burns (Takayanagi, Kawai et al. 1999). At RPH, administrative and clinical staff time is spent preparing for patients who have booked outpatient appointments. However, this is associated with inefficiency related to non-attendance. As discussed previously, within a cohort of patients who had sustained upper limb burns and had a hospital length of stay of three days or less, 40% failed to attend a one month follow-up appointment (Finlay, Burke et al. 2009). This has financial implications as non-attendance at outpatient follow-up in 2002 in the United Kingdom was found to be in the order of 10% at a cost of £65 (Hull, Alexander et al. 2002). Programmes that aim to reduce the burden of injury on the health system by minimising burn centre contact for minor burn patients with a low risk of complications and who are

displaying rapid progress to a good outcome have recently been explored (Vercruysse and Ingram 2012).

Determining the minimum amount of hospital outpatient attendance required to produce good outcomes for minor burn patients is important in streamlined care strategies (Jansen, Hynes et al. 2012). Use of QoL self-report surveys are often used to establish recovery status. (Noble, Gomez et al. 2006). However, to date, no studies have employed surveys to reduce the need for patient attendance at outpatient clinics for the purpose of assessing outcome in the post-acute phase. In minor burns, self-assessment of progress may be paramount especially in those that are unable or unwilling to make the journey to hospital for medical review. Thus the use of outcome surveys has the potential for producing cost-savings for the patient and the health service involved. Cost-savings generated from providing a quality of life survey as an alternative follow-up strategy for minor burn patients could be redirected to research, new treatment options and injury prevention strategies with the goal of improving outcomes for severely burned patients.

2.7 Prediction of Outcome from Burn

Predicting the quality of eventual recovery in the early stages following burn injury can be useful for burn clinicians and health services (Shakespeare 2003). Identification of the demographic and injury factors that are associated with good outcome is useful in assisting burn care providers in streamlining services with minimum risk to selected patients (Fauerbach, Lezotte et al. 2005). For instance, patients with small surface area burns have been identified as being suitable for non-specialist burn care so that burn centres can focus on the treatment of major burns (Vercruysse, Ingram et al. 2011). Treatment regimens and resource allocation can thus be tailored to specific patient groups to promote good outcome and efficiency of health care provision (Vercruysse and Ingram 2012).

Early recognition of patients with the potential to proceed to full recovery without complication, through standardized outcome measurement, can provide clinicians with the ability to prioritize time and resources more effectively (Jansen, Hynes et al. 2012). One study of mass casualties sustaining burn injuries, grouped patients according to burn size (%TBSA) and anticipated outcome for the purpose of triage (Saffle, Gibran et al. 2005). Thus fewer resources were allocated for small burns (up to 30% TBSA) in patients up to 60 years of age. It should be noted that in this

instance outcome refers to survival whereas in many burn centres including RPH, outcome is measured in terms of quality of survival (Edgar, Wood et al. 2005, Falder, Browne et al. 2009).

In most instances minor burn patients recover quickly, however, there is still some uncertainty surrounding the factors that predict recovery from minor burn (Vercruysse, Ingram et al. 2011). Previous research has found that a combination of patient and injury characteristics is the best indicator of outcome following burn injury rather than a single factor (Gravante, Delogu et al. 2007). This is highlighted by the variability of injury severity in those classified as minor according to extent of burn (Cochran, Edelman et al. 2004). Like all burns, minor burns need to be managed according to potential outcome (Shakespeare 2003). Factors linked to adverse outcomes in the minor burn population include increased burn depth; underlying conditions that delay healing, such as diabetes; and complications like infection (Barsun, Sen et al. 2013). Thus wound healing time is the strongest link to a good outcome (Deitch, Wheelaham et al. 1983). Clinicians can be confident that minor burn patients whose wounds heal early may require little long-term physical intervention. As previously noted, in some cases, minor burns can cause psychological distress (Shakespeare 1998). Thus, the addition of patient reported satisfaction with progress can provide further evidence of a good outcome (Kalson, Jenks et al. 2012).

Early assessment of progress after minor burn is important in clinical practice as injury severity is not solely predictive of eventual outcome. A small proportion of patients with minor burns have reported less than optimal recovery (Kalson, Jenks et al. 2012). Standardised, tools that measure patient perception of their condition can be strong indicators of their final outcome. In burn patients at RPH, the BSHS-B has been used extensively for this purpose (Edgar, Finlay et al. 2009, Finlay, Edgar et al. 2010). Further, as BSHS-B score have been shown to plateau from one month post-burn, early reports of a satisfactory outcome as demonstrated by a high score on the BSHS-B can provide a strong forecast of long-term outcome (Edgar, Dawson et al. 2010). Patient treatment and follow-up can thus be individualised in light of patients' early responses to the BSHS-B.

Outcome forecasts in the early stages of recovery may assist clinicians to determine the amount and type of treatment and rehabilitation that is most beneficial for each patient. Nomograms are prognostic calculation tools which use a combination of

important patient information to forecast outcomes for individual patients and are common in oncology (Nowak, Francis et al. 2010), cardiovascular medicine, urology and pharmacologic therapy (Dong, Kattan et al. 2008, Monkman, Lazo-Langner et al. 2009, Heart Foundation 2010). Nomograms for predicting mortality or fluid resuscitation after burn injury have been used to aid burn management since the 1960's (Bowser, Caldwell et al. 1968). More recently, burn patient demographic and injury information has been used in a nomogram to predict likelihood of abnormal scarring (Gangemi, Gregori et al. 2008). A nomogram used for predicting QoL after burn is currently unknown. Further, to date, there is a lack of information on the use of early QoL outcome information to predict long-term QoL after burn injury.

2.9 Chapter Summary

With expert care, burns up to and including 15% TBSA have the ability to progress smoothly to good outcome indicated by minimal scarring, full function and return to pre-injury quality of life, compared with larger burns (Ewings and Pollack 2008, Finlay, Burke et al. 2009, Vercruysse, Ingram et al. 2011). However, the likelihood of poor outcome still exists in this population and individual factors that influence outcome such as necessity for skin graft surgery must be taken into account. Early evaluation of outcome is therefore crucial in managing any deviations from the expected recovery process. To this end, accurate assessment tools are necessary. Expert opinion is the traditional form of evaluation but is time consuming, costly and is subject to patient attendance at review. Self-report survey instruments have the potential to be used to provide QoL information with minimal cost to the health service, increased convenience to the patient and without compromising outcome.

A significant proportion of health care resources are used in the management of burn injuries (Takayanagi, Kawai et al. 1999, Vercruysse, Ingram et al. 2011). Previous studies have provided information on alternate management of minor burns to improve the sustainability of burn care. Minor burns patients comprise 90% of all those treated for burns at a tertiary care facility and are a reasonable target for the application of a more efficient care strategy due to the low severity of their injuries and their propensity for a good outcome. Refining the sample further, patients with burns up to and including 15% TBSA which heal in two weeks with conservative management and only ambulatory care are a logical group to receive a more streamlined care process with minimal negative impact. As approximately 40% of these patients fail to attend burn clinic appointments from one month post-burn,

and are lost to follow-up, a more effective method of review would be useful. Use of a posted standardised QoL survey such as the BSHS-B may assist minimise loss to follow-up compared to hospital based review appointment, improve efficiency of clinical practice and minimise patient burden. Further, education of the burn patient is known to be useful in facilitating good outcomes and a multidisciplinary tailored patient care booklet was produced for and used to support the streamlined model of minor burn care.

The BSHS-B is the sole reliable and validated burn related outcome measure described in the literature, though only in major burns. Prior to commencement of this research, no published validated self-reported outcome tool was available to assess patients with burns of 15% or less. The BSHS-B was selected as the most extensive and appropriate instrument capable of providing a definitive evaluation of outcome from minor burn (Willebrand and Kildal 2011). Therefore further research to describe the accuracy of the BSHS-B in measuring QoL after minor burn injury may be helpful to clinical care across a whole burn population.

Identification of burn patients with injuries that have the capacity to proceed to a good outcome can produce benefits for patients and health services. A nomogram that uses patient personal and injury information to calculate likelihood of hypertrophic scarring after burn has been previously reported (Gangemi, Gregori et al. 2008). No studies, to date, have used early outcome assessment in a nomogram to predict likelihood of long-term outcome.

The literature on minor burn care demonstrates a need for improvement in the efficiency of minor burn care. However, in its lack of minor burn QoL outcome information and guidelines for management, particularly with regard to follow-up it also highlights, by omission, an opportunity for specific care practices. The significant numbers of minor burn patients failing to attend review clinics points to the lack of evidence based guidelines available for their management. Wasted appointments can result in inefficient service delivery resulting in difficulties coping with the ongoing high demand for burn care and good outcomes for all burns.Streamlining post acute minor burn care can have service wide benefits, potentially freeing up valuable staff time and resources that could be better utilized in the management of more severe burns. Streamlined models of minor burn care may be useful in assisting the sustainability of quality health care into the future. In

addition, evidence is necessary to facilitate a worldwide change in practice through the adoption of more efficient standards of care for selected minor burn patients.

CHAPTER THREE METHODS

This research comprises three studies which aim to a) investigate a new management protocol for minor burns, b) validate the use of the BSHS-B in the minor burn population and c) provide evidence for the use of a predictive nomogram used as a risk management tool in the new model of care. The methodology undertaken to complete the three studies are outlined in brief below. Additional detail is contained in each of the study chapters further in this thesis.

3.1 Study 1: Development and evaluation of a new model of care for minor burn patients

3.1.1 Study 1 Hypothesis

Patients with minor burns of 15% TBSA or less, who are managed conservatively as outpatients and whose wounds heal in 14 days or less who are assessed using mailed BSHS-B surveys at one month and who receive a tailored burn patient self-care manual have the same or better QoL as that of patients who attend hospital for one month review.

3.1.2 Study 1 Objectives

- Design and produce a multidisciplinary tailored education manual for self-management of patients with minor burns.
- Evaluate the effectiveness of a new model of outpatient care for selected minor burns patients.
- Develop a nomogram to predict the successful outcome of burn patients for use as a risk management tool in the new model of care.

3.1.3 Study 1 Procedure

In this two cohort comparative study, the QoL outcomes of a sample of minor burn patients who received a new intervention were compared to those of a second similar but independent sample that received standard care. The intervention, a streamlined model of care, involved discharging selected, consenting patients at or

before two weeks post injury and replacing a routine one month hospital clinic visit with a posted burns self-report survey, the BSHS-B. Interventional group patients were also provided a multidisciplinary tailored burn care manual to assist ongoing care of the healed burn and minimise potential complications. Patients identified as suitable to receive the intervention included those with burns of 15% TBSA or less, who had not been admitted to hospital, did not have burns surgery and who healed in 14 days or less. The comparison group comprised those with matching criteria who received standard care of a one month clinic review appointment and who returned a one month BSHS-B survey. The intervention was implemented over nine months between November 2008 and July 2009. A nomogram to predict the likelihood of a burn patient scoring 150 points or more on the BSHS-B was developed to provide a safety net by identifying potential inaccuracies in patient selection. The one month Intervention group participants were also surveyed with the RPH Burn Patient Satisfaction Survey. For the purposes of this research only the question regarding satisfaction with the burn service will be reported. Median BSHS-B responses of intervention group participants that were the same or better than those of the comparison group determined the success of the study.

3.2 Study 2. Enhancing the clinical utility of the Burn Specific Health Scale – Brief: to incorporate minor burns

3.2.1 Study 2 Hypothesis

The BSHS-B demonstrates reliability along with content, construct and criterion validity in measuring QoL after minor burn.

3.2.2 Study 2 Procedure

RPH burn patients who provided outcome information up to two years post-injury from January 2009 to February 2013 through a programme of routine data collection comprised the initial sample for analysis in this descriptive cohort study. No inclusion criteria were applied. Statistical analyses were used to investigate the hypothesis as per previous research presented in two previous studies involving the BSHS-B (Willebrand and Kildal 2008, Willebrand and Kildal 2011). Reliability was assessed by measuring internal consistency using the Cronbach's alpha test. First and second order factor analysis determined content validity by examining the factor structure of

the scale and sub-domains. Logistic regression analysis was used determine the relationship between severity factors (TBSA, LOS, surgery) and BSHS-B total and domain scores up to three months post injury to provide an understanding of construct validity. Finally, criterion validity was examined using longitudinal regression analysis to describe the pattern of BSHS-B total and domain scores over time. Polynomial regression modelling was used in this analysis as it is robust to deviations from normality and non-linear data.

Incomplete BSHS-S surveys were excluded from the all but the longitudinal analysis which involved those with two or fewer missing question responses to boost statistical power. In those cases the mean of the completed questions were used as an estimate of the score for each missing response. Potential bias from missing data was assessed by comparing the demographic and injury information of the sample that provided excluded data to that which provided included data.

3.3 Study 3. Development and evaluation of a nomogram for predicting quality of life six months after burn injury

3.3.1 Study 3 Hypothesis

The RPH burn nomogram is a valid tool for calculating the probability that a patient will score 150 points on the BSHS-B at six months using the patient's one month BSHS-B score along with patient personal and injury information.

3.3.2 Study 3 Procedure

This study describes two phases. In phase I, a predictive nomogram was developed using a sample of RPH burn patients with available BSHS-B survey data extracted from a burn patient outcome database. The patients attended RPH for acute burn management from January 2006 to November 2008. The nomogram was developed firstly using univariate logistic regression analysis to determine the patient and factors that predicted BSHS-B total score at one month post injury. Significant factors were combined in a multivariate model. A nomogram was produced that used the strength of each predictor's association with the outcome variable (BSHS-B total score) combined with the mean BSHS-B one month score to determine the probability of a patient scoring 150 points or more out of a possible 160 points on the BSHS-B at six months.

A second unrelated patient sample was used to investigate the accuracy of the nomogram in Phase II. Patients in the sample included those who were managed At RPH between January 2010 and October 2012 and who supplied outcome information at one and six months post-injury. Statistical validation of the nomogram was explored by comparing six month BSHS-B total score predicted at one month by the nomogram to the actual patient response obtained at six months post injury. Receiver Operating Curve (ROC) analysis determined the accuracy of the prediction by measuring the error associated with various probability estimates.

3.2 Thesis Significance

The health burden posed by minor burns is significant as they comprise the majority of burn cases and because some minor burns can generate long term morbidity. Further, the literature is deficient in high quality research on minor burns. In a health system of limited resources there is a need to optimise clinical care. Any new model of care will need to be assessed and to achieve this one must have a reliable and valid (content, construct and criterion) specific assessment scale. The significance of this thesis is that the three main studies will make an original contribution to this body of knowledge addressing many of these issues.

The new model is aimed at providing more efficient care of minor burn patients without adversely affecting their quality of life post-burn. Introducing postal self-report survey follow-up along with an education manual for minor burn patients to assist their post-acute burn care spares them from hospital based review and should compensate for missed appointments that are common in this patient group without compromising outcome. In addition, fewer follow-up appointments for minor burn patients that have a good prognosis will potentially result in longer appointments for more severely burned patients and reduced stress on clinic staff. Minor burn patients may benefit from not having to attend hospital post recovery by avoiding hospital review appointments which minimises patients' economic and time burden related to work, childcare and travel. Additionally, potential advantages to the community include minimising productivity losses incurred through leaving work to attend hospital appointments. Further, knowledge gained from use of the burns self-care manual at home may be disseminated to the wider community through the patient, relatives and friends. The proposed new model of care, if successful, may

be implemented in other burn services nationally and in similar populations worldwide to the benefit of the majority of burn patients, health care and the community.

CHAPTER FOUR EVALUATION OF A STREAMLINED MODEL OF CARE FOR MINOR BURNS

This is a non-final version of an article published in final form in the Journal of Burn Care and Research.

Finlay V, Wood F, Hendrie D, Allison G, Phillips M, Edgar D. Evaluation of a streamlined model of care for minor burn patients. Journal of Burn Care and Research. 2014;35(4):342-8

http://journals.lww.com/burncareresearch/Abstract/2014/07000/Evaluation_of_a_Streamlined_Model_of_Care_for.10.aspx

Foreword

The following is a publication describing the first study undertaken in this research. The paper explains the methods and results involved in an intervention study investigating the impact of streamlining care of minor burns. Prior to this study, few scientific studies exploring the efficient care of this majority category of burn injury had been published. It was noted however that worldwide interest in improving efficiency of this large cohort had been increasing in recent years. Further, clinical intuition identified several areas of redundancy and inefficiency in the care of minor burn patients which pointed to the need for a more streamlined clinical care strategy.

Study 1 Hypothesis*:*

'Patients with minor burns of 15% TBSA or less, who are managed conservatively as outpatients and whose wounds heal in 14 days or less who are assessed using mailed BSHS-B surveys at one month and who receive a tailored burn patient self-care manual have the same or better QoL as that of patients who attend hospital for one month review.'

4.1 Abstract

Minor burns represent the majority of all burn patients in developed countries yet little information regarding their outcomes is available in the literature. Minor burns at Royal Perth Hospital are currently provided routine outpatient clinic follow-up at one month post injury resulting in increased ambulatory care demand and inefficiency due to high failure to attend rates. We hypothesised that improving patient education and using a posted quality of life survey in place of a one month outpatient clinic follow-up visit for minor burn patients would improve efficiency without compromising outcome compared to current standard practice.

A sample of conservatively managed minor burn outpatients who healed within 14 days were administered a burn care education manual and discharged. Participants were assessed using postal Burn Specific Health Scale- Brief (BSHS-B) survey and satisfaction surveys at one month post-burn. Their responses were compared to those of patients who had received standard care.

The results demonstrate that the intervention did not adversely affect the quality of life of participants (n=107) as assessed by comparing their median BSHS-B scores with those of the comparison group (n=62) (p=0.05). The intervention group reported high levels of satisfaction with service.

The new model of care is an appropriate strategy for management of minor burn. Its benefit over current hospital-based follow up is that it saves one clinic appointment, improves efficiency related to non-attendance and reduces patient burden.

4.2 Introduction

Minor burns, defined as 15% total body surface area (TBSA) or less, comprise > 90% of burn patients presenting to many burn units in developed countries (Morgan, Bledsoe et al. 2000, Chipp, Walton et al. 2008). There has been a recent increase publications investigating reducing the burden of minor burn care (Vercruysse, Ingram et al. 2011). However our review of the literature has identified that less than one percent of all burn publications provide information on minor burns and fewer still describe outcome from minor burn (Bezhuly, Gomez et al. 2004, Noble, Gomez et al. 2006). None have involved the use of established measures of outcome to determine impact of changing standard of care.

The lack of available data regarding scar and functional outcome after minor burn has resulted in the routine provision of hospital follow-up appointments for all patients treated at Royal Perth Hospital (RPH) so that level of recovery can be assessed first hand (Morgan, Bledsoe et al. 2000, van Baar, Essink-Bot et al. 2006). However, significant numbers of minor burn patients fail to attend routine follow-up appointments resulting in inefficiencies. It has been reported that 55% of post-acute review appointments issued within six weeks post injury for minor burn patients are unattended (Finlay, Burke et al. 2009). When non attending patients were re-surveyed it was found that their outcomes as measured by the Burn Specific Health Scale – Brief (BSHS-B) were comparable with those that attended. Patients who did not respond to multiple attempts at contact were identified as young males who commonly drop out of research studies or fail to attend scheduled appointments due to good recovery (Finlay, Burke et al. 2009).

Significant costs are associated with burn care with even minor burns such as scalds in children constituting an economic burden (Griffiths, Thornton et al. 2006). Programs that streamline patient care to improve efficiency of burn clinical practice and reduce health care costs have previously been investigated (Vercruysse, Ingram et al. 2011, Vercruysse and Ingram 2012). Fast-tracking of the patient journey through the health system for those with minor injuries is not a new concept (Cooke, Wilson et al. 2002). To date, few strategies for improving efficiency of minor burn management appear to have been investigated.

Streamlining or fast-tracking minor burn care requires effective burn patient education to assist in minimising complications, improving patient confidence and

facilitation of good outcomes (Yurko and Fratianne 1988, Finlay, Davidoss et al. 2012). Evidence based, multidisciplinary education can assist patients to effectively self-manage their post-acute burn care, recognize problems and know when to seek help (So, Umraw et al. 2003, Alsbjorn, Gilbert et al. 2007). In spite of quality specialist care, a proportion of minor burn patients have ongoing problems after their wounds have healed (Shakespeare 1998). Prediction of outcome using early response to treatment along with patient and injury information may be useful in servicing a variety of minor burn patients (Sagraves, Phade et al. 2007).

When selecting patients for streamlined burn care programs, it is important to identify factors that are associated with good recovery such as burn severity. Two of the major determinants of burn severity are extent of burn and depth of burn (Atiyeh, Gunn et al. 2005, Chipp, Walton et al. 2008). Thus small burns that heal quickly are among the least severe burns as demonstrated by previous research which found that conservatively managed burns that heal within 14 days recover with low incidence of abnormal scarring (Deitch, Wheelaham et al. 1983). Incorporating perception of scar outcome through body image and participation in social activity, quality of life is one of the chief indicators of recovery from burn injury and is strongly related to burn severity (Warden 1987, Kraemer, Jones et al. 1988, Anzarut, Chen et al. 2005, Schneider, Holavanahalli et al. 2006). Individuals with severe burns are more likely to have significant and life-changing deficits while those with smaller partial thickness burns that heal quickly report a better quality of life (Deitch, Wheelaham et al. 1983, Gangemi, Gregori et al. 2008).

Quality of life surveys involve self-reporting of outcomes providing direct and accurate information of a patient's perception of their recovery (Baker, Jones et al. 1996, van de Kar, Corion et al. 2005, Jarrett and McMahon 2008). The BSHS-B is a comprehensive self-report tool which quantifies patients' views on aspects of post-burn health and wellbeing related to scar, self-care, physical activity and psychosocial function. (Cromes, Holavanahalli et al. 2002, Kildal, Andersson et al. 2002, Littleré Moi, Wentzel-Larsen et al. 2003, Willebrand and Kildal 2008). The Burn Service of Western Australia (BSWA) at RPH has been routinely collecting outcomes from burn injured adults using the BSHS-B since 2006 for use as comparison in the evaluation of intervention studies (Falder, Browne et al. 2009).

This study aimed to test a new model of burn care (MoC) at a major outpatient burn facility that involved provision of a new standardised education package and

elimination of hospital based follow-up to a defined group of minor burn patients. The new MoC was evaluated by comparing the median one month post-burn BSHS-B scores of the patients that received the intervention with a similar cohort that received standard care consisting of existing education materials and routine hospital follow-up. In order to demonstrate the value of the new MoC, the scores of the intervention group should not be significantly worse than those of the comparison group. As an aid to the MoC, a nomogram was developed to predict six month BSHS-B scores to highlight potential problems.

The proposed benefits of the new minor burn MoC are more efficient service delivery across the whole population with only patients needing ongoing treatment attending; fewer unattended appointments; more comprehensive, tailored patient education and reducing the burden of hospital attendance for recovered patients.

4.3 Patients and methods

This study is a two cohort comparison of outcome using prospectively gathered data. Ethics approval was granted by the RPH (EC2008/147) and Curtin University (HR49/2009) ethics committees.

4.3.1 Patient population

Intervention group:

Patients attending the RPH Burns Outpatient Clinic between the 1st of November 2008 and 30th of June 2009 were assessed for suitability to receive the intervention. Inclusion criteria were: burns less than 15% TBSA that did not require hospital admission, wounds were 98% healed within 14 days of injury with conservative management and full range of motion of affected joints. Patients who received their injuries at their place of employment were not considered for inclusion. Translators were available for non-English reading patients.

Comparison group:

A sample of RPH minor burn patients who received standard care and for whom BSHS-B data were available formed the comparison group. Outcome data was obtained from patients through the postal system and in person during clinic

attendance. Only data from patients who returned surveys were used in the analysis.

4.3.2 Study Procedure

Minor burn patients attending the RPH burn outpatient clinic during the period of the study intervention were observed in the first two weeks post injury while receiving standard treatment comprising wound care, exercises and scar management. Those who fitted the inclusion criteria and gave consent were recruited to the study.

Participants in the intervention group were provided a tailored multidisciplinary burn patient education manual designed and produced for the study and then discharged from further clinical care. Participants were issued with the BSHS-B and satisfaction surveys to complete and return at one month post injury in lieu of a clinic visit. No further physical follow-up appointments were provided and participants were advised to contact their General Practitioner or the RPH burn care team if concerned about any aspect of their post-burn recovery.

The comparison group used were those who had received standard care management for minor burns prior to inception of the study. Additional data for comparison was collected at the end of the study period when standard care resumed. At this facility standard care comprises of routine wound care; exercises; scar management; patient education comprising verbal and written advice; and then hospital outpatient clinic review four to six weeks after injury.

As a measure of progress, participants in both groups were asked to complete the BSHS-B at one month post burn injury. Participants in the intervention (new MoC) group were also asked to complete a satisfaction survey. Surveys were returned from intervention group participants by mail and were supplied with a stamped self-addressed envelope for this purpose. Surveys from participants in the comparison group were collected at their one month outpatient review.

As a risk management strategy, a nomogram (see description below) was developed to calculate the probability of scoring 150 points on the BSHS-B at six months from burn. Those who were noted to have a less than 60% probability of achieving a good score (150 points or more) were offered a hospital review appointment. The 60% cut-off was identified through ROC analyses as having an acceptable 10% risk of a false positive (Finlay et al, unpublished data).

4.3.3 Outcome measures

Burn Specific Health Scale-Brief (BSHS-B)

The BSHS is the principle outcome variable for assessing the impact of the intervention on the study participants' health status and quality of life after burn injury. The scale has recently been validated in minor burns, demonstrating a strong relationship with burn severity markers (TBSA, length of stay and surgery); and an identical factor structure produced in major burns (Finlay, Phillips et al. 2013.) Based on normative studies conducted at RPH, the score for a good recovery after minor burn using the BSHS-B was defined as 150/160 points, or 94% (Kvannli, Finlay et al. 2010). BSHS-B scores of intervention group participants were compared to those of the comparison group to determine if the new model of care had a negative impact on quality of life. A difference of five points between group medians was designated as indicating a clinically meaningful difference in outcome.

Burn Patient Satisfaction Survey (BPSS)

Patients in the intervention group were asked to rate their satisfaction with the way the BSWA managed their burn. The BPSS was developed at RPH for use in a previous study (Finlay, Burke et al. 2009). Patient satisfaction is rated using a 5-point Likert scale where 1 is highly satisfied and 5 is highly unsatisfied.

4.3.4 Study tools

Burn Patient Education Manual

The burn care manual was developed for the study as a standardised patient education resource to aid study participants self administer ongoing post-acute burn care. Research, discussion and consensus within the multidisciplinary team resulted in collation of evidence-based burn care information into a comprehensive manual to assist patients in managing their burn wounds and scars at home. The manual comprises a core generic component, applicable to the majority of patients covering topics such as pain management, normal movement, washing the burn and signs of infection. The RPH burn patient self-care manual is published on the Fiona Wood Foundation website and can be accessed by following the link at www.fionawoodfoundation.com. This was supplemented by selected patient and injury specific information including exercises and caring for the minor facial burn. The manual involved standardisation of existing RPH burn patient self-care

education after staff reported duplication of effort regarding advice on aspects of after-care to patients throughout the burn management process. Information in the manual was presented at the level of understanding of an 11 year old as per RPH guidelines.

RPH Burns Nomogram

A predictive nomogram created for use as a risk management tool for participants of the intervention group. The following information provides proof of concept. The nomogram was based on data from 121 consecutive burn patients managed by the BSWA between January 2006 and October 2008. BSHS-B data used to produce the nomogram was collected up to one month post-burn and at least six months post-burn. The sample consisted of 78% males with a mean age of 40.8 years (CI 37.8-43.8), TBSA 4.9% (CI 4.0-6.0) and 50% with a history of a burn related surgical procedure.

Multivariable spline regression modelling produced the nomogram that estimates the probability of good outcome at six months post-burn by combining a patient's one month BSHS-B score with their personal and injury characteristics to calculate the likelihood of the patient achieving 150 points or more on the BSHS-B (Figure 1).

The nomogram model illustrates a non-linear relationship between TBSA and BSHS-B score with burns under one percent and over four percent associated with a worse score than burns between one and four percent. It was inferred that one percent burns may be more likely to occur on the hand and face thus having a greater impact on quality of life.

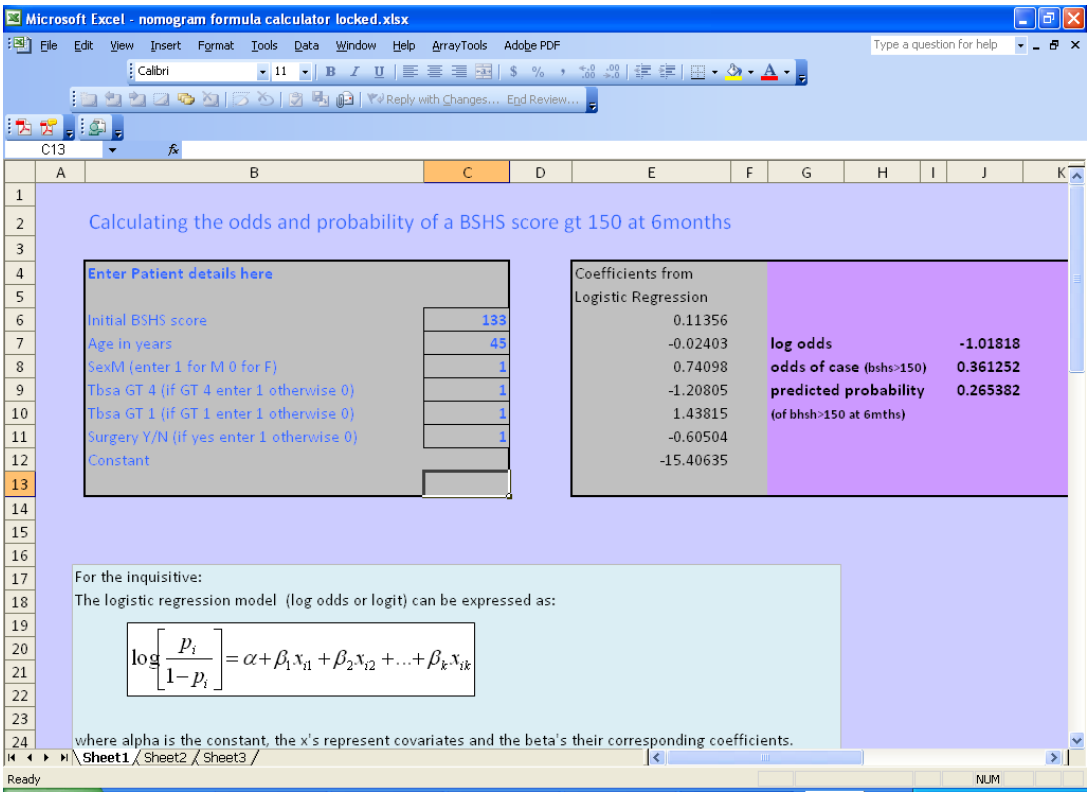

Figure 4.1 RPH burns nomogram

4.3.5 Data Analysis

All data were analysed using the STATA v 10 statistical software package (Staton Version 9.2).

Descriptive results reported include medians, inter-quartile ranges and proportions. As the patient data from each group was skewed, non-parametric tests of equivalence (Wilcoxon rank sum test) were conducted to compare differences in age, %TBSA, time to healing and BSHS-B scores of the two samples. A Chi square test was used to compare gender proportions. Quantile regression analysis was used to describe the influence of predictor variables on the one month BSHS-B score. Boot strapping was used to enhance analysis in a small sample size and provide a more robust estimation of the size of the predictions. Significance was set to 0.05.

4.4 Results

4.4.1 Sample information

Following application of the inclusion and exclusion criteria, 107 consenting participants were included in the intervention group. Participants were recruited an average of nine days post-injury. The comparison group comprised 62 participants fitting the inclusion criteria with available BSHS-B one month survey results.

Table 4.1 Demographic and injury characteristics of intervention and comparison groups: median, inter-quartile range, proportion

	Intervention group	Comparison group	p
Age (years)	30.0 (18.0)	33.0 (14.0)	1.00
Gender (male)	61%	53%	0.34
TBSA (%)	1.0 (1.0)	1.5 (2.5)	0.30
Time to healing (days)	9.0 (5.0)	13.0 (4.0)	<0.001

The median of the demographic and injury characteristics of both groups were compared. The comparison group displayed a statistically significantly larger median time to healing than the intervention group. However a difference in four days, if healing occurs under 14 days, is not deemed to be clinically important. The bootstrapped quantile regression analysis of intervention and comparison data found no relationship between one month BSHS-B score and either TBSA 0-15% (intervention p=0.27, comparison p=0.87); or time to healing (intervention p=1.00, comparison p=0.35) within 14 days post burn. There was no difference in age, gender or TBSA between groups.

The number of surveys returned from intervention group participants at one month was 63, resulting in a 59% response rate. However, there was no detectable difference in gender (p=0.82), age (p= 0.08) or %TBSA (0.14) between responders and non-responders.

4.4.2 Comparison of one month BSHS-B scores

The median of the total score of the BSHS-B of the intervention group was 156.0 (IQR 7.0) and of the control group was 153.0 (IQR 16.0). A Wilcoxon rank-sum test of the median scores was unable to detect a significant difference between groups (p=0.05).

The scores of all participants who returned surveys at one month post-burn were loaded into the nomogram model, along with their personal and injury characteristic to calculate the probability of achieving 150 points or more at six months post injury. The majority of participants had at least a 60% chance of reaching the target. Two participants from the intervention group who had a <60% probability of this result were contacted and offered ongoing treatment.

4.4.3 Patient Satisfaction

All intervention participants who returned satisfaction surveys reported that they were satisfied with the burn care provided. Group median score was 1 indicating they were highly satisfied with the way the BSWA managed their burn.

4.5 Discussion

The results demonstrate that selected minor burn patients whose conservatively managed wounds heal within 14 days are not disadvantaged when provided with standardised multidisciplinary tailored burn care education and are followed up with BSHS-B survey at one month post-burn rather than hospital outpatient review. The principal study objective was to ensure that the study group did not have a worse QoL than the comparison group who had received standard care. We demonstrated that the new MoC did not result in adverse outcome for the intervention group and although not statistically significant (p=0.05), the intervention group demonstrated a three point higher median BSHS-B score than the comparison group. A three point difference in median scores is unlikely to be clinically important according to the guidelines set a priori. Previous research has indicated that burns with a healing time under 21 days have low risk of hypertrophic scarring (Deitch, Wheelaham et al. 1983). However, we are unaware of research that demonstrates a difference in outcome between burns that heal in nine days compared to 13 days.

The lower median BSHS-B score from the comparison group may have been a factor of the group's statistically though not clinically significant longer median time to healing. On further exploration the quantile regression analysis was unable to detect an association between time to healing (within 14 days) and one month BSHS-B score suggesting that time to healing, if within 14 days, is not predictive of QoL as demonstrated by BSHS-B score at one month post-burn. The provision of the burn care manual with accessible, easy to follow information may have helped facilitate good outcomes of intervention group participants. All patients who participated in the new model of care and returned surveys reported high levels of satisfaction with the service.

An outcome based nomogram that predicts probability of scoring 150 points on the BSHS-B at six months was included in the study as proof of concept. The nomogram was used to assess risk of applying an intervention that streamlines minor burn care by changing follow-up from direct contact to self-report survey. Our preliminary results show that this nomogram has potential to identify 'at risk' individuals who may require face to face clinical follow up, over and above that provided by the new MoC. The validity and clinical applicability of this tool is currently being further assessed.

The timeframe for data collection was constrained by requirements of a Western Australian Department of Health grant that provided funding. Thus the main study limitations involved a 59% response rate from the intervention group and a small comparison group sample of 62 participants. The first problem was mitigated by the similarities in baseline characteristics of age, gender and TBSA between responders and non-responders. The loss to follow-up was consistent with poor RPH minor burn patient clinic attendance and survey return with other studies reporting similar issues (Anzarut, Chen et al. 2005, Finlay, Burke et al. 2009). It may be that our low response rate was due to patients with minor burn showing good recovery and therefore voluntarily dissenting from completion of the survey portion of this study. Previous research on patients with minor burns who had failed to return surveys found that their reason for non-response was because they had recovered fully (Finlay, Burke et al. 2009).

We are confident that patients with minor burn outcome information can be obtained via posted BSHS-B survey as opposed to compulsory clinic review attendance. The tool provides multi-factorial response to burn injury and patients are able to self-

evaluate progress across many areas of concern including hand function, scar outcome and interpersonal relationships (Kildal, Andersson et al. 2001, Willebrand and Kildal 2008). Using a standardised outcome measure such as this where the patient's views have prominence is as useful as a face to face clinical appraisal.

Application of study results to a wider population may be improved by including additional data on patients who have been admitted to hospital or who have small areas grafted. Collection and analysis of additional outcome data on patients with small grafts (<1% TBSA) is underway to guide their future management.

4.6 Conclusion

With appropriate clinical screening and education patients with minor burns that heal within 14 days with conservative management can be reviewed via BSHS-B survey instead of hospital clinic appointment. Patients who recover early are spared the expense and inconvenience of attending hospital to provide evidence of burn outcome. Possible benefits to health services include cost savings from fewer clinic appointments and more efficient service delivery as a result of fewer unattended appointments.

4.7 Acknowledgements

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CHAPTER FIVE ENHANCING THE CLINCAL UTILITY OF THE BURN SPECIFIC HEALTH SCALE – BRIEF: NOT JUST FOR MAJOR BURNS

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Finlay V, Phillips M, Wood F, Hendrie D, Allison G, Edgar D. Enhancing the clinical utility of the Burn Specific Health Scale – Brief: Not just for major burns. Burns 2013,

The following is the complete manuscript as published.

Foreword

The second paper presented in this thesis is a published study of the performance of the Burn Specific Health Scale – Brief (BSHS-B), a quality of life survey, in a majority minor burn cohort. The BSHS-B is the instrument used to evaluate the effectiveness of the streamlined model of care described in the previous study. It is also used as the predictive and outcome variable in the nomogram used to evaluate the accuracy of patient selection for the new model of care. This is the first published study that explores the validity of using the BSHS-B to measure recovery after minor burn.

Study 2. Hypothesis:

'The BSHS-B demonstrates reliability along with content, construct and criterion validity in measuring QoL after minor burn.'

5.1 Abstract

Like many other Western burn services, the proportion of major to minor burns managed at Royal Perth Hospital (RPH) is in the order of 1:10. The Burn Specific Health Scale-Brief (BSHS-B) is an established measure of recovery after major burn, however its performance and validity in a population with a high volume of minor burns is uncertain. Utilising the tool across burns of all sizes would be useful in service wide clinical practice. This study was designed to examine the reliability and validity of the BSHS-B across a sample of mostly minor burn patients.

BSHS-B scores of patients, obtained between January 2006 and February 2013 and stored on a secure hospital database were collated and analysed. Cronbach's alpha, factor analysis, logistic regression and longitudinal regression were used to examine reliability and validity of the BSHS-B.

Data from 927 burn patients (2031 surveys) with a mean % total burn surface area (TBSA) of 6.7 (SD 10.0) were available for analysis. The BSHS-B demonstrated excellent reliability with a Cronbach's alpha of 0.95. First and second order factor analyses reduced the 40 item scale to four domains: Work; Affect and Relations; Physical Function; Skin Involvement, as per the established construct. TBSA, length of stay and burn surgery all predicted burn specific health in the first three months of injury ($p<0.001$, $p<0.001$, $p=0.03$). BSHS-B whole scale and domain scores showed significant improvement over 24 months from burn ($p<0.001$).

The results from this study show that the structure and performance of the BSHS-B in a burn population consisting of 90% minor burns is consistent with that demonstrated in major burns. The BSHS-B can be employed to track and predict recovery after burns of all sizes to assist the provision of targeted burn care.

5.2 Introduction

The vast majority (90%) of cases managed by Burn Service of Western Australia at Royal Perth Hospital are minor, defined as 15% total burn surface area or less (Duke, Wood et al. 2011). Burn services in other Western countries manage similar patient populations consisting of an extensive variety of burn injuries from small wounds that heal quickly with dressing care to catastrophic insults requiring long periods of hospitalisation and several surgical procedures (Brandt, Coffee et al. 2000, Brezuhly, Gomez et al. 2004, Chipp, Walton et al. 2008). However, the literature abounds with studies that routinely present data limited to a specific range of burn size or severity (Cromes, Holavanahalli et al. 2002, Jarrett and McMahon 2008, Pishnamazi, Rejeh et al. 2013). The majority of burn research focuses on major burns leaving clinicians minimal information to guide efficient management of a large portion of their patient population, minor burns (van Baar, Essink-Bot et al. 2006).

Burn size has been significantly associated with severity however this does not presume that minor burn injuries are insignificant. It has been reported that between 31% and 65% of patients admitted to hospital with minor burns require at least one skin graft operation (Vercruysse, Ingram et al. 2011), (Finlay, 2012, unpublished data). Since severity influences outcomes such as quality of life (QoL) we can generally expect major burns to do worse than minor burns (Costa, Engrav et al. 2003, Gravante, Delogu et al. 2007). However, even within the category of minor burn there can be significant variation both in severity and outcome (Shakespeare 1998, van Baar, Essink-Bot et al. 2006). As good outcome from minor burn cannot be assumed from the outset, close tracking of progress throughout the recovery period is necessary (Noble, Gomez et al. 2006). Thus early and accurate assessment of outcome can aid the clinical decision making process at crucial points in the burn care pathway. In this way, amount and type of ongoing intervention can be tailored to patient achievement of pre-determined outcome targets.

Quality of life (QoL) is an important indicator of recovery after a complex injury such as a burn (Brasel, deRoon-Cassini et al. 2010, van Loey, van Beeck et al. 2011). Patients can experience new psychosocial problems or exacerbation of existing problems after even minimal burn injury (Shakespeare 1998, Noble, Gomez et al. 2006). Self-reported quality of life information obtained from validated assessment

tools are often used to describe patient recovery status post-burn (van Loey, van Beeck et al. 2011, Koljonen, Laitila et al. 2013). Little information is available in the literature regarding use of QoL data to aid patient-directed treatment selection and provision of efficient burn care across the spectrum of burn injuries. Streamlining burn patient management according to injury severity has advantages for health services however; no protocols have yet described QoL as a factor in patient selection or evaluation of change in practice. (Alsbjorn, Gilbert et al. 2007, Vercruysse, Ingram et al. 2011)

The Burn Specific Health Scale- Brief (BSHS-B) is often used to assess outcome; providing accurate information for clinicians and easy comparison across burn patients of similar severity (Kildal, Andersson et al. 2001). The BSHS-B originated from a scale developed using data from patients with burns over 20% TBSA (Blades, Mellis et al. 1982). The majority of published information on the scale describes its use in a major burn population (Munster, Fauerbach et al. 1996, Cromes, Holavanahalli et al. 2002, Kildal, Andersson et al. 2002). To date the performance of the BSHS-B in populations consisting mostly of small burn injuries has not been scrutinised resulting in a lack of tools to deal with this patient group.

Evaluation of reliability and validity of the BSHS-B has been previously performed by examining internal consistency, factor structure, association with measures of severity (TBSA, length of stay, surgery) and change in patient responses over time. The BSHS-B may be a useful in clinical practice for evaluating the result of treatment, measuring recovery and determining the direction of future treatment across the spectrum of burn severity if its validity in minor burns can been established. The aim of this study is to examine the ability of the BSHS-B to measure quality of life across the gamut of burn injuries thereby establishing its clinical applicability in an entire burn population.

5.3 Patients and Methods

5.3.1 Study Design

This is a two cohort comparison study using six and a half years of prospectively collected longitudinal data to examine the application of the BSHS-B across burns of all sizes, the majority of which are 15% TBSA and under.

5.3.2 Sample population

RPH burn patients with available BSHS-B survey responses obtained between 1st January 2006 and 1st February 2013 were included in the study. The majority of data was obtained from those who were admitted to hospital, with a small proportion from those receiving only ambulatory care. RPH is a mostly adult care facility which occasionally manages patients as young as 15.

5.3.3 Procedure

RPH burn patient demographic, injury and outcome data is routinely collected as part of a quality improvement program, the Burns Clinical Outcome Research Project, instigated in January 2006 (CSQU# 080429-1) (Falder, Browne et al. 2009). Data capture is aimed at one, three, six, 12 and 24 months from injury. Data was also collected at point of discharge from hospital until December 2007 when the practice ceased to reduce patient burden. Applicability of the BSHS-B at discharge is demonstrated by analysis of 89 patients which found a significant association between discharge and one month BSHS-B total scores ($r=0.678$, $p<0.001$). Data for the study was extracted and reviewed for specific variables of interest including age, gender, length of stay, percentage of total body surface area burned (%TBSA) and surgical treatment.

5.3.4 Burn Specific Health Scale Brief (BSHS-B)

The BSHS-B, consisting of 40 items was derived in 2001 from the initial 80 item BSHS developed in the United States of America (Blades, Mellis et al. 1982, Kildal, Andersson et al. 2001). The scale has been validated in several non-English speaking countries, most recently China and Iran. Researchers at the Uppsala University in Sweden have extensively investigated the performance of the BSHS-B in major burns (Kildal, Andersson et al. 2001, Willebrand and Kildal 2008). Using a factor analytic approach nine separate subscales were initially identified: Simple Abilities, Hand Function, Work, Heat Sensitivity, Treatment Regimens, Affect, Body Image, Interpersonal Relationships and Sexuality (Kildal, Andersson et al. 2001, Willebrand and Kildal 2008). Due to high inter-correlations between the subscales, a second order factor analysis was performed producing a three-factor solution comprising: (1) Interpersonal Relationships, Affect and Sexuality, (2) Simple abilities and Hand function, (3) Heat Sensitivity, Treatment Regimens, Body Image (Willebrand and Kildal 2008). Work was not included as it consistently double loaded

and thus formed a separate domain. The three-factor structure accounted for 74.4% of the variance in the Swedish sample (Willebrand and Kildal 2008).

5.3.5 Data analysis

All statistical calculations were conducted using STATA v 11. The significance for all analyses was set at 0.05 (Staton Version 9.2).

Burn patients with available BSHS-B data for the time period studied were included in the analysis. The demographic and injury characteristics of the sample group were explored.

Reliability (Internal consistency)

The first survey obtained post injury for each patient was used in this part of the analysis. The reliability of the BSHS-B was assessed using Cronbach's alpha test to determine the strength of the correlation of the scores for each item in the scale (Willebrand and Kildal 2008). The internal consistency of the items in a scale is indicated by Cronbach's alpha coefficient, with values above 0.8 demonstrating excellent reliability.

Content validity (factor analysis)

In accordance with previous published studies, the factor structure of the BSHS-B was modelled using a principal component factor analysis performed on individual item responses of all RPH burn patients with available data (Kildal, Andersson et al. 2001). Again, the first survey available was used. The analysis was then replicated on a subset of minor burns. A factor solution that explains at least 80% of the total variance is considered acceptable (Nunnally and Bernstein 1994). Varimax rotation was used to extract components with Eigen values greater than one. A factor loading of 0.40 was considered important in identifying items belonging to a factor (Peterson 2000). A second order factor analysis was performed on the subscales produced by the initial factor analysis in an attempt to further simplify the domain structure (Willebrand and Kildal 2008).

A number of guidelines on the appropriate sample size needed for factor analysis are available in the literature (Floyd and Widaman 1995). Various authors have suggested five participants for each variable (item). In this study at least 200

participants to assess the 40 item instrument would be necessary (Comrey and Lee 2009).

Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) test of sampling adequacy were used to assess sample size. Values above 0.5 from the KMO test indicate that the sample is of adequate size for the factor analysis to proceed. Bartlett's test should be significant (Fabrigar, Wegener et al. 1999).

Construct Validity (correlation between BSHS-B and burn severity)

The first BSHS-B recorded prior to three months post-burn was used in the analysis in order to maximise data without including multiple observations per patient. The relationship between severity and early BSHS-B scores were examined to determine construct validity of the scale. Logistic regression analysis explored the ability of established severity indicators %TBSA, LOS and surgical involvement (as a dichotomous variable, yes/no) to predict first BSHS-B whole scale and domain scores from surveys obtained within three months of injury.

Prediction of outcome using continuous variables such as TBSA can be complex due to non-linearity of the association (Schmidt, Ittermann et al. 2013). Fractional polynomials use a wide range of powers to deal with non-linear associations. In a similar study of trauma patients, the Revised Trauma Scale was validated using fractional polynomial regression to determine its predictive capacity (Moore, Lavoie et al. 2005).

LOS data was transformed using a log normal function to deal with deviations from normality before applying linear regression. Surgery, as a binary variable, was explored in a linear regression.

Criterion validity (BSHS-B total and subscale scores with time)

Fractional polynomial random-effects maximum likelihood regression analysis was used to demonstrate change in BSHS-B total and subscale scores obtained up to two years post-injury taking into account non-linearity of longitudinal data with deviations from normality. All BSHS-B responses from patients were included in analysis.

5.3.6 Missing data

Missing data is a common occurrence in clinical studies (Hull, Alexander et al. 2002, Finlay, Burke et al. 2009). In this study, for the majority of the statistical analyses, records with scores missing from individual BSHS-B questions were removed. The patient group who provided incomplete surveys was compared to those with completed surveys.

In longitudinal studies, missing data is often due to patient attrition and increases with time from injury. Rate of survey return has been reported as low as 42% after two attempts (Cochran, Edelman et al. 2004). For the longitudinal analysis of BSHS-B scale score over time, in order to maximise statistical power with minimal bias, surveys with two or fewer unanswered questions were retained. The two missing questions were estimated by calculating the individual survey mean of all the questions answered (Houck, Mazumdar et al. 2004).

5.3.7 Ethical Considerations

All data were collected as part of the Burns Clinical Outcome Research Project and registered with the Clinical Services Quality Unit (EC# 4863783), a subsidiary of the RPH Ethics Committee. Under a waiver of consent approved by the RPH Ethics Committee, all burn patients presenting to RPH are approached for outcome data collection. They may ‘opt out’ if they do not wish to provide their information. To our knowledge no patients declined to provide their data when approached.

5.4 Results

5.4.1 Sample information

Data from 927 patients with 2031 available BSHS-B data comprised the sample available for analysis. Each patient returned two surveys on average, with the response rate at each collection point as follows: 23.4% at discharge, 66.6% at one month, 47.5% at three months, 35.9% at 6 months, 29.0% at 12 months and 7.4% at 24 months post injury. Demographic and injury specific information for the initial sample is presented in Table 5.1. In addition, 73% of the sample was male and 67% had at least one surgical procedure. Data on employment status was available for ~74% of the patients in the sample. Of these, 559 (60%) were working at time of injury.

Table 5.1 RPH burn sample demographic and injury severity characteristics

	Age (years)	TBSA (%)	LOS (days)
Mean	32	6.9	10.3
SD	17.2	10.0	14.8
Median	35	4	7
Range	16-83	0.25-58	0-72

After limiting the sample to fully completed surveys, 1890 records from 823 patients were used in the reliability and factor analysis of the BSHS-B. Patients with minor burns comprised 90% of the sample. According to established guidelines, the data included formed a strong sample for analysis exceeding the recommended 300 observations required to form six factors. This applied also to surveys from patients with minor burns. The numbers of patients (n=80) and observations which constituted the major burn sub group were inadequate to provide conclusive evidence and their results are not presented. For the first order factor analysis, the

KMO test of sampling adequacy resulted in a value of 0.94 indicating that the whole sample was of acceptable size for factor representation. Bartlett's test of sphericity was significant ($p<0.001$).

The sample for the examination of the relationship between severity (TBSA, LOS, Surgery) and BSHS-B scores was again reduced as only complete first surveys obtained up to three months from burn were used in the analysis.

5.4.2 Reliability

Reliability of the total score from the scale was excellent in the main sample and the minor burn subset with a Cronbach's alpha 0.95 for both. The internal consistency of the subscales was also excellent ranging from 0.88 to 0.95 (Table 5.3).

5.4.3 Validity

Factor analyses

Principal components factor analysis with orthogonal rotation provided the initial factor solution. Six factors with Eigen values of ranging from 1.04 to 13.09 explained 95% of the variance, confirmed by the Scree plot (Fig 5.1).

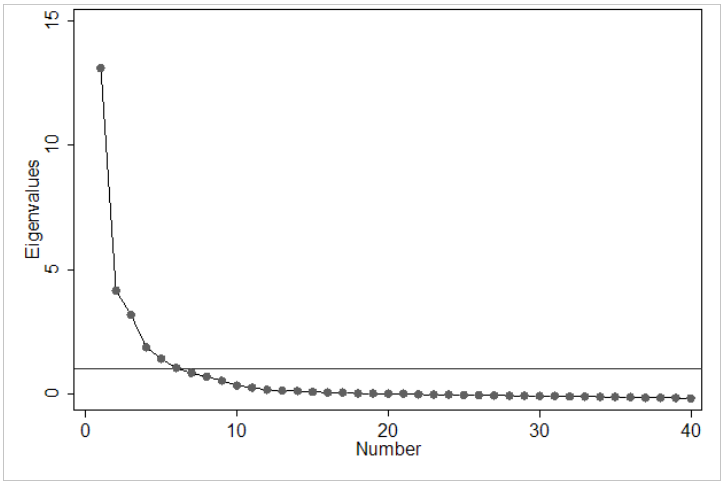

Figure 5.1 Scree plot of first order BSHS-B factor Eigen values in all RPH burns

The modified initial factor structure combined items pertaining to Affect, Interpersonal Relations and Sexuality into a single factor; and Hand Function with Simple Abilities into a second factor (Table 5.3). Limiting the sample to minor burns only, produced an equivalent factor structure (results not shown).

Table 5.2 BSHS-B factor structure in RPH burns

BSHS-B Questions	Factor 1 Affect, Interpersonal Relations, Sexuality	Factor 2 Simple Abilities, Hand Function	Factor 3 Heat Sensitivity	Factor 4 Body Image	Factor 5 Work	Factor 6 Treatment Regimens
1. Bathing independently		0.78				
2. Dressing by yourself		0.83				
3. Getting in and out of a chair		0.72				
4. Signing your name		0.85				
5. Eating with utensils		0.88				
6. Tying shoelaces/bows		0.82				
7. Picking up coins from a flat surface		0.81				
8. Unlocking a door		0.87				
9. Working in your old job performing your old duties					0.71	
10. I am troubled by feelings of loneliness	0.63					
11. I often feel sad or blue	0.65					
12. At times, I think I have had an emotional problem	0.72					
13. I am not interested in doing things with my friends	0.74					
14. I don't enjoy visiting people	0.75					
15. I have no one to talk to about my problems	0.66					
16. I have feelings of being caught or trapped	0.65					
17. My injury has put me further away from my family	0.53					
18. I would rather be alone than with my family	0.78					
19. I don't like the way my family acts around me	0.68					
20. My family would be better off without me	0.71					
21. I feel frustrated because I cannot be sexually aroused as well as I used to	0.52					

22. I am simply not interested in sex any more	0.58				
23. I no longer hug, hold or kiss	0.57				
24. Sometimes, I would like to forget that my appearance has changed			0.79		
25. I feel that my burn is unattractive to others			0.86		
26. My general appearance really bothers me			0.71		
27. The appearance of my scars bothers me			0.81		
28. Being out in the sun bothers me		0.78			
29. Hot weather bothers me		0.75			
30. I can't get out and do things in hot weather		0.81			
31. It bothers me that I can't get out in the sun		0.59			
32. my skin is more sensitive than before		0.50			
33. Taking care of my skin is a bother					0.69
34. There are things that I've been told to do for my burn that I dislike doing					0.80
35. I wish that I didn't have to do so many things to take care of my burn					0.85
36. I have a hard time doing all the things I've been told to take care of my burn					0.76
37. Taking care of my burn makes it hard to do other things that are important to me					0.57
38. My burn interferes with my work				0.92	
39. Being burned has affected my ability to work				0.97	
40. My burn has caused problems with my working				0.97	

A second order factor analysis with further orthogonal rotation of BSHS-B responses was performed on five of the six factors produced in the initial factor analysis excluding the work subscale as per previous studies (Willebrand and Kildal 2008). From this, a single factor was identified (Eigen value 2.10) combining the remaining

subscales of Heat Sensitivity (0.69), Body Image (0.69) and Treatment Regimens (0.62). Three of the four domains had been constructed in the first factor analysis. Thus the final structure comprised four main domains: Work; Affect and Relations (Affect, Interpersonal Relations and Sexuality); Physical Function (Simple Abilities and Hand Function); Skin Involvement (Heat Sensitivity, Body Image and Treatment Regimens).

Construct Validity (correlation between BSHS-B and burn severity)

Construct validity of the BSHS-B whole scale and subscales was evaluated by examining the strength of their associations with established indicators of severity within three months of injury. The proportion of the sample that provided at least one survey in the first three months post burn was 90%. TBSA ($p<0.001$), LOS ($p<0.001$) and Surgery ($p=0.03$) significantly predicted BSHS-B whole scale score. As expected, the correlation coefficients demonstrated an inverse relationship with increases in severity resulting in lower scores.

The relationship between the severity indicators and each of the first order subscales is outlined in Table 5.3 below. It can be noted that LOS predicted each subscale; TBSA predicted all but one (Affect, Interpersonal Relations and Sexuality) and Surgery predicted only the Work and Treatment Regimens subscales. Further exploration of the interaction between TBSA and the BSHS-B subscales demonstrated a linear relationship with two factors: Simple Abilities/Hand Function and Work; and a non-linear association with Heat Sensitivity, Body Image and Treatment Regimens.

When looking only at minor burns, TBSA predicted the whole scale score as well as three of the six subscales; Skin Sensitivity ($p<0.001$), Body Image ($p=0.03$) and Work ($p<0.001$). LOS significantly predicted all six subscales ($p<0.01$). History of a surgical procedure was not predictive of outcome.

Table 5.3 BSHS-B Total and subscale mean scores, Cronbach's alpha and correlation with severity indicators up until three months post-burn

All RPH Burns					
BSHS-B	Factor score, Mean (SD)	α	Correlation to		
			TBSA	Surgery	LOS
Total score	135.80 (22.1)	0.95	p<0.001	p=0.03	p<0.001
Factor 1: Affect, Interpersonal Relations and Sexuality (14 items, max score 56 points)	51.53 (7.30)	0.92	0.09	0.18	<0.001
Factor 2: Simple Abilities and Hand Function (8 items, max score 32 points)	28.45 (5.88)	0.91	<0.001	0.41	<0.001
Factor 3: Heat Sensitivity (5 items, max score 20 points)	15.29 (4.34)	0.88	<0.001	0.69	<0.001
Factor 4: Body Image (4 items, max score 16 points)	13.54 (3.66)	0.95	<0.001	0.87	<0.001
Factor 5: Work (4 items, max score 16 points)	10.14 (5.79)	0.95	<0.001	0.01	<0.001
Factor 6: Treatment Regimens (5 items, max score 20 points)	17.26 (3.73)	0.89	<0.001	0.01	<0.001

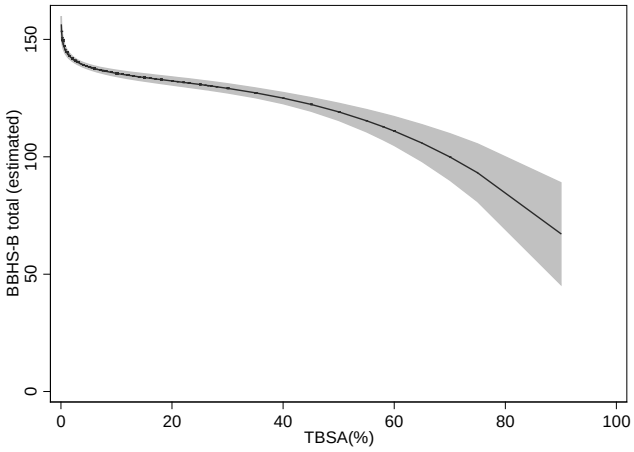

Figure 5.2 Graph of association between burn size (%TBSA) and BSHS-B total score within three months of injury

Criterion validity (BSHS-B total and subscale scores with time)

To maximise available longitudinal data for analysis of BSHS-B whole scale scores over time, records with up to and including two missing questions were used. The missing values were estimated using the mean of the available scores. Removal of 123 records with more than two missing values left 1908 surveys for the random effects longitudinal regression analysis, accounting for 94% of the total sample.

As seen in Figure 5.3, BSHS-B whole scale score ($p<0.001$) improved significantly over 24 months post-burn in the main sample and minor burn subset (coefficient=3.48, $p<0.001$). The mean scores for the Work (coefficient=1.63, $p<0.001$); Physical Function (coefficient=1.09, $p=0.001$); Affect and Relations (coefficient=0.49, $p<0.001$); and Skin Involvement (coefficient=0.16, $p<0.001$) domains also improved and approach the maximum possible domain scores, depicted by the horizontal lines on Figure 5.4

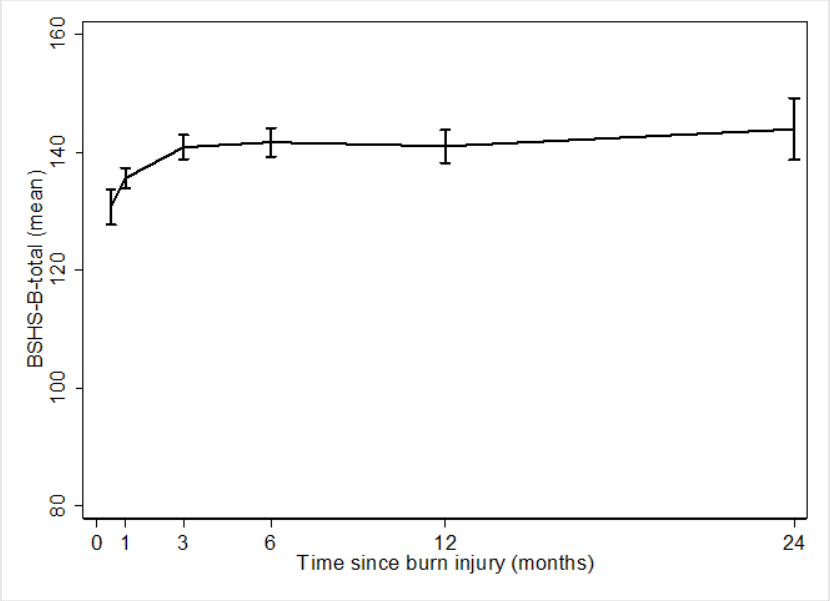

Figure 5.3 Change in mean BSHS-B whole scale scores over time- all burns (95% CI)

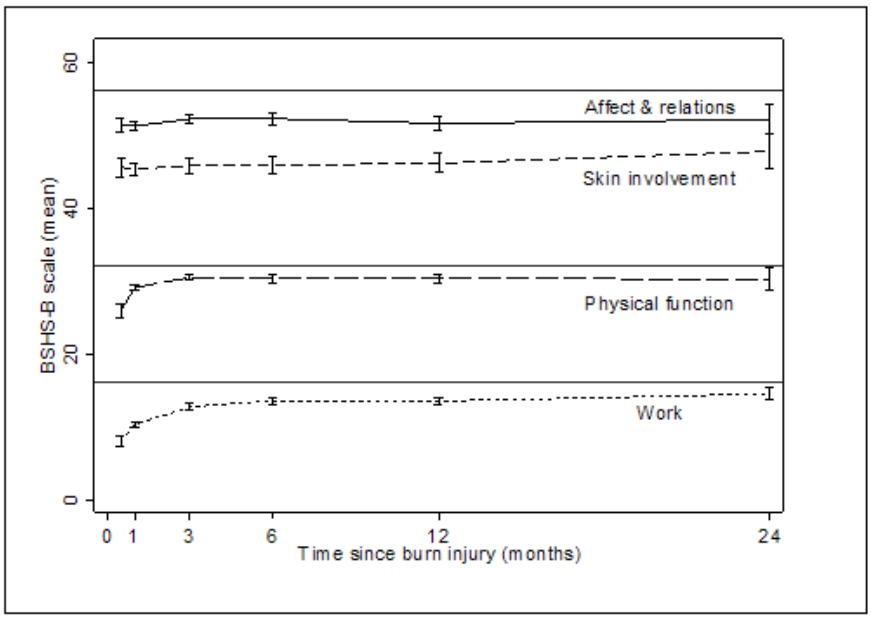

Figure 5.4 Change in mean BSHS-B domain scores over time- all burns (95% CI)

5.4.4 Missing Data Assessment

The vast majority of patients (n=823, 93%) in the initial sample had completed surveys with values for all questions of the BSHS-B while 104 patients had 141

surveys that had at least one question unanswered. As incomplete surveys were excluded from the reliability, factor and logistic regression analysis the characteristics of patients who returned surveys with missing questions and those with all survey questions answered were compared. A Wilcoxon rank sum test could find no statistically significant differences in age (p=0.21), gender (p=0.40) TBSA (p=0.10), LOS (p=0.10) or surgery (p=0.30). Further, patients with missing data approximated 7% of the whole sample and based on a previous study are unlikely to have a significant impact on the outcome (Zelle, Bhandari et al. 2013).

As previously stated, in the longitudinal analysis, surveys with two or fewer missing item responses were included. Examination of these responses found that the proportion of missing questions for each of the first order domains was as follows: Affect/Interpersonal Relations/Sexuality 37%, Work 24%, Heat Sensitivity 13%, Treatment Regimens 12%, Simple Abilities/Hand Function 8% and Body Image with 6%.

5.5 Discussion

This study has demonstrated the reliability, validity and performance of the BSHS-B in a population of mostly minor burn patients. Reliability (internal consistency) of the BSHS-B scale and six subscales obtained by factor analysis was excellent. Cronbach's alpha for the entire scale was 0.95 and the values for the subscales ranged from 0.88 to 0.94 in the whole sample as well as in the minor burn subset.

The first order factor analysis produced a six factor structure, explaining 95% of the variance but differing from the nine factors suggested a priori (Kildal, Andersson et al. 2001). Our initial factor analysis combined the items relating to Affect, Interpersonal Relations and Sexuality into one factor where previously this occurred after a second order factor analysis (Willebrand and Kildal 2011). Further, Hand Function and Simple Abilities produced a single domain. Though our first order factor analysis produced three fewer initial subscales than previous studies, the overall structure of the scale replicated the earlier results with individual items combining in the same way.

The second order factor analysis performed on our six subscales mirrored the factor structure from prior attempts (Willebrand and Kildal 2011). The final four domains produced, consisting of Affect and Relations, Physical Function and Skin Involvement, were identical to previous descriptions including a separate domain for

Work (Willebrand and Kildal 2008, Willebrand and Kildal 2011). For the first time, analysis of a large sample of mostly minor burn patients has discovered that the BSHS-B factor structure is stable across burns of all sizes, further establishing its content validity.

All the severity variables; TBSA ($p<0.001$), LOS ($p<0.001$) and surgery ($p=0.03$) were predictive of the BSHS-B whole scale score within three months of injury as demonstrated by the logistic regression analysis. The Work and Treatment Regimens subscales were the strongest performers, predicted by all three severity markers (TBSA $p<0.001$, LOS $p<0.001$ and Surgery $p=0.01$). The Affect and Relations domain was again found to be significantly associated with LOS ($p<0.001$) (Willebrand and Kildal 2008). LOS was the most powerful predictor, associated with all six subscales. TBSA predicted all subscales with the exception of Affect/Interpersonal Relations/Sexuality. Our study clearly reflects previous definitive research, notwithstanding differences in time from injury to assessment and burn size (mean of nine years; mean %TBSA 21, SD 16.0) (Willebrand and Kildal 2008). This suggests that the association is consistent across burn size and time since burn. Analysing minor burns only, the relationship between all severity variables and overall BSHS-B score was also significant. Further, all domains were again predicted by LOS. Thus construct validity of the scale and subscales in a predominantly minor Western burn population has been demonstrated.

Criterion validity was confirmed by the significant improvement in BSHS-B whole scale and domain mean scores of patients in the first two years after injury in burns of all sizes. BSHS-B scale score increased by an average of 3.48 points per month, while the Work domain demonstrated the biggest improvement with an average of 1.63 points per month. Affect and Relations; and Skin Involvement showed small though significant changes. The greatest change in scores was noted in the first three months from burn, followed by a slow gradual rise, confirming previous research (Edgar, Dawson et al. 2010). Skin Involvement was most severely affected at all time points as seen in Figure 5.4, and to be expected, with the curve furthest away from the horizontal line above (representing the highest possible score).

5.6 Conclusion

The pleasing results from this study form the basis for future work into the use of the BSHS-B in burn management. Now that the tool has demonstrated service wide application, in burns of all sizes, investigation of its predictive capacity is recommended. As part of a raft of assessment strategies, the BSHS-B could add value to clinical care by assisting the evaluation and modification of burn management programs.

5.7 Conflict of interest

The authors of this manuscript wish to state that no conflicts of interest are associated with the research or publication of this paper.

5.8 Funding source

This research is based on data collected with the assistance of a LotteryWest grant issued in 2006.

CHAPTER SIX PREDICTING QUALITY OF LIFE AFTER BURN USING THE BURN SPECIFIC HEALTH SCALE – BRIEF

Foreword

This chapter outlines the third study in the thesis, describing the development and post hoc validation of the predictive nomogram employed as a risk management tool in the first study. The tool was developed using available patient outcome data prior to testing of the intervention which comprised the streamlined minor burn model of care. The nomogram was used in the new model to predict the likelihood of a patient receiving streamlined care achieving full recovery at six months post-burn as measured by the BSHS-B. Any patients who were identified by the nomogram as falling short of the expected target were offered standard care. The accuracy of the nomogram prediction is explored in this study to determine the potential risk of an incorrect prediction of good outcome (false negative).

This study is aimed at increasing the understanding of the clinical applicability of a predictive tool in the management of burn injury. In addition, validation of the nomogram will provide confirmation of the usefulness of the tool in the new model of care.

Study 3. Hypothesis:

'The RPH burn nomogram is a valid tool for calculating the probability that a patient will score 150 points on the BSHS-B at six months using the patient's one month BSHS-B score along with patient personal and injury information.'

6.1 Abstract

Burn treatment is often based on prognosis of recovery quality. Early prediction of recovery can promote efficiency of burn care by assisting the selection of patients to separate care streams. This study aimed to develop and validate an outcome-based nomogram that predicts the likelihood of good quality of life after burn as measured by the Burn Specific Health Scale – Brief (BSHS-B). A valid predictive tool may provide a useful safety net when the allocating minor burn patients to a streamlined burn care pathway.

The development and validation of the RPH predictive nomogram was conducted in two stages:

1. Multivariable regression analysis of personal, injury and one month BSHS-B data from 121 burn patients was used to construct a model that estimates the probability of a patient scoring a minimum of 150 points on the BSHS-B at six months post-burn. A nomogram calculation device was produced using the regression model.

2. Receiver Operating Curve statistical analysis on an independent sample of 60 patients was used to demonstrate validity of the nomogram by comparing the predicted outcome to the actual outcome collected at six months post-burn.

The development phase of the study produced a nomogram that combines a patient's age, gender, total burn surface area and surgical history with their one month BSHS-B score to provide a probability of good recovery at six months. The validation phase demonstrated that a ≥ 70% probability of a score of 150 or more on the BSHS-B predicted by the nomogram was associated with a false positive rate of 8%.

The RPH burns nomogram is a useful tool for identifying patients likely to score highly on the BSHS-B. The nomogram may be used to assess the accuracy of selecting patients to receive a streamlined model of care.

6.2 Introduction

The burn patient population managed at Royal Perth Hospital (RPH) in Western Australia, as with other developed nations services a multitude of burn injuries. A high proportion (90%) of injuries are minor, defined as 15% TBSA or less (Morgan, Bledsoe et al. 2000, Hettiaratchy and Dziewulski 2004, Rea and Wood 2005, Chipp, Walton et al. 2008). Minor burns can vary greatly in severity and outcome but little published information on outcome from minor burn is currently available. Burn treatment is based on a combination of published evidence and clinical judgement, however, the information in the literature focuses on major burns. There is a lack of published minor burn protocols based on expected outcome to guide the management of this majority patient population. Early identification and efficient management of straightforward injuries can provide benefits to the service as a whole, potentially liberating resources that can be used to treat more complex cases. Without a method of predicting outcome from burn injury, it is difficult to forecast the result of all but the most superficial of injuries, resulting in a lack of evidence for changing routine care.

Burn severity can influence long-term quality of life (Kimmo, Jyrki et al. 1998, Kildal, Andersson et al. 2002, Costa, Engrav et al. 2003). Though information on quality of life after minor burn is lacking in the literature, it is generally expected that the majority of minor burns will have a better QoL than those with major burns (Deitch, Wheelaham et al. 1983, Finlay, Burke et al. 2009). However, a small proportion of minor burn sufferers demonstrate systemic consequences of burns and report ongoing problems after their wounds have healed (Shakespeare 1998, Anderson, Zorbas et al. 2010, Grisbrook, Reid et al. 2010). Long term burn complications that cannot be known from a simple wound assessment in the acute stage include psychological effects and scarring from delayed healing (Deitch, Wheelaham et al. 1983, Shakespeare 1998). In addition, significant numbers of major burns require extensive and long-term medical care at significant personal and community cost with ongoing negative impact on quality of life.

Patient self assessment of quality of life can provide important information on the level of recovery from burn injury. Patient outcomes reflect burn severity as well as other patient specific factors such as pre-injury functional ability, body image and psychosocial status (McMahon 2008). The use of patient-reported outcomes is becoming more frequent due to the recognition of the importance of health-related

quality of life and patient-centric care (Bradley 2001, Shikiar, Bresnan et al. 2003). Validated quality of life tools such as the Burn Specific Health Scale-Brief (BSHS-B) can give valuable insight into a breadth and depth of burn patient experience that can assist burn clinicians with service planning. In order to track the progress of burn patients, the Burn Service of Western Australia (BSWA) at RPH routinely collects quality of life information using the BSHS-B at one, three, six and 12 months post-injury. The BSHS-B measures the subjective responses of burn patients regarding their injury across a number of areas including physical, psychosocial and sexual functioning and scar outcome. A higher score on the BSHS-B is an indicator of better recovery after burn injury (Cromes, Holavanahalli et al. 2002).

The ability to forecast outcome following burn is useful in assisting clinicians to predetermine the amount and type of treatment that is most beneficial for each patient. The application of streamlined, standardised services that provide a good outcome for a large proportion of burn patients can have benefits for the service as a whole (Dattolo, Trout et al. 1996, Kagan and Warden 2001). Thus, improving efficiency of burn care without compromising patient outcomes has the potential to enhance the sustainability of resources necessary to achieve recovery goals. Prediction of patient outcomes is often a multifactorial process including though not limited to, age and gender of patient; wound size, depth, location and healing time of the burn; co-morbidities; and psychosocial issues including body image and family support (Esselman, Ptacek et al. 2001, McMahon 2008). Burns have a non-linear pattern of recovery characterised by a fall in a patient's functional outcomes at the time of injury, followed by a return to near baseline levels by six months post-burn (Cromes, Holavanahalli et al. 2002, Jarrett and McMahon 2008). A ceiling effect from one month post-burn demonstrated by the BSHS-B in a similar cohort suggests that early assessment of quality of life could be a strong indicator of eventual outcome (Kvannli, Finlay et al. 2010). A combination of a patient's one month BSHS-B score together with injury and demographic variables has the potential to forecast a high score on the BSHS-B at six months from injury. Nomograms are prognostic tools which forecast outcomes for individual patients and are common in oncology, cardiovascular medicine, urology and pharmacologic therapy (Dong, Kattan et al. 2008, Monkman, Lazo-Langner et al. 2009, Nowak, Francis et al. 2010). Nomograms for predicting mortality outcome after burn injury have been used to aid burn management since the 1960's (Bowser, Caldwell et al. 1968, Gangemi, Gregori et al. 2008). However, there is a lack of information regarding

prediction of quality of life after burns. A nomogram predicting quality of life after burns would have significance in clinical practice aimed at maximising efficiency of burn care.

This study aimed to develop and validate a nomogram to predict six month burn specific health status in individuals who attended the RPH with burns.

6.3 Methods

6.3.3 Procedure

The study comprised a two-part exercise based upon analysis of two independent RPH burn patient samples. Firstly a nomogram based on demographic, injury (Total Burn Surface Area, Burn Depth, Surgery) and early (one month or less) BSHS-B survey scores was produced for predicting quality of life as measured by the BSHS-B at six months. Secondly, statistical analysis of predicted and actual six month BSHS-B scores examined the accuracy of the nomogram and its value as an assessment tool in burn management.

6.3.4 Sample Participants

Nomogram development

A sample of consecutive burn patients managed by the BSWA at RPH between January 2006 and November 2008 were included in the study. Only patients with available BSHS-B outcome data extracted from a secure RPH database were included in analysis. Included participants were required to have longitudinal outcome data obtained prior to or including one month post-burn as well as at six months or more post-injury.

Nomogram validation

The data for this component of the study was obtained from patients who returned BSHS-B surveys as part of routine data collection, unrelated studies or following recruitment for this study. The sample of 60 burn patients had outcomes collected between January 2010 and October 2012. Only patients with burns that were at least six months old were considered.

6.3.5 Data Collection

Nomogram development

Data for the nomogram development was obtained from a secure RPH burns outcome database. The outcome data was available through a programme of routine data collection, the Burns Clinical Outcome Research Project (BCORP) instigated in January 2006. Attempts were made to collect survey and functional outcome information from patients during hospital admission or outpatient visits at regular time points; discharge, one, three, six and 12 months. For the purposes of this study, only surveys collected at discharge or one month, ($BSHS\text{-}B_{early}$) and six months or more post-burn were used in the analysis.

Nomogram validation

For the validation component of the study, initially, stored data available through routine data collection were retrieved. Dedicated data collectors were used to prospectively collect additional outcomes from patients who had reached six months from burn. The extra data collection was aimed at reducing selection bias from loss to follow-up, increasing sample size and improving statistical power. BSHS-B responses were collected in person during hospital visits or through postal survey some of which required telephone prompts. Some survey information was retrieved by research assistants via telephone. The validation sample did not overlap with that used the development of the nomogram.

6.3.6 Outcome Measure

The Burn Specific Health Scale- Brief is commonly used to measure outcome from burn injury. It is has evolved into a reliable and valid tool consisting of 40 questions based on the original 80 item scale. To date most of the information the BSHS-B presented in the literature has been confined to major burns with a lower limit of 10% TBSA though a recent study involved burns as low as 5% and three studies investigated burn samples with mean %TBSA's between 3.8% and 8.9% (Edgar, Dawson et al. 2010, Finlay, Edgar et al. 2010, Kvannli, Finlay et al. 2010, Willebrand and Kildal 2011). A validation study of the scale in a burn sample unrestricted by size has recently been completed (Chapter 5) and found the BSHS-B performed as well in minor burns as it had previously in major burns. In addition, reference data based on responses to a modified version of the BSHS-B has been obtained from a

sample of the non-burned population of Western Australia (Kvannli, Finlay et al. 2010). This study demonstrated that a score of 146 out of a possible 160 approximate a normal response. Thus a total score of 150 points presents a conservative target for full recovery from burn injury based on normative data. This result is independent of patient demographic or injury factors which should be included in any algorithm used for estimating patient outcome.

6.3.6 Data analysis

Comparison of sample groups

The baseline characteristics (age, gender, %TBSA, surgical intervention) of each group was analysed using the statistical package STATA v 10 (Staton Version 9.2). TBSA and age of the samples in each phase were compared using a Kruskal-Wallis rank sum test while a likelihood ratio chi square test (χ^2LR) compared gender and surgery (as a dichotomous variable). Patients with missing data were compared to those whose data were available using a Wilcoxon rank sum test for age and TBSA and a likelihood ratio chi square test for gender.

Phase I: Nomogram development

The first stage of the nomogram development used univariate logistic regression analyses to identify potential predictors of recovery (BSHS-$B_{6months}$). Variables with a *p* value less than 0.2 were considered for the multivariable analysis. Prior analysis has determined that discharge or one month BSHS-B score (BSHS-B_{early}) is strongly associated with BSHS-B score at six months or more from burn (BSHS-$B_{6months}$) (p<0.0001). Further, as discharge BSHS-B and one-month scores are equivalent (p= 0.18), either score was used in this study to minimise missing data (Unpublished data, DW Edgar, n=89 paired entries). When combined with BSHS-B_{early}, the variables of interest were surgical intervention (skin grafting not including revisions), %TBSA, intensive care admission, age, and gender. Surgery was included as a dichotomous variable as the majority (94%) of RPH burn patients who have surgery have a single procedure (Unpublished data, FM Wood). The presence of full thickness burn and length of stay were not included because they were not significant independent predictors of outcome. Patient's age was included despite having a high univariate p value because this was found to be a consequence of interaction with other significant variables.

Continuous predictor variables such as TBSA can have a non-linear relationship with the outcome variable in this instance, BSHS-B score. Change in burn size has been noted to produce a varying slope when associated with BSHS-B. Differing sizes of burn influence BSHS-B score to varying degrees. Regression models used to create predictive equations must take into account varying relationships between predictor and outcome variables. Spline regression models have been used previously in burns and cancer populations to build predictive nomograms (Gangemi, Gregori et al. 2008, Wu, Dai et al. 2009, Huang, Isharwal et al. 2010). Spline models are used to improve the relationship between the predictor and outcome variables by accounting for the variability between linear and non-linear data (Harrell Jr, Lee et al. 1988). A reduced cubic spline regression was used in this study to account for potential non-linearity of continuous predictor variables such as age and %TBSA (Wu, Dai et al. 2009, Huang, Isharwal et al. 2010). The final multivariate logistic model was used to produce the nomogram using the 'Design' package (Akerlund, Huss et al. 2007) of 'R' (Cameron, Gabbe et al. 2012) and significance was set at 0.1. An excel version of the nomogram was also created to improve its utility in a clinical setting.

Phase II: Clinical validation

The validation of the nomogram entailed the comparison of predicted and observed six-month data collected for an independent minor burn cohort. The level of agreement between the predicted outcome and the actual outcome was assessed using a Receiver Operating Characteristic (ROC) curve. ROC curves describe a test's sensitivity (false positive rate) versus its specificity (false negative rate) and are used for evaluating the accuracy of predictions using dichotomous outcome variables (Obuchowski 2005). The outcome variable ($BSHS\text{-}B_{6\ months}$) was dichotomous with the positive outcome threshold set at ≥150. The area under the curve (AUC) represents the sensitivity and specificity of the measure and has a maximum of 1.0 or perfect accuracy (Miller, Bessey et al. 2008). In this study, the AUC demonstrates the concordance between the nomogram predicted probability of achieving a BSHS-B score greater than 150 at six months and the observed BSHS-B score for each patient in the sample with AUC values above 0.80 indicative of high concordance (Obuchowski 2005). Further, the ROC analysis produced a table that provides sensitivity and specificity values relating to the recovery predictions generated by the nomogram.

6.3.7 Assessment of Missing Data

The Heckman method is used to assess and control for selection bias in studies involving quality of life data which is dependent on survey responses from a study sample. (Sales, Plomondon et al. 2004) The Heckman method describes a two-step process. First, the factors associated with non-response are modelled. A variable termed the Inverse Mills Ratio (IMR) is also derived in the first step. Next the IMR is inserted into the initial regression model before accounting for missing data bias. In this study, Heckman selection models were used to examine the influence of missing variables such as age, gender, TBSA and six month BSHS-B scores on the regression models used to construct the nomograms in Phases I and II.

6.3.8 Ethics

The study used baseline and outcome data collected from burn patients as part of a quality assurance project registered with the Clinical Safety and Quality Unit (CSQU 080429-1), a subgroup of the RPH Ethics Committee. The collection of burn patient data for inclusion in local and national registries involves opt-out consent (RPH EC2009/065). Thus, essentially all data from routine outcome collection into the WA burn registry was available for inclusion in this study. Additional data for Phase III, specifically collected from minor burn and ambulatory patients following informed consent, in a previous study, was included with RPH ethics approval (EC2008/147).

6.4 Results

6.4.1 Study Population

Two samples of consecutive burn patients managed by the BSWA at RPH with available data were included in the study.

1. Demographic and BSHS-B data from 121 burn patients was used in the development of the nomogram.

2. A second sample of 60 patients used to enable comparison between the predicted and actual BSHS-B response at six months post-burn.

Characteristics of the independent patient samples from each phase are displayed in Table 6.1.

Table 6.1 Patient characteristics at each phase of the study

Variable	Nomogram development sample	Nomogram validation sample
	Mean (95% CI)	
Age	40.8 (37.8-43.8)	37.7 (33.3-42.0)
Total burn surface area (%)[a]	4.9 (4.0-6.0)	2.9 (2.2-3.8)
Initial Burn Specific Health Scale	135.5 (131.9-139.2)	134.7 (129.0-140.4)
	Frequency (%)	
Gender (male)	93 (76.9)	43 (71.7)
Surgery	61 (50.4)	34 (58.6)
Total patients	121 (100)	60 (100)

[a] Geometric mean and geometric standard deviation for log-normally distributed variables.

[b] Only for inpatients.

6.4.2 Nomogram Development

The spline multivariate regression analysis determined that the BSHS-B_{early} score, age, gender, TBSA (%), surgical intervention (as a dichotomous variable) produced the best predictive model (Table 6.2). BSHS-B_{early} score was shown to be the strongest linear predictor of recovery and has a high weighting in the nomogram. Age showed an inverse linear relationship with recovery such that youth, along with male gender and conservative management were associated positively. Females and those who had surgical intervention did not receive positive points on the nomogram and have a potentially lower probability of full recovery. As depicted in figure 6.1, TBSA had a non-linear relationship with BSHS-$B_{6\ months}$. Small burns of <1% TBSA are associated with *poorer* outcome relative to slightly larger burns (1-3.9% TBSA). Burns between one and 3.9% TBSA were associated with a better chance of a good outcome while burns of 4% and above have a decreasing chance of a good outcome. This is a reflection of the tendency for small burns in functionally and cosmetically significant areas such as the face and hand to be associated with a poorer outcome compared to larger TBSA burns to the torso, thigh or upper arm. As a result, two categories of TBSA were included in the nomogram as being predictive of good outcome, TBSA ≥ 1% and TBSA ≤ 4% (Figure 6.1). Those with TBSA < 1% and > 4% do not accumulate extra points on the nomogram.

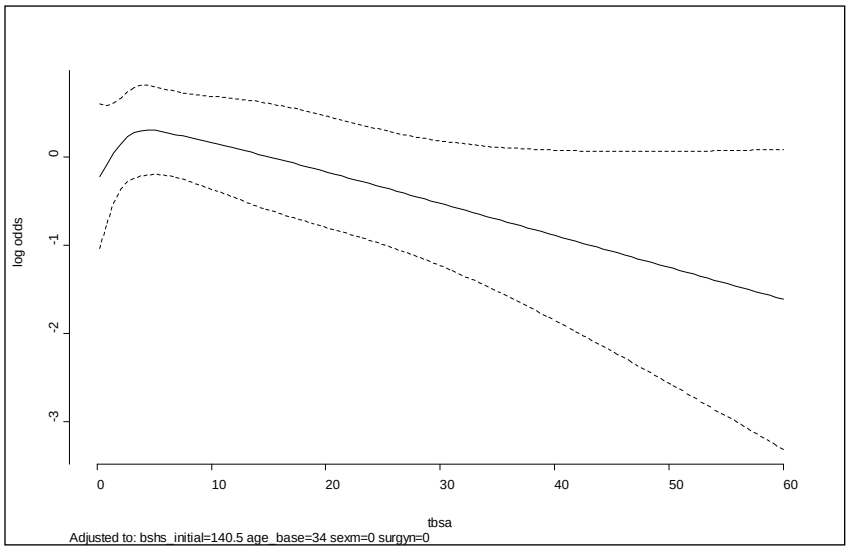

Figure 6.1 Association between TBSA (%) and the probability of achieving a BSHS-B score ≥ 150 at six months post burn

The final model is shown in Table 6.2. The model was used to estimate the probability of achieving a BSHS-B greater than or equal to 150:

$$Score = \frac{1}{1 + \exp\{-[-15.4 + (0.11 * BSHSearly) - (0.02 * Age) + (0.74 * Male) - (1.2 * TBSA > 4\%) + (1.4 * TBSA > 1\%) - (0.61 * Surgery)]\}}$$

Table 6.2 Logistic regression model for Phase I

	Phase I model			
	Number of observations = 735 χ^2_{LR} = 399.7 p < 0.0001			
Independent variable *	Coefficient	95% CI		p
		LCL	UCL	
BSHS-B_{early}	0.115	0.096	0.135	<0.001
TBSA(%)>4	-1.19	-1.69	-0.689	<0.001
TBSA(%)>1	1.52	0.848	2.19	<0.001
Gender (male)	0.528	0.030	1.03	0.038
Age	-0.021	0.033	-0.010	<0.001
surgYN	-0.447	-0.859	-0.035	0.033
Constant	-15.4	-18.9	-12.6	<0.001

* Variables from the univariate analysis that remained significant in the multivariate model

The nomogram was produced as a figure (Figure 6.2) and as an Excel spreadsheet for application in a clinical setting (Figure 6.3).

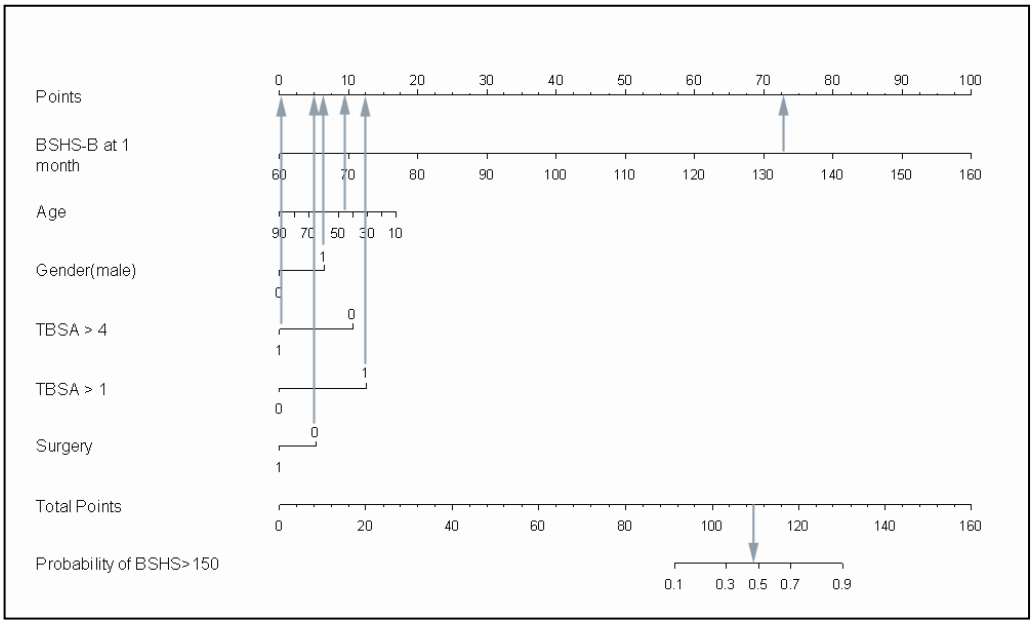

Figure 6.2 RPH burns nomogram

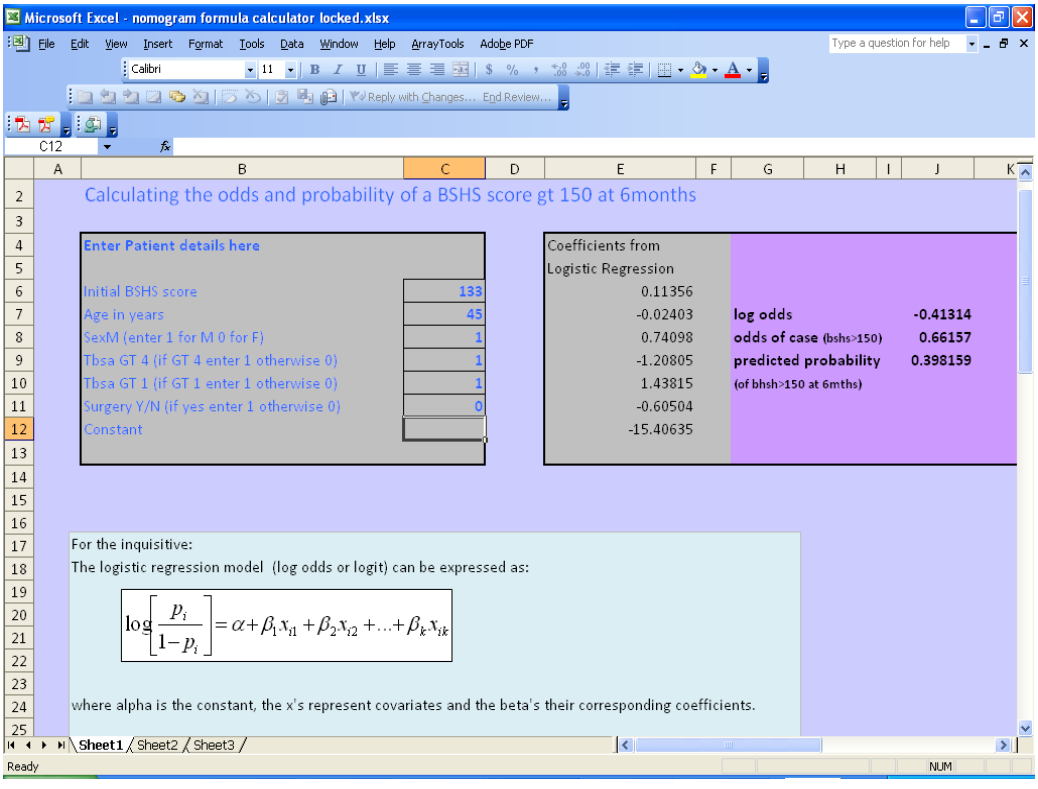

Figure 6.3 Excel version of the RPH burns nomogram for clinical use

The following case study is provided as an example of the use of the nomogram in RPH burn clinical practice.

A 45 year old man presented to the RPH Burns outpatient clinic with a 5% partial thickness scald injury to both forearms. His wound epithelialised 10 days with conservative management and his one month BSHS-B score was 133. The patient's age, gender, burn size and history of surgery along with his one month BSHS-B score were used in the nomogram to calculate the probability of scoring at least 150 points at six months from injury. The number of points corresponding to each variable when added totalled 109. This value is applied to scale marked BSHS-B 6 months and when aligned with the proportion scale underneath showed that he had a 40% chance of scoring at least 150 on the BSHS-B at six months from injury. An examination of the BSHS-B questions where the patient scored poorly indicated that his main problems were psychosocial. He was contacted by an RPH Burns Clinical Nurse Specialist to whom he reported that his problems were not burn related. He declined an offer of counseling and further burn follow-up. His responses to a satisfaction survey completed at the same time revealed that he was satisfied with the appearance of the burned area and had returned to full-time employment.

6.4.3 Clinical Validation

The ROC curve for the nomogram score is shown in Figure 6.4 which demonstrates the AUC as 87.7% indicating that the nomogram has high specificity (low false positive rate) (Obuchowski 2005).

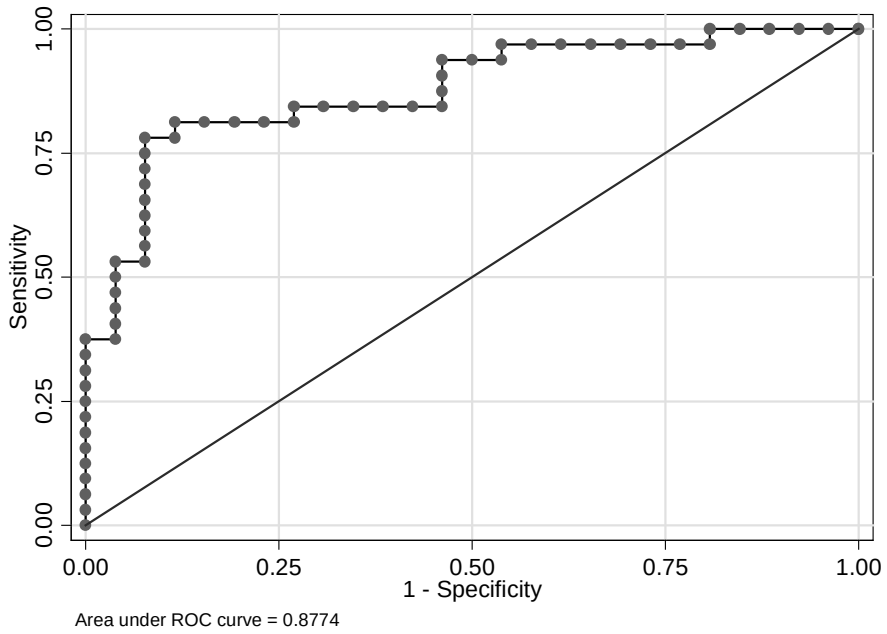

Figure 6.4 ROC Curve showing the accuracy of the the RPH burn nomogram

Table 6.3 shows the specificity or probability of the nomogram correctly predicting that a patient will recover well (true positive); and the sensitivity or probability of the nomogram correctly estimating that a patient will not recover (true negative). The nomogram provides several probability values associated with various levels of sensitivity and specificity. Thus, a probability of 0.7 of a good recovery from the nomogram has a 92.3% specificity or <10% risk of being incorrect. Lower forecast probabilities are associated with a greater risk of false negatives and lesser risk of false positives while the converse is true of larger forecast probabilities.

Table 6.3 Sensitivity and specificity of nomogram predicted outcome

Probability of scoring 150 on the BSHS-B at 6 months	Sensitivity (%)	Specificity (%)	Correctly predicted (%)
0.6	73.5	80.8	76.7
0.7	64.7	92.3	78.3
0.8	52.9	96.2	71.7

6.4.4 Missing Data Assessment

Insertion of the Inverse Mills Ratio into the regression equations in Phases I and II found no bias due to non-response ($p = 0.637$ and 0.740 respectively) in the nomogram models. However, the Heckman selection models show that there is a significant association between selection and age ($p < 0.001$ and 0.005 respectively) and as such the data is missing not-completely-at-random (Heckman 1976).

6.5 Discussion

This study has demonstrated the accuracy and clinical applicability of a predictive nomogram based on the BSHS-B scale score in the RPH burn population. The nomogram predicts the probability of a patient achieving good quality of life demonstrated by scoring 150 points on the BSHS-B at six months from burn. The nomogram confirms that patients who report good early progress have a greater likelihood of maintaining a good recovery trajectory in the longer term.

The sample used for the development and evaluation of the RPH burn nomogram was independent of burn size. The samples used in this research were predominantly comprised (90%) of minor burns of 15% TBSA or less. This is an appropriate spread of severity in that the nomogram is intended for use in predicting good recovery from burn and it is minor burn patients in particular who are expected to recover well by six months. Conversely, the nomogram can identify patients who may not reach 150 points on the BSHS-B by six months as described by the case study presented. This suggests the nomogram is a valuable risk management tool as it highlights instances when recovery is not proceeding as expected.

The nomogram estimates the probability of recovery for each patient based on a combination of their discharge or one month outcome ($BSHS\text{-}B_{early}$), age, gender, %TBSA and surgical management. A ROC analysis on a burn cohort separate to that used in the nomogram development found that the nomogram has over 87% accuracy when predicting likelihood of a patient scoring at least 150 points from six months post-burn. The patient's BSHS-B score at one month from injury is by far the biggest predictor of outcome at six months accounting for almost 80% of the prediction. The sensitivity and specificity associated with each nomogram prediction determines how it can be applied in a clinical setting. As per table 3, each of the

prediction values is associated with a proportion of sensitivity and specificity. The probability cut point selected for use in clinical decision-making should be determined by the relative 'costs' of the resultant rate of false-positives (specificity) and false negatives (sensitivity). In the context of the RPH burn population, the 'cost' of a false positive would be to manage a patient with less intensive therapy based on an expectation of good recovery, who went on to a poor outcome. The 'cost' of a false negative would be to assign a patient to more intensive therapy than is required for a patient likely to show a good recovery, thus providing less efficient care. Since the cost of a false positive for the patient far outweighs that of a false negative for the hospital, we determined a cut point score of 0.7 for the nomogram which would maximise specificity at the expense of sensitivity. The nomogram correctly identifies 92% of patients with a 70% or greater probability of attaining a score of at least 150 on the BSHS-B at 6 months from burn. The RPH burn nomogram has been designed to assist in the management of low severity burns. The associated 8% risk of a false prediction of good recovery is acceptable as the RPH burn nomogram is intended only as an adjunct to expert opinion and other intervention protocols.

The current version of the nomogram has limitations in its application in major burns. A data linkage programme in progress in WA will provide additional data on location of burn, burning agent, patient co-morbidites, and multiple surgical procedures to assist further development of the nomogram for the management of higher severity burns (Duke, Edgar et al. 2011). The limitations of the clinical validation component of the study included missing data, timing accuracy with regards to the data collection, and possible bias in the surveys. Missing patient outcome data is a well recognised problem in clinical studies (Houck, Mazumdar et al. 2004). In our study the amount of missing data is highest in the nomogram development sample; attributable to the difficulties in data collection and management in the early stages of an outcome tracking program. Previous attempts to reduce the impact of data missingness by intensive data collection resulted in a 67% retrieval rate. Further, that younger patients are more likely to be missing at six months, as demonstrated by the Heckman method is as expected from a previous study that showed that these patients disproportionately fail to attend follow-up appointments (Finlay, Burke et al. 2009). This has a conservative bias on the nomogram predicted outcomes i.e. the nomogram underestimates outcomes thus reducing the error rate. In several cases, phone follow-ups were only successful after several attempts, leading to

delays in data collection of up to two weeks. Phone surveys were potentially affected by patients reporting better or worse outcomes than if they were completing surveys without the presence of researchers.

The RPH burn nomogram is based on a Western Australian casemix. The clinical utility of the nomogram would be established with further testing in unrelated burn populations, using our algorithm. The nomogram may need modification for use in other burn facilities and with a greater proportion of major burn patients. Further, individual burn centers must decide on the balance between efficiency and patient safety when making their choice of a nomogram probability value ('cut point') for their specific patient populations.

6.6 Conclusion

The RPH burn nomogram quantifies the potential risk involved in predicting patient recovery and assists in determining the possible effects of assigning clinical pathways for individual patients based on early assessment of outcome.

CHAPTER 7 SYNOPSIS OF RESULTS (DISCUSSION)

7.1 Introduction

Facilitating good outcomes with maximum efficiency for minor burn patients is a priority for many burn services (Jansen, Hynes et al. 2012).

The previous chapters clearly describe and discuss the results of the three studies investigating the streamlined minor burn model of care and the validation of the tools used to provide the evidence for the new model. Following on, this chapter will discuss where this research resides in the current body of knowledge. Finally, the limitations of the research and the recommendations for future studies will be presented.

This body of work aimed to provide evidence for more efficient management of minor burns based on strict criteria and prediction of outcome as measured by a quality of life instrument, the BSHS-B. The first study investigated a new streamlined minor burn model of care in which the QoL of minor burn patients who were discharged from outpatient care with the provision of a patient education booklet and without further physical follow-up was compared to the QoL of a similar cohort that that received standard care. Second, the validity of the BSHS-B, the tool used to measure QoL in the first study; was examined using a cohort of mostly minor burn patients. Finally, a nomogram predicting the likelihood of a good six month BSHS-B score, designed to assist in the minor burn model of care study was described and its clinical applicability examined.

7.2 Synopsis of Results

7.2.1 Chapter 4, Study 1: Streamlined model of care for minor burns

Hypothesis:

'Patients with minor burns of 15% TBSA or less, who are managed conservatively as outpatients and whose wounds heal in 14 days or less who are assessed using mailed BSHS-B surveys at one month and who receive a tailored burn patient self-care manual have the same or better QoL as that of patients who attend hospital for one month review'

The unique results of the first study in this thesis presents evidence of a streamlined model of care that describes a separate care pathway for minor burn patients who do not require surgery. The study involved guided patient self-management of the healed burn followed by postal survey outcome review with a validated QoL outcome scale at four weeks and utilisation of a predictive model as a safety net.

This hypothesis was tested by comparing the one month BSHS-B scores of intervention group participants with those of patients who attended a burns outpatient clinic for review as per standard care. Equivalent median BSHS-B scores between groups support the hypothesis; suggesting that follow-up by postal survey does not disadvantage patients with minor burns that heal quickly. Further, the median BSHS-B scores of this minor burn population approximate the QoL of non burned individuals as determined by previous research (Kvannli, Finlay et al, 2012). In addition, intervention group participants demonstrated high levels of satisfaction with the streamlined model of care as measured by the Burn Patient Satisfaction Survey.

The study results demonstrate that streamlined care for burn patients based on specific criteria of inclusion is feasible with benefits for both the health service and the patient. The study was instigated in response to high levels of non-attendance at outpatient review appointments, suggesting, in minor burn patients that hospital based review is inconvenient and unnecessary. Self-report of outcome via validated postal survey has been proven to be a convenient and cost-effective method of assessing progress in a low-risk population. Consideration of patient safety strengthens the model of care through the addition of a patient burn care booklet

and a predictive nomogram that calculates the likelihood of good outcome. RPH burn nomogram prediction of a poor outcome at six months using one month QoL information triggers phone contact and an offer of additional intervention.

Care must be taken when extrapolating the information gained through this research, particularly when attempting to provide more cost-effective management of targeted patients. Previous work in facilitating more efficient management of minor burns has advocated for the care of selected patients being provided by non-burn surgeons in hospitals without dedicated burn centres (Sagraves, Phade et al. 2007). In that study, burn care training of personnel and collaboration with burn specialists was suggested to maintain quality outcomes while lowering costs. While non-specialist care for minor burns has its place, the variation in the spectrum of minor burn carries an inherent risk of a poor outcome particularly in inexperienced hands. The potential for poor outcomes related to extension of the initial burn wound, slow healing through ineffective treatment and complications such as infection may be substantial in the absence of non-specialist care. This is demonstrated by a 13.4% rate of skin graft surgery in a sample of 311 patients with a mean TBSA of 2.9% who were treated at a burn clinic located in a rural trauma centre (Sagraves, Phade et al. 2007). In contrast, another study of a cohort of similar severity burns (10% TBSA burns or less) managed initially at a burn outpatient clinic found that 2% of all patients required split skin grafting (Vercruysse, Ingram et al. 2011). This suggests that minor burns may benefit from acute care and monitoring based at a burn centre during the healing phase.

Prior to this research, no studies promoting new models of care of minor burns have used standardised outcome measures such as the BSHS-B to evaluate the effectiveness of a change in standard care. Use of outcome measurement for benchmarking in minor burn management may provide the basis for quality control and improvements in both specialist and non-specialist burn care. The streamlined model of care proposed here provides specialised burn care in the first instance along with standardised monitoring and the opportunity for more convenient and efficient home care without compromising eventual outcome.

This model is the first iteration of a new minor burn care strategy. Like all new interventions, it should be subject to continuous quality assessment and improvement. The addition of other, in depth methods of outcome evaluation according to the International Classification of Function such as scar assessment

and occupational fitness may provide useful information to further judge the success of the model of care.

7.2.2 Chapter 5, Study 2: Validation of the BSHS-B in minor burns

Hypothesis:

'The BSHS-B demonstrates reliability along with content, construct and criterion validity in measuring QoL after minor burn.'

The second study in the thesis confirmed, for the first time, the appropriateness of the BSHS-B as an assessment tool to measure the progress after minor burn. The BSHS-B was employed as a predictive and outcome measure in the streamlined model of care. The study confirmed content, construct and criterion validity of the BSHS-B in a mostly minor burn population as had been previously established in major burns (Willebrand and Kildal 2011). Factor analyses replicated the original factor structure of the scale; burn severity as indicated by TBSA, LOS and surgery predicted BSHS-B total and domain scores up to three months post-injury; and BSHS-B total and domain scores changed significantly over 12 months. Thus, the results confirm the hypothesis stated a priori.

This study provides evidence for the use of the BSHS-B as a means to track recovery and as a valid metric to form the basis for optimising minor burns care protocols. Identification of specific domains of the instrument can inform clinicians of patient response to aspects of burn recovery such as physical function and scar outcome. Isolating scores from different domains assists in clarifying areas of need that are likely to be obscured when viewing the only the total score.

Quality of life is becoming an increasingly motivating factor in burn care. Clinicians are prioritising the use of multi-dimensional injury specific quality of life scales for determining the efficacy of treatment. Metrics such as the BSHS-B are being used to provide optimal, standardised, targeted models of care for complex conditions such as burns. Thus, validation of the BSHS-B across a whole burn population facilitates the use of reliable patient reported quantitative recovery information in the clinical decision making process. Further, confirming the performance of the scale in minor as well as major burns demonstrates that recovery from burn can be compared across all patient groups.

The novel results of this study provides evidence for the use of standardised injury-specific outcome tools in the evaluation of management strategies aimed at improving efficiency in the care of minor burns. Previous studies describing similar burn care initiatives have provided only epidemiological information on the sample population to support the value of changing standard of care. For example, a study advocating the treatment of minor burns at a trauma centre instead of a burn centre reported a complication rate of 9.9% as evidence of the benefit of the protocol (Sagraves, Phade et al. 2007). Another study of minor burn patients who sustained home oxygen burns provided intermediate outcome information on length of stay and healing by conservative means to demonstrate the cost benefit of local physician care over burn centre care (Vercruysse and Ingram 2012). Now that the BSHS-B has been validated for use in minor burns, clinicians may be more likely to use the instrument to evaluate patient response to new burn care practices.

7.2.3 Chapter 6, Study 3: Predicting recovery after burn using the BSHS-B

Hypothesis:

'The RPH burn nomogram is a valid tool for calculating the probability that a patient will score 150 points on the BSHS-B at six months using the patient's one month BSHS-B score along with patient personal and injury information.'

Ten years ago, an important point on decision making in burns was made by the then editor in chief of *Burns* (Shakespeare 2003). Shakespeare suggested that clinical treatment is often based on prognosis of outcome rather than diagnosis of condition. While mortality was the outcome Shakespeare was referring to, today, morbidity compares highly as an incentive for optimal care of the majority of burn patients (Pereira, Murphy et al. 2004). The third and final study demonstrates this point to some degree by describing the development and validation of a nomogram that predicts the likelihood of a patient reaching a pre-determined degree of QoL. The nomogram was employed in the first study to justify the selection of patients to receive a new streamlined model of care. Based on the prediction, patients either stayed within the new model of care or were returned to the standard care pathway.

The initial nomogram model was tested in an unrelated burn cohort using ROC analysis to determine how closely the actual reported six month BSHS-B score mirrored that of the nomogram prediction based on one month BSHS-B score. This

hypothesis was accepted as the nomogram was found to be 90% accurate with a less than 10% false positive rate of associated with a 70% probability forecast of achieving a score of 150 points. In statistical and clinical terms, this is an acceptable risk as no predictive tool is infallible. Clinicians interested in using the nomogram to predict the outcome of burn patients in other environments should carefully consider the target population and support infrastructure available to minimise the risk of poor outcome from false positives. In the RPH situation, an additional safety net is provided by provision of the patient burn care manual and instructions to contact the burn service for an appointment if the patient requires further advice or is unhappy with their outcome.

The novelty this study is represented by the use of early outcome data to predict likelihood of full recovery at a later date. The RPH burn nomogram was designed to use BSHS-B data collected up to one month post injury. Further research is required to determine whether the inclusion of two or three month outcomes to predict outcome at six months and beyond is appropriate.

Calculating the probability of reaching a particular level of QoL at a specified time point by using early QoL information is a new approach in prognostic studies involving burn populations. Previous studies have mainly explored the effect of injury severity on QoL, (Cromes, Holavanahalli et al. 2002, Fauerbach, Lezotte et al. 2005). In contrast, in this study, the addition of QoL as determined by BSHS-B score at one month to the baseline independent variables of age, gender, TBSA, LOS and surgery found that it accounted for 80% of the prediction of BSHS-B score at six months. This suggests that patient and injury factors are not the main determinant of outcome, rather, a patient's evaluation of the impact of the burn on their lives. Even minor burns can have varying levels of outcome, not necessarily related to the severity of the injury (Shakespeare 1998). In a recent study Connell et al found that 30% of a RPH burn patient sample with mean TBSA of 10% reported a negative impact of the burn on their body image (Connell, Coates et al. 2013).

As demonstrated by this research, evaluation of early response to injury from the patient's perspective becomes an important factor in determining eventual QoL. As clinicians, we are concerned with the patient's opinion in the long-term and this must be considered in the decision making process early on. If attainment of good QoL within a reasonable time frame, so that patients feel able to participate fully in family and community life after burn injury, is the return on investment of care and

resources highly sought after by burn services, it follows that it should be a priority measure of recovery. Further, evaluating QoL throughout the burn recovery process can be a useful measure of progress after injury providing early information that may concur with or refute clinical opinion. Early problems such as the psychosocial impact of the injury can be identified by patient responses to specific questions posed by instruments with sound psychometric properties such as the BSHS-B. Tracking BSHS-B scores gathered throughout the recovery period can provide information on the recovery pathway of specific groups of burn patients. This information used in predictive algorithms may prove useful in targeting patients with potential for good or poor outcome.

7.2.4 Research Limitations

Though the results of this research are conclusive, the main study, evaluation of a streamlined model of care for minor burns could have been strengthened by additional information. Timeframe and data constituted minor limitations of this study which was controlled by the involvement of a State Government research grant. Funding for the project was dependent on completion of the work within nine months thereby limiting the time for data collection, particularly in regard to the comparison group. Thus the sample of 62 patients was smaller than the 100 planned for the study. As seems to be the case at other burns centres, the collection of outpatient data is not prioritised. In this study, prospective collection of comparison data was necessary instead of relying on previously collected information as expected.

Additional information about the participants such as ethnicity, presence of co-morbidities and body location of burn would have provided greater detail in describing their characteristics. However, as the injury and management factors such as TBSA, LOS and surgery were deemed to be those most influencing outcome on conception of the study, this information was not collected.

A thorough cost analysis of the intervention compared to standard care was planned but was not completed due to lack of available data. Information on rural and remote patient transport costs is collected by the Patient Advisory Travel Service at the WA Department of Health, which does not store data on patients managed solely as outpatients. A basic cost analysis which calculated the result of replacing one outpatient clinic follow-up visit, with an average cost of $275, at one month post-burn with a mailed outcome survey suggests that savings in the order of $29,000

were possible within this cohort. However, no data analysis was undertaken to test the hypothesis that cost-savings were produced as a result of changing the model of care, a limitation of the study that will be addressed in future research.

Another limitation, addressed in each of the studies, is the reduced survey response rate as well as patient loss to follow-up in longitudinal data collection. Earlier work by the candidate has demonstrated that patients who do not return to hospital for follow-up when contacted, report good QoL as measured by the BSHS-B. Those who could not be contacted, mostly young males, are associated with good QoL and high patient attrition rates (Finlay, Burke et al. 2009). Bias from missing data due to reduced survey response rates can be addressed through statistical analysis such as multiple imputation or the Heckman method (Sales, Plomondon et al. 2004). These methods identify the bias associated with "missingness" so that the results can be clarified and inferences made from analysis can be better understood. In the third study, non-response bias was explained using the Heckman method which found a significant association between missing data and younger age suggesting the data was missing not-completely-at-random. This confirms the results of the previous research discussed above.

The predictive nomogram described in the third study may be further explored to expand its use in the clinical setting. The risk of a false positive may be reduced by improving the sensitivity and specificity of the burn nomogram by updating the model using a larger sample and supplementary data. In particular, scar assessment information obtained using standardised instruments such as the Vancouver Scar Scale and the Patient and Observer Scar Scale may provide greater detail of burn patients' recovery. This may have the added benefit of expanding the inclusion criteria to the programme to cover patients that have had small skin graft surgery and a short hospital admission. For instance, patients with a single one percent TBSA skin graft along with those admitted to hospital for up to three days may also thrive with a more expeditious pathway through the hospital system facilitated by the use of a standardised self-report QoL survey such as the BSHS-B.

CHAPTER EIGHT CONCLUSION

8.1 Conclusion

The hypotheses of all three studies outlined in this dissertation were supported by analysis of the available data. A specific category of minor burn patients can be successfully managed with a streamlined model of care that includes a multidisciplinary tailored burn patient education manual and one month quality of life survey follow-up. The BSHS-B is reliable; has content, construct and criterion validity; and is an appropriate measure of outcome in the minor burn population. A nomogram for predicting successful outcomes at six month post-injury is a useful safety net for minor burns patient who follow the new model of care.

8.2 Research Translation and Future Directions

The three studies that comprise this Master's thesis all have significant clinical application. The main study involving description and evaluation of a streamlined care pathway for minor burns was born out of need for expediency in minor burn management. Significant numbers of patients were choosing to forego follow-up appointments at a hospital outpatient burn clinic. Recovery from injury and return to normal daily activity as demonstrated by high QoL survey scores has been identified as a significant factor in failure to present for follow-up (Finlay, Burke et al. 2009). Thus providing a more efficient model of care for patients with a high probability of a good outcome seemed a worthwhile endeavour.

In designing the new model of care for minor burns, the priority was to ensure patient outcomes were not adversely affected. Prior to the commencement of this research, no standardised instrument was known to have demonstrated suitability for measuring quality of life after minor burn. Thus the second study in this research provided evidence of the reliability and validity of using the BSHS-B in a cohort representative of that managed by most developed burn centres. The BSHS-B can now be used to track the progress of individuals for the purpose of targeted treatment selection, to assess the effect of various burn management protocols and to allow benchmarking between burn service providers.

In this way, validation of a nomogram for predicting likelihood of a good six month BSHS-B survey score is illustrative of the translation of research into clinical protocols and tools. The streamlined minor burn model of care utilised a newly validated instrument to collect information early in the recovery pathway and uses this to map eventual outcome. Those whose recovery trajectory is less than optimal are flagged for alternative treatment strategies. Further investigation of the nomogram is warranted. Addition of new data to increase the sample size may provide a nomogram strengthened by extensive patient information. An updated nomogram model that may be capable of even less predictive error is highly desirable when aiming to reduce the risk of a false positive in the application of streamlined care strategies.

Confirmation of the feasibility of the streamlined model of care for minor burns suggests that other similar injury cohorts such as those sustaining brain or orthopaedic trauma may benefit from being managed by a process designed to facilitate a patient's journey through the medical system.

Another product of this research, the patient self-care manual "Caring For Your Burn' (Appendix 3) designed and produced through the first study has broad application, as a useful clinical aid, in the wider burn community. The format featuring clear, straightforward instructions with explanatory photographs that can be tailored to individual patient needs, may, after modification, be utilised in specific burn cohorts such as indigenous or occupational groups. Other injury populations may also benefit from a similar tool.

The results of this research provide a basis for the ongoing studies into the management of burns that involve a wider spectrum of severity. The minor burn model, shown to be effective in the streamlining of care to burns of 15% TBSA or less that heal in 14 days or less while managed conservatively as outpatients may be further tested with incremental increases in one or more of the severity variables used as criteria for inclusion. For any such scheme to succeed the rate limiting step of time to healing needs to be accounted for. Burn wound healing time is one of the greatest factors in calculating the prognostic capacity for good outcome, and one that needs to be explored in more detail in future research.

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APPENDICES

Appendix 1 Patient Information Sheet and Consent Form

Patient Information Sheet

Title of Project:

Comparing the outcomes of burn patients using a multidisciplinary burn resource package with those who receive usual care.

Principle Investigator:	**Co-Investigator:**
Dale Edgar, B. Phty (First Class Honours)	Vidya Finlay, B.Sc (phty)
Senior Physiotherapist	Senior Physiotherapist
Telstra Burns Outcome Centre	Telstra Burns Outcome Centre
Royal Perth Hospital	Royal Perth Hospital
Telephone (08) 9224 2244: Page 2117	Tel (08) 9224 3591

Study summary

Most minor burn injuries heal quickly, especially those that do not need a skin graft. However, even minor burn scarring continues to change for some time and normally we, the Burns Team, would ask you to return to RPH for follow-up for 12 months after injury. However, we understand that minor burn scars need not stop you quickly returning to your normal life. In fact, commonly people manage their burns by themselves without needing to come regularly to the hospital. We would like to

increase the number of patients who can safely do this with the help of individual self-help packages. The information pack will include advice from the burns doctors, nurses, physiotherapists, occupational therapists, psychologists, dieticians and social workers. The pack will have contact information for health care providers in your area.

If you become part of this study, after your burn has healed, you will receive the information needed to take care of your burn successfully without coming into the hospital. If you need additional help, you are encouraged to contact RPH or your local hospital or GP.

Your role in the study

While enrolled in the study, you will receive all the treatment required to heal your burn at RPH. When your burn has healed, the Burn Team will conduct measurements of your movement and function as per usual practice. We will provide you with a tailored package of information at that time. You will not be given any appointments to come to RPH at this stage. We will then assess your recovery at one month after injury with a number of questionnaires. Using predictions based on over 400 previous patients, we will use all of your results to make sure that you will not have any foreseeable complications. If you are progressing as expected we will contact you at six months after your injury and ask you to complete our questionnaires again to confirm that you still have no complications. If your results at one month indicate that you could encounter problems in the longer term, we will organise appropriate treatment for you and you will not be required to continue with the trial.

The questionnaires, which will take about 15 minutes of your time, will be mailed to you. You should return them using the postage paid envelopes provided. If you change your address, please notify us as soon as possible.

Risks and Benefits

In theory, there may be a small increase in risk of complications arising from managing your own recovery from burn injury. This risk has been minimised by planned contact at one and six months, and the use of predictions using your own results. You may develop problems with your burn that you do not know how to deal with. If that occurs, you are encouraged to contact the RPH Telstra Burns Clinic on

92243575 or the Burns Unit on 92242154. You can also contact your GP or your local hospital for assistance or advice. The burns team at RPH will forward detailed information regarding your condition to your GP.

By being involved in this study, you will save at least three trips to hospital in the 12 months after your burn. This will result in reduced need to travel, miss work and organise childcare as well as a reduction in your costs and waiting times. You will be able to fill out the questionnaires at your convenience.

Confidentiality

If you enter this study, you will be allocated a patient number. The investigator will hold the information gathered about you or obtained from measurements, in strict confidence. The data will be stored in a computer in the Royal Perth Hospital with access via a password known only to the investigators. All data collection sheets will be stored in a locked filing cabinet for a period of seven years, as required by law.

Your trial records (without your name attached) will be made available to government regulatory bodies in Australia if required. All people who handle your information will adhere to the standards of confidentiality and will comply with all relevant privacy legislation. In Australia, this is the Privacy Act 1988. The Ethics Committee has obtained assurances from the investigator that the 'Information Privacy Principles' laid down in the Act will be met, and will oblige the investigator and other hospital staff to meet strict privacy standards. The Privacy Act does not apply overseas but if the results of the trial are published in an international medical journal, as is intended, no reader will be able to identify individual patients.

Refusal or withdrawal

We require your signed consent to be a part of this study. You may refuse to participate or withdraw from the study at any point and your decision will be respected. It will not influence your Medical, Nursing or Allied Health care. If you decide to withdraw from the study please contact any of the Investigators at the earliest opportunity and all your data will be destroyed.

Action if an adverse event arises during the study

In the event that you suffer an adverse event or a medical accident during the study that arises from your participation in the study, you will be offered all full and necessary treatment by Royal Perth Hospital. The Ethics Committee has approved this study on the basis (amongst others) that the reported risk of such an event is either small or acceptable in terms of the risk you face as a result of your current illness or the benefit that is possible with the new treatment being tested. No provisions have been made in this trial to offer trial subjects who suffer an adverse reaction monetary compensation, but the absence of such a provision does not remove your rights to seek compensation under common law.

Requests for more information

The Ethics Committee at Royal Perth Hospital has approved this research project. Further information may be obtained from the Chief Investigator or from Assoc Prof F M Van Bockxmeer, Chairman of the Ethics Committee, telephone (08) 9224 2244. The investigators encourage you to discuss any questions or concerns regarding the study with them at any time throughout the study.

Patient Consent Sheet

Title of Project:

Comparing the outcomes of burn patients using a multidisciplinary burn resource package with those who receive usual care.

Principle Investigator:	**Co-Investigator:**
Dale Edgar, B. Phty (First Class Honours)	Vidya Finlay, B.Sc (phty)
Senior Physiotherapist	Senior Physiotherapist
Telstra Burns Outcome Centre	Telstra Burns Outcome Centre
Royal Perth Hospital	Royal Perth Hospital
Telephone (08) 9224 2244: Page 2117	Tel (08) 9224 3591

I,..... agree to participate in the above study. I have read and understood the Study Information and I have received a copy of it. I have had the opportunity to ask questions about the study. I understand that I may withdraw from the study at any time without affecting my future medical treatment, or the treatment of the condition that is the subject of the

trial. I give my permission for any results to be used in any report or research paper, on the understanding that my identity will be kept private.

I understand that the investigator and sponsor of the trial will adhere to usual standards of confidentiality in the collection and handling of my personal information and that the standards of the Privacy Act 1988 will apply to the way my information is handled.

Signed.....
Date.....

Patient/Parent/Guardian

I have explained the nature of and the procedures involved in the study to which the subject has consented to participate and have answered all questions.

Signature of Investigator.....
Date.....

Appendix 2 State Health Research Advisory Grant Application Form (selected sections)

State Health Research Advisory Council

Department of Health

SHRAC Research Translation Projects 2008/09

'Evidence for a Sustainable Health System'

APPLICATION FORM

Closing Date: Thursday 26 June 2008 at 4.00pm

The Department of Health is making available funding for short-term projects or initiatives that will investigate and evaluate efficiencies and cost savings that research can deliver to WA Health in the overall process of health care.

Applications are invited in accordance with the conditions described in the **Guidelines for Applicants** which are available at: www.shrac.health.wa.gov.au/funding

Note: this application form must be typed in Arial font 11 point or larger, and EIGHT copies, including the original, are required.

Associate Investigator 2	
Title, First Name, SURNAME	Ms Vidya FINLAY
Discipline / Profession	Senior physiotherapist, clinical researcher.
Institution	McComb Foundation
Telephone number	92243591
Email address	vidya.finlay@health.wa.gov.au

Role in this project	**Project Manager** Ms Finlay has worked as a senior physiotherapist in burns for over 5 years and as a burns clinical researcher for 18 months. She has been involved in two recent publications, one of which has been accepted pending revision. As a result of her work on the Burns Clinical Outcome Research Project Ms Finlay has been invited to present at the Australian and New Zealand Burn Association conference in Melbourne this year. Ms Finlay will be involved in all aspects of this project.
Time contribution to this project	15 hours per week

Scientific Background

While the focus of burn care in recent times been to facilitate optimal recovery, the burn injury model of care has evolved in the last decade. Today, functional outcomes and the success of reintegration into society are the markers of burn team performance and, patient satisfaction[2,3]. To this end the BSWA team compiled the multidisciplinary BOB, and invested in the regular, prospective collection of information as part of usual practice from January 2006. The BSWA team have recognized the lack of validated outcome measures in the burn population and have undertaken a program of validation to facilitate accurate and reliable outcome measures to guide clinical care[4-6].

Several patients with burns that heal without complication were noted to be self selecting by not attending follow up clinic appointments. It is proposed that these patients may be able to be managed and monitored without the need for face to face medical contact. The outcomes of a test group of patients who had upper limb burns and a hospital length of stay less than three days were investigated in order to develop an accurate, reliable predictive equation to be used in selecting prospective patients into a self management programme.

Detailed Methods:

Phase1: Development of new Burn Management Model (3 months- September to December)

A. Use of predictive markers to direct patients into appropriate management group.

Predictive markers developed in the preliminary stages will be used to identify appropriate patients for direction to specific management groups. Pilot data indicates that age and injury severity will be variables used in the predictive equation. Results of functional testing are being used to validate other variables. Patients will be assessed between 1 and 6 weeks post injury and their recovery at 6 months post injury will be predicted. Patients who are expected to attain full functional recovery by six months will be placed in the self management group and given a multidisciplinary burn care information package including validated monitoring tools.

B. Development of tailored Self Management Packages (SMP)

The information package will contain comprehensive easy-to-follow advice on all aspects of post-acute burn care such as exercises (physiotherapy), scar management (occupational therapy), wound breakdowns (nursing), scarring (medical), body image (psychiatry) and diet (dietician). Additional support will be sought from the patients' GP's if required. The patients will be monitored through the use of self-report functional assessment tools such as the Burn Specific Health Scale-Brief (BSHS-B), the Disabilities of Arm Shoulder and Hand (DASH) and the Lower Limb Functional Index (LLFI). If any problems are identified, patients will be followed up with a phone call, telehealth review, directed to a local health care provider or given an RPH clinic appointment.

A registered nurse in collaboration with the multidisciplinary team at RPH, PMH, satellite and rural hospitals and GP's will be compile a comprehensive post-burn care package. The emphasis will be on encouraging capable patients to self manage their rehabilitation and recovery. The patients will be required to take an active role in their own management and monitoring with the necessary support from the BSWA team.

Each package will consist of management and monitoring strategies based on individual patient needs. Packages will be put together using a bank of burn care information developed from existing patient information resource material for the specific purpose of self management of burn injuries.

Each patient will also be invited to participate in this research project in order to evaluate the effectiveness of the new management strategy. Informed consent will be sought from all those included in the study.

C. Printing of Burns Self Management Pack.

Collaboration with the department of Medical Illustrations will be necessary in order to design the layout of the package. Photos of patients will be included in the information booklet with the patient's consent. The pack will consist of handouts printed in colour that can be put together in various combinations suited to individual patients. The SMP will be printed onsite at RPH.

D. Development of cost analysis markers

Consultation with a health economist will be necessary in order to develop markers with which to provide cost-benefit analysis of the project. Data on number of clinic attendances compared to previous year will be collected and cost savings associated with reduction in use of consumables will be calculated.

Appendix 3 Abstract from study two published manuscript

BURNS XXX (2013) XXX–XXX

Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.elsevier.com/locate/burns

Enhancing the clinical utility of the Burn Specific Health Scale-Brief: Not just for major burns

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ABSTRACT

Introduction: Like many other Western burn services, the proportion of major to minor burns managed at Royal Perth Hospital (RPH) is in the order of 1:10. The Burn Specific Health Scale-Brief (BSHS-B) is an established measure of recovery after major burn, however its performance and validity in a population with a high volume of minor burns is uncertain. Utilizing the tool across burns of all sizes would be useful in service wide clinical practice.

Aim: This study was designed to examine the reliability and validity of the BSHS-B across a sample of mostly minor burn patients.

Method: BSHS-B scores of patients, obtained between January 2006 and February 2013 and stored on a secure hospital database were collated and analyzed

Cronbach's alpha, factor analysis, logistic regression and longitudinal regression were used to examine reliability and validity of the BSHS-B.

Results: Data from 927 burn patients (2031 surveys) with a mean % total burn surface area (TBSA) of 6.7 (SD 10.0) were available for analysis. The BSHS-B demonstrated excellent reliability with a Cronbach's alpha of 0.95. First and second order factor analyses reduced the 40 item scale to four domains: Work; Affect and Relations; Physical Function; Skin Involvement, as per the established construct. TBSA, length of stay and burn surgery all predicted burn specific health in the first three months of injury ($p < 0.001$, $p < 0.001$, $p = 0.03$). BSHS-B whole scale and domain scores showed significant improvement over 24 months from burn ($p < 0.001$).

Discussion: The results from this study show that the structure and performance of the BSHS-B in a burn population consisting of 90% minor burns is consistent with that demonstrated in major burns.

Conclusion: The BSHS-B can be employed to track and predict recovery after burns of all sizes to assist the provision of targeted burn care.

Development and Evaluation of a DVD for the Education of Burn Patients Who Were Not Admitted to Hospital

Vidya Finlay, BSc(Phty),* Nishant Davidoss,† Cory Lei,† Juhui Huangfu,† Sally Burrows, BMath,‡ Dale Wesley Edgar, BPhty, PhD,* Suzanne Rea, FRCS,† Fiona M. Wood, FRACS†

Patient involvement is an important component of burn care and is necessary to produce good outcomes. Patient education using multimedia resources is useful in facilitating self-management and recovery from burn injury. The study aims to provide and evaluate an instructional DVD to assist burn patients with their self-management. The project was divided into three phases: 1) research about the needs of patients, 2) production of the DVD based on those needs, and 3) evaluation of the effectiveness of the DVD. In phase III, 49 burn patients (73% male; median age 32 years, median TBSA 3%) completed a survey on confidence in their burn care before development of an educational DVD, the results of which were compared with those of 55 burn patients (58% male; median age 35 years, median TBSA 3%) who completed the same survey questions after viewing a burn care DVD. Patient confidence in all self-management activities showed a statistically significant improvement ($P < .01$). An instructional burns DVD improves confidence in self-management of patients who have not been admitted to hospital and is a useful adjunct to current burn practice. (J Burn Care Res 2012;33:e70–e78)

Appendix 3 Survey Tools –BSHS-B and RPH Burn Patient Satisfaction Survey

BURN SPECIFIC HEALTH SCALE (BRIEF VERSION)

Please answer (circle) ALL questions based on your condition in the last 7 days. If you did not do the activity, please estimate your answer. Please return to Burns Unit physio in the enclosed envelope. Thanks

How much difficulty do you have:	Extreme	Quite a bit	Moderate	A Little Bit	None
1. Bathing independently?	0	1	2	3	4
2. Dressing by yourself?	0	1	2	3	4
3. Getting in and out of a chair?	0	1	2	3	4
4. Signing your name?	0	1	2	3	4
5. Eating with utensils?	0	1	2	3	4
6. Tying shoelaces/bows etc?	0	1	2	3	4
7. Picking up coins from a flat surface?	0	1	2	3	4
8. Unlocking a door?	0	1	2	3	4
9. Working in your old job performing your old duties?	0	1	2	3	4

To what extent does each of the following statements describe you?	Extremely	Quite a bit	Moderate	A Little Bit	Not at All
10.I am troubled by feelings of loneliness.	0	1	2	3	4
11.I often feel sad or blue.	0	1	2	3	4
12.At times, I think I have had an emotional problem.	0	1	2	3	4
13.I am not interested in doing things with my friends.	0	1	2	3	4
14.I don't enjoy visiting people.	0	1	2	3	4
15.I have no one to talk to about my problems.	0	1	2	3	4
16.I have feelings of being caught or trapped.	0	1	2	3	4
17.My injury has put me further away from my family.	0	1	2	3	4
18.I would rather be alone than with my family.	0	1	2	3	4
19.I don't like the way my family acts around me.	0	1	2	3	4

To what extent does each of the following statements describe you?	Extremely	Quite a bit	Moderate	A Little Bit	Not at All
20.My family would be better off without me.	0	1	2	3	4
21.I feel frustrated because I cannot be sexually aroused as well as I used to.	0	1	2	3	4
22.I am simply not interested in sex any more.	0	1	2	3	4
23.I no longer hug, hold or kiss.	0	1	2	3	4
24.Sometimes, I would like to forget that my appearance has changed.	0	1	2	3	4
25.I feel that my burn is unattractive to others.	0	1	2	3	4
26.My general appearance really bothers me.	0	1	2	3	4
27.The appearance of my scars bothers me.	0	1	2	3	4
28.Being out in the sun bothers me.	0	1	2	3	4
29.Hot weather bothers me.	0	1	2	3	4
30.I can't get out and do things in hot weather.	0	1	2	3	4

PLEASE TURN PAGE OVER

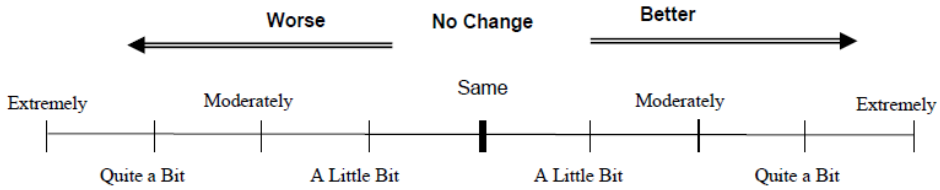
BURN SPECIFIC HEALTH SCALE (BRIEF VERSION)

To what extent does each of the following statements describe you?	Extremely	Quite a bit	Moderate	A Little Bit	Not at All
31.It bothers me that I can't get out in the sun.	0	1	2	3	4
32.My skin is more sensitive than before.	0	1	2	3	4
33.Taking care of my skin is a bother.	0	1	2	3	4
34.There are things that I've been told to do for my burn that I dislike doing.	0	1	2	3	4
35.I wish that I didn't have to do so many things to take care of my burn.	0	1	2	3	4
36.I have a hard time doing all the things I've been told to take care of my burn.	0	1	2	3	4
37.Taking care of my burn makes it hard to do other things that are important to me.	0	1	2	3	4
38.My burn interferes with my work.	0	1	2	3	4
39.Being burned has affected my ability to work.	0	1	2	3	4
40.My burn has caused problems with my working.	0	1	2	3	4

Please remember to fill out the scale below!

PATIENT GLOBAL RATING SCALE – Same, Better or Worse?

Compared to your overall **emotional and physical** wellbeing when **you last filled out** this Burns questionnaire, which point on the scale below best describes your present condition (circle only one):



BURN SPECIFIC HEALTH SCALE (BRIEF VERSION)

Kildal M, Andersson G, Fugl-Meyer AR, Lannerstam K, Gerdin B 2001, 'Development of a Brief Version of the Burn Specific Health Scale (BSHS)', Journal of Trauma, Injury, Infection and Critical Care, vol 51, pp.740-746.

Burn Patient Satisfaction Survey

Injury Details:

Date of Burn: _____

Admitted to hospital ☐ Not admitted to hospital ☐

Date admitted to hospital: _____ Date discharged from hospital: _____

Number of days from day of burn to day wound healed: _____

When you think about the treatment you received for your burn injury. (Please circle the response that describes your feelings best.)

1. I am **satisfied** with the way the WA Burns service has managed my burn injury.

   a. Strongly agree
   b. Agree
   c. Unsure
   d. Disagree
   e. Strongly disagree

   Comments_____
   _____

When you think about the way your burn injury is now. (Please circle the response that describes your feelings best.)

2. I am **unhappy** with the appearance and/or feel of my scar.

   a. Strongly agree
   b. Agree
   c. Unsure
   d. Disagree
   e. Strongly disgree

   Comments: _____
   _____

3. My burn does **not** stop me from doing all the things I want to do.

a. Strongly agree
b. Agree
c. Unsure
d. Disagree
e. Strongly disagree

Comments:_____
_____

When you think of how the burn injury has affected your ability to return to paid work

4. Have you returned to work?
(Please tick the box below that applies to you)

Did not have paid work prior to burn (Go to question 7) ☐
Had paid work prior to burn but have not returned to work ☐
Have returned to work ☐

Comments:_____

If you have returned to work

5. What type of work did you do after your burn injury? (tick as many boxes as necessary)

Same work as before ☐
Different work ☐
Full-time ☐
Part-time ☐
Light duties ☐

6. If you did return to work, how many days after your burn did you return to work? _____

When you think of the information you were given about managing your burn

7. What information were you given? (tick as many boxes as necessary)

Yellow booklet "Caring for your burn"	☐
Other written information	☐
Verbal information	☐

8. Was the information

Difficult to understand	☐
Easy to understand	☐
Helpful	☐
Unhelpful	☐

9. Was the amount of information

Too little	☐
Too much	☐
The right amount for you	☐

10. Was the timing of the information

Too late	☐
Too early	☐
At the right time	☐

Appendix 5 Patient Educational Material

Caring for your Burn

Information about the burn of:

If found please return to Royal Perth Hospital

The Burn Service of Western Australia at Royal Perth Hospital is committed to providing a service of excellence by:

- Ensuring the best outcomes possible for burn patients
- Dedicating ourselves to the pursuit of scarless healing
- Educating ourselves and others on burn care and prevention
- Working together with relevant health and research bodies
- Continually expanding our knowledge and experience in burn related fields
- Engaging in scientific and clinical research directed to those areas of most importance to our patients and families

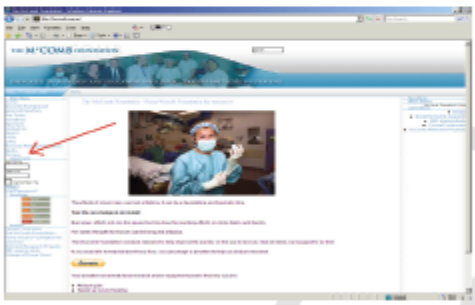
Completing Surveys

Following your burn, it is important that the Burn Service of WA at RPH know how you have recovered and if you are satisfied with our service. To provide this information you will be asked to fill out some surveys.

The surveys can be posted to you. With the surveys, you will receive a postage paid envelope that you can use to return your surveys.

You can fill out the survey online via the McComb Foundation website by following the instructions below.

1. Log onto the Internet and go to www.mccomb.org.au in your preferred Internet browser
2. Click surveys on the main menu.



3. Select the survey you wish to complete.
4. To log in, the details are:
   Username: patient
   Password: burns
5. Please complete the survey and click the finish button when complete.

Thankyou for your participation.

Caring for your Healed Burn

- Your recently healed burn will be fragile and need care and protection.
- Your burn can dry out and crack causing an open wound. This can become infected. To avoid drying and cracking, **moisturize** twice a day using a non-perfumed cream (eg Sorbolene).
- Your burn may result in a thickened or raised scar. To reduce the chances of a raised scar, **massage** the area twice a day using a non-perfumed cream. (See sheet on Massage)
- Your burn may become discoloured if it gets sunburnt. Use **sunscreen** (SPF 30+) on exposed areas and cover burns with clothing when going outside for at least 2 years after your injury. (See sheet Slip Slop Slap).
- In the first two weeks after your burn has healed, the new skin is softer than on the rest of your body. **Protect** the area from knocking or scratching this area as a new wound may develop.
- It is important to move normally to allow your new skin to stretch. Make sure you have full **movement** and are able to do all your normal activities.

Regularly check for signs of infection (see sheet on Signs of Infection)

Washing your Burn

- It is very important to keep your burn clean.
- Wash your burn area as often as directed under running water (e.g. shower) using ordinary soap.
- Pat the area dry with a clean, dry towel.
- Apply moisturizer and massage or a dressing as directed by the burn clinic.

Regularly check for signs of infection (see sheet on Signs of Infection)

Signs of Infection

Protect your wound!

It is important to keep the wound free of infection. Infection can delay wound healing and result in deepening of the burn. This may lead to worse scarring or even the need for skin graft surgery.

Keeping the area clean and moist will help prevent infection.

If you notice any of the following:

- Increase in pain from the burn
- Increase in the amount of redness surrounding the burn
- Increase in heat from the area around the burn
- Increase in swelling around the burn
- Increase in the amount of ooze from the burn
- Change in the colour and/or smell of the ooze from the burn
- Increase in your body temperature
- Decrease in movement of the joints near the burn

Your burn could be infected.

If you have any of the signs above please contact a Doctor within 24 hours.

Wound Breakdown

- In the early stages your healed burn is fragile and needs protection.
- There is a chance that small areas of new skin may open and may then become infected.
- If this happens keep the wound clean and contact the Burns clinic (see contact sheet at the front of the file).

Regularly check for signs of infection (see the sheet on Signs of Infection)

Pain Management

The burn injury makes your nerves more sensitive and sensations that were once comfortable become uncomfortable or painful. It is the aim of the burns team to minimize your pain.

You should take pain medicine at regular intervals as prescribed to help you control your pain and to enable you to move and function at all times.

Remember to take your pain medicine before dressing changes.

Increased pain may be a sign of infection (see sheet on Signs of Infection.

Returning to Normal Function

The main goal in your recovery is for independence and safety in your everyday tasks. Your outcome depends on you.

It is important to move and stretch your wound while your burn is healing. Performing everyday tasks helps your skin, muscles and joints to stretch and move normally. It also prevents tightness.

Doing a task in your normal way helps the scar tissue to stretch and makes these movements easier to perform over time.

It is important that you return to what you were doing before your burn.

Make sure you do tasks such as showering/dressing, eating/drinking, cooking and housework as you normally would.

When returning to work you may need to use protective gloves, socks and footwear to protect your newly healed skin from knocks and scratches. Your doctor will advise you when it is safe to return to work.

Exercises

Scar tissue stops you moving normally. The more you move the better your scar will be. Moving (with care) reduces the need for further surgery in the future.

You have been provided with exercises to do each day. These are essential as well as doing your normal activities. There is only a limited time when scar tissue can lengthen, flatten and gain normal movement.

The earlier you start moving normally the better your scar will be.

Managing Swelling after Burn Injury

Swelling is Our Enemy!!

Immediately after a burn, the inflammatory process makes the blood vessels leaky. This causes swelling. Some swelling is a normal part of wound healing, however if there is too much swelling the burn wound may become deeper.

To avoid excess swelling:

- Move the injured area. Contracting the muscles pushes the excess fluid away.
- Elevate the injured area. The swollen part should be kept above the level of the heart when you are resting to allow the excess fluid to drain away.
- Use the pressure bandage or sleeve you have been given when moving around to prevent build up of excess fluid.

Increased swelling may be a sign of infection.

Regularly check for signs of infection (see sheet on Signs of Infection)

Managing Swelling using Tubigrip

- Swelling is common after a burn (see the sheet on Swelling).
- Excess swelling can deepen your burn and needs to be prevented.
- Tubigrip is a sleeve that can be put on your arm or leg to provide pressure that will minimise swelling.
- Apply the tubigrip to the area as directed.
- Ensure that the edges of the tubigrip do not roll down. This can affect your circulation and damage your new skin.
- If you are unable to stop the tubigrip from rolling down, remove it completely and contact the burns clinic for advice.
- You may be able to manage the swelling effectively in other ways (see sheet on Swelling).

Increasing swelling may be a sign of infection (see sheet on Signs of Infection).

Sun Care: SLIP SLOP SLAP

Sunburn happens frequently throughout WA at all times of the year, even on cloudy days.

Your skin is more sensitive to sun burn for up to 2 years following a burn injury. Unprotected exposure to the sun causes permanent discolouration to your skin.

Apply 30+ sunscreen, wear sun protective clothing, a hat and sunglasses whenever your healed burns are exposed to the sun.

Scar Prevention

Moisturising and Massage:

- Healed burns are naturally very dry and need to be moisturised often throughout the day. Dry skin cracks and gets infected and inhibits normal movement. Moisturizing keeps your skin soft and supple helps maintain movement.

Use perfume free sorbolene, lanolin or emollient as these will not irritate or dry your skin.

- It is fine to swim in the sea or pool as long as your wounds are fully healed, and you wear sun protection. Swimming can dry your skin so you need to rinse off in fresh water and moisturise afterwards.
- Massage helps the skin to heal flat and assists in preventing scar tissue developing. Massage firmly so that your skin turns white (blanches) when pressed. Concentrate on any hard, raised, sensitive or dry areas as these require extra attention. Be careful not to massage newly healed wounds too hard as you do not want to cause breakdown.

Use your thumb to massage in deep circular motions.

Scar Revision

As your burn wound was mainly superficial you are not expected to have a bad scar. If you are unhappy with the result after your burn it may be possible to have treatment at a later date (at least six months but usually one year).

Some simple methods of treatment:

- Application of adhesive tape after wound healing to help flatten the scar
- Topical steroid cream
- Steroid injection (several injections may be required)
- Silicone gel dressing or cream
- Compression garments

Complex scar treatment may need to be performed under general anaesthetic and needs careful consideration.

The decision to have your scar surgically treated should only be made after discussion with your surgeon. Take your time making a decision and make sure you are well informed.

Feel free to make an appointment to see your Burn Surgeon.

Desensitisation

Burns to the skin damages nerve endings. You may notice your skin is sensitive to touch in certain areas. This condition is known as ***hypersensitivity***.

It is natural to protect your burns but if you continue to avoid touching the skin and doing everyday tasks this hypersensitivity will get worse.

It is important to re-educate your skin to respond to touch 'normally' again. Massage and exposure to a variety of stimuli is effective in reducing hypersensitivity. It is very important that you resume everyday tasks, particularly in hand burns.

Itch

Healing scar tissue can become very itchy. To reduce itch we recommend you:

- Do not scratch
- Regularly moisturise
- Use soap free products (eg Dermaveen, available from chemists).
- Avoid hot showers
- Apply a cool wet face cloth to itchy areas

Healthy Eating at Home

For Burns Patients at home it is recommended that you follow the

"Dietary Guidelines for Australian Adults".

This will assist your physical recovery as well as optimise your health for the future:

- Enjoy a wide variety of nutritious foods
- Eat plenty of cereals *(including breads, rice, pasta and noodles, preferably wholegrain)*
- Include lean meat, fish, poultry and / or alternatives
- Include milks, yoghurts, cheeses and / or alternatives (*Reduced-fat varieties should be chosen, where possible)*
- Drink plenty of water

And take care to:

- Limit saturated fat and moderate total fat intake
- Choose foods low in salt
- Limit your alcohol intake if you choose to drink
- Consume only moderate amounts of sugars and foods containing added sugars.

Maintain a Healthy Weight Range

It is important that there is a balance between your food intake and physical activity.

What is your weight in relation to how tall you are?

Body Mass Index (BMI) uses both your weight and height measurement to estimate your total amount of body fat.

To work out your Body Mass Index you need to know your weight (in kilograms) and your height (in metres).

Formula

$$BMI = \frac{\text{Weight}}{(\text{Height} \times \text{Height})}$$

Example

eg. If weigh 70 kg and are 180 cms in height
= 70 divided by (1.8m x1.8m)
= 70 divided by 3.24
= BMI 22

BMI Categories (If 18 Years or over):

Weight Category	BMI
Underweight	BMI less than 18.5
Healthy Weight	BMI 18.5-25
Overweight	BMI 25-30
Obese/Severely Obese	BMI Greater than 30

A BMI Chart is included on the next page so you can work out if your are a "Healthy Weight" without doing the maths.

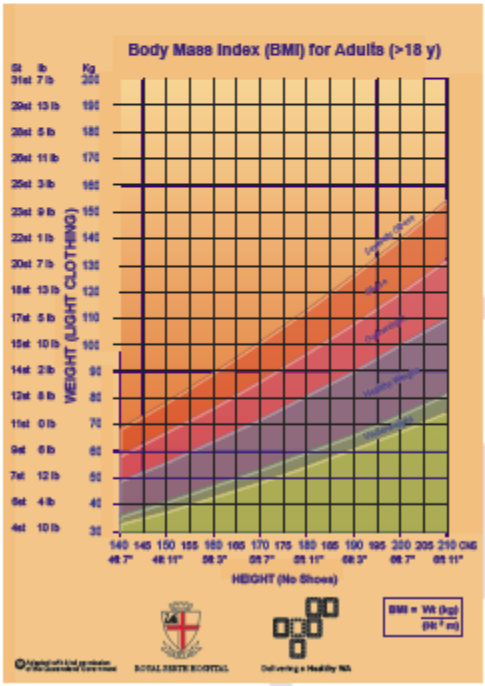
Body Mass Index Chart
(for Adults 18 years and over)

Instructions:

Find your **height** on the chart first, then go up the graph to find where this line crosses with your **weight**.

What colour is your cross in?

Is it in the Healthy BMI area? (Purple Area)



Coping with your Burn

People respond in all kinds of ways to a burn injury, but often there is a period during which you might notice some common emotional changes. In most cases these settle over time and are related to factors such as your experience of the burn injury (e.g. whether it was traumatic), rather than to the size of the injury.

Common reactions can include such things as feeling over-sensitive, disturbed sleep, difficulty concentrating, being easily startled, feeling down and/or feeling tense, irritability, intrusive thoughts of the injury, withdrawal from family and/or social situations.

Coping Strategies

There are several things you can do to look after yourself and promote recovery:

- Try to maintain a normal routine; keep busy and structure your day
- Take time to do things that feel good to you, like listening to music
- Do not try to block out thoughts of what has happened
- Give yourself permission to feel what you feel and share your experiences and feelings with others who will understand
- Make sure you do not unnecessarily avoid certain activities or places
- Practise relaxation exercises to ease stress or anxiety
- Mobilise supports - contact friends
- Use humour
- Ensure you are getting enough sleep and maintain a regular sleep pattern
- Return to your usual activities as soon as you are able
- Avoid overuse of alcohol or other drugs to cope

Support from Friends and Family

Others can support you by:

- Offering a listening ear and trying to understand what you are feeling
- Allowing you to do things for yourself when possible
- Doing fun or relaxing things with you, however small
- Trying to keep routines as normal as possible
- Not taking anger or other feelings personally
- Giving you some private time, if needed
- Encouraging you to resume interests and activities as soon as you're able
- Reminding you of your personal strengths and how much you mean to them

Changing your lifestyle

Following a burn injury people may decide to improve aspects of their lifestyle, such as their alcohol or other drug use. A number of services exist in both metropolitan and rural areas to assist people in making these decisions and then making the desired changes.

If you would like more information, phone ADIS (Alcohol and Drug Information Service) on 9442 5000. This is a 24-hour telephone information and support service that can link you in with the most appropriate agency for your needs.

Sexuality Following your Burn Injury

As your burn heals you may have some issues regarding your sexuality and relationships. Your injury should not stop you from enjoying your intimate relationships. Please use safe sex practices and positions/activities at all times to protect your healing burn from infection or damage.

Please contact the Burns Service if you would like help or advice regarding your physical appearance, sexuality or relationships.

Support Services

Seek professional help if you:

- Are unable to cope with your feelings
- Feel that your cognitive (thinking) or emotional symptoms are not returning to normal after approximately three to four weeks
- Have no person or group with whom you can share your feelings
- Find that relationships with friends, family and colleagues seem to be suffering
- Are becoming accident prone and are increasing the use of alcohol or drugs.

Who should I approach for professional assistance?

- Your doctor (GP) can refer you to a mental health professional, such as a Clinical Psychologist or Psychiatrist.
- The staff at the Telstra Burns Clinic or the Burns Unit (see contact sheet at the front of the file).

Social Work

If you have personal, practical or family matters that are causing you concern, you can ask to see a social worker for advice or assistance.

The social workers are able to offer advice on a wide range of issues including:

- Financial matters.
- Compensation
- Accessing legal help
- Accommodation
- Child care
- Transport
- Home help and support
- Adjustment to your illness or disability
- Counselling and bereavement.

Workers Compensation

If you are burnt while doing your job for an employer you may be eligible for Workers Compensation payments.
On your first visit to the G.P or the Hospital you should be given a "Work Cover First Medical Certificate".
From your employer you should receive a "Worker's Compensation Claim Form 2B". You must complete this form as soon as possible and return it to your employer with the First Medical Certificate attached.
If you have not received this form within seven days you should telephone the Work Cover Advisory Service on 1300 794 744 (Hearing Impaired: TTY (08) 9388 5537) or you can access the website on www.workover.wa.gov.au.

Centrelink

If you are not eligible for Workers Compensation but need time off work to recover from your burn you may wish to claim Centrelink payments.
There are two types of payments for people unable to work due to injury.

1. New start (sickness)- for people who have no job to return to after their recovery.

2. Sickness allowance- for people who have a job to return to after their recovery.

Contact Centrelink on 132717 (Hearing Impaired: TTY Freecall TM 1800 810 586). Or you can access the website at www.centrelink.gov.au

Voluntary Transport

Royal Perth Hospital, most other Perth hospitals and some country hospitals have a transport service run by volunteer drivers. This service may help you to get to your medical appointments.

The service is generally for people who are physically unable to travel by public transport.

Some hospitals have a fixed cost for this service but others ask for a donation as payment.

Ring your local hospital if you need to use this service.

Local governments (council) have a Home and Community Care Transport Service. Call you local council if you would like to use this service.

Patient Assisted Travel Scheme (PATS)

This is for people who live more than 100 kms from Perth and require specialised treatment at a Perth city hospital.

If eligible, you may be able to get help with travel and accommodation as part of your visit.

Most hospitals have a department that will help you access this service.

Follow-up

When you are discharged from hospital you will need to be reviewed at certain times depending on your needs.

You may be given an appointment to come to the Burns Clinic at Royal Perth Hospital. However, you may be reviewed in other locations or in other ways.

For those who live in Perth:

- GP
- Local hospital
- Telephone
- Questionnaire (mail or online)

For country patients:

- GP
- Nursing outpost
- Local hospital
- Telehealth
- Questionnaire (mail or online)

Care of the Minor Facial Burn

- Wash your face carefully as directed each day with a simple non perfumed soap and water. Remove any loose skin and crusting while washing. Gently pat dry with a clean towel. Men should shave each day to reduce the risk of infection.
- Apply a thin smear of emollient based ointment to all burn areas except for the eye lids. Take special care of burns to the ears.
- Take special care of the eyes, applying eye ointment, as directed by your doctor, to the eye lids.
- After eating or drinking, apply an oily cream such as 'Lanoline' to the lips to prevent them from becoming dry and cracked. This helps to reduce infection.
- The burn may cause the face to swell. Putting your head up on two or more pillows at night will help to reduce facial swelling.
- Avoid using makeup until the burn is healed.

Regularly check for signs of infection (see sheet on Signs of Infection)

Royal Perth Hospital
9224 2244

RPH Burns Unit
9224 2154

RPH Telstra Burns Unit
9224 3566

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THE McCOMB FOUNDATION

DEDICATED TO RESEARCH AND EDUCATION INTO BURNS, TRAUMA AND SCARLESS HEALING

Royal Perth Hospital

Department of Health