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A retrospective study analysing mortality and outcomes in the paediatric burns intensive care unit at the Chris Hani Baragwanath Academic Hospital, Johannesburg

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2021

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A retrospective study analysing mortality and outcomes in the paediatric burns intensive care unit at the Chris Hani Baragwanath Academic Hospital, Johannesburg

Dr Noxolo Zekhethelo Mashavave



A research report for submissible paper submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfillment of the requirements for the degree of Master of Medicine (MMed) in Paediatric Surgery

Johannesburg

12 October 2021

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DECLARATION

I, Noxolo Zekhethelo Mashavave, declare that this Research Report is my own, unaided work. It is being submitted for the Master of Medicine (MMed) in Paediatric Surgery Degree at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



(Signature of candidate)

11th of October 2021

in Johannesburg

Declaration: Student's contribution to article(s) and agreement of co-author(s)

I, **Noxolo Zekhethelo Mashavave**, student number 0700226F, declare that this Research Report is my own work and that I contributed adequately towards research findings published in the article stated below which are included in my Research Report.

Signature of Student ..... **Date** 09/03/2021

Name of Primary Supervisor: Prof J. Loveland

Signature of Primary Supervisor ..... **Date** 09-03-2021

Agreement by co-authors: By signing this declaration, the co-authors listed below agree to the use of the article by the student as part of her Research Report. In cases where the student is not the 1st author of a published article, the primary supervisor must explain (under comments) why the student is entitled to use the paper for her degree purposes.

Article Title: A retrospective study analysing mortality and outcomes in the paediatric burns intensive care unit at the Chris Hani Baragwanath Academic Hospital, Johannesburg

Journal name, year, volume and page numbers:

South African Journal of Child Health 2020;14(4):212-216. https://doi.org/10.7196/SAJCH.2020.v14i4.1724

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Fully supported.

DEDICATION

I dedicate this work to my parents, Nonhlanhla and Thamsanqa Xaba who have strived to give us opportunities they were never afforded and showing unrelenting support in every milestone, and to my husband, Cedric Mashavave who offers unconditional love and is a constant supporting force.

ACKNOWLEDGEMENTS

I would like to thank my Father in heaven for all the strength and grace he grants me day in and day out, and to finish this research project.

I would like to thank my supervisors: Prof J Loveland, Dr A Withers, Dr B Jugmohan and Dr L Doedens for all the support, guidance, suggestions and the effort they put to make this research project possible.

I would also like to thank the Paediatric Surgery Department Research unit for its' input and support.

The Paediatric Burns Unit nurses, doctors, allied professionals for all the hard work and dedication they invest into ensuring healing of the children they have been entrusted with. Your efforts speak for themselves in the improved outcomes seen over the past few years and your care has significant impact in these children's lives forever.

And lastly, I want to thank my husband, Cedric, and my son, Nathaniel, for all that they do for me. Your dedication to lifting my head up, constantly holding my hand through every season is astounding. Thank you for your support in making sure this research report got completed.

PUBLICATIONS AND PRESENTATIONS ARISING FROM THIS STUDY

- A retrospective study analysing mortality and outcomes in the paediatric burns intensive care unit at the Chris Hani Baragwanath Academic Hospital, Johannesburg, SAJCH December 2020, Vol. 14, No. 4, Pages 212- 216

PUBLISHED ARTICLE

A retrospective study analysing mortality and outcomes in the paediatric burns intensive care unit at the Chris Hani Baragwanath Academic Hospital, Johannesburg

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Background. Data on mortalities related to paediatric burns in South Africa are scarce and outcomes in transferred and direct admissions into paediatric intensive care units have not been compared.

Objectives. To describe the demographic profile, aetiology and extent of injuries in patients treated at the paediatric burns intensive care unit (PBICU) at the Chris Hani Baragwanath Academic Hospital (CHBAH), Johannesburg and to compare outcomes of direct admissions and patients transferred to the unit.

Methods. This was a retrospective cohort study of all patients younger than 10 years admitted to the PBICU at CHBAH from January 2013 to December 2017. Statistical differences between groups were analysed using log-rank analysis and Kaplan–Meier curves were used to determine survival.

Results. Of the 2 506 admissions into the general ward and ICU over the 5-year study period, 428 admissions were to the PBICU. A total of 109 deaths occurred (25.47% of PBICU admissions), with an overall mortality of 4.4%. Of the total number of deaths (n=109), 58 (53.21%) were among direct admissions and 51 (46.79%) among transferred patients. The mortality rate in the respective groups was 18.58% (direct admissions) and 43.97% (transferred patients). The survival rate was significantly different between the two groups (p<0.01).

Conclusion. A favourable outcome was more likely in direct admissions than in transferred patients. With standardised protocols for management of severe burns and stable availability of resources, improvements in outcome are expected.

S Afr J Child Health 2020;14(4):212-216. https://doi.org/10.7196/SAJCH.2020.v14i4.1724

Introduction

Internationally, thermal burns account for 300 000 mortalities per year, of which 180 000 are estimated to occur in low- to middle-income countries.[1,2] In South Africa (SA), 2.8/100 000 children die annually from thermal injuries and burns remain the third most common cause of external trauma and subsequent mortality in children younger than 18 years.[3,4] In the SA context, the incidence and patterns of burn injuries have been noted to be attributed largely to urbanisation and urban migration, disorganised development, inaccessible electrical supply, unsafe energy sources, poverty and overcrowding.[5] A retrospective study by Jugmohan *et al.*[6] identified the risk factors for mortality in paediatric burn victims at the Chris Hani Baragwanath Academic Hospital (CHBAH) as age below 5 years, burn injury with a total body surface area (TBSA) >30%, presence of inhalational injury and admission to the paediatric intensive care unit (PICU). Informal observations in our unit suggested that worse outcomes and higher mortality were associated with patients transferred to us from referral centres than seen in direct admissions from the emergency department. It was reasoned that this may be due to patients being transferred fairly long after the burn occurred and that burn injuries were more extensive. Literature review revealed no studies that compared the outcomes between direct admissions and patients transferred from a referral centre, which prompted us to analyse the outcomes in these patient groups formally.

Methods

The Johnson & Johnson Paediatric Burns Unit at CHBAH treats state-sector patients from Soweto and surrounds as well as from distant referral sites, often accepting patients from centres in provinces outside our referral area. The referral and admission criteria are in line with the guidelines of the American Burn Association. [7,8]

The study aimed to compare the outcomes (defined as the proportion of mortalities versus discharges) of patients who had been admitted directly from the emergency department or referred locally from Soweto with those of patients transferred to our unit from other healthcare institutions. To this end, case data from 1 January 2013 to 31 December 2017 were retrieved from the patient registry of the paediatric burns' unit.

The total number of admissions to the unit and also the number of admissions to the paediatric burns intensive care unit (PBICU) over the 5-year period were determined. Patients older than 10 years and re-admissions into the PBICU were excluded. Admission and demographic data were used to differentiate between patients admitted directly from the emergency department and those transferred from referral centres outside of Soweto. Direct admissions were defined as patients from within our institution's catchment area and included both patients who arrived at hospital on own accord and those brought in by emergency medical services, without prior treatment at another institution.

Data collected from records of each group included age, gender, mechanism of injury, percentage of body surface area burned, length of stay and outcome. Outcome was based on whether the patient demised or was discharged from the PBICU.

Four age groups were defined, namely 0 - 12 months, 13 - 36 months, 37 - 60 months and 61 - 120 months. The Lund and Browder chart was used for descriptive analysis of TBSA burned in each age group (per year), with the extent of burn injuries classified as <20%, 21 - 40% and >40%. The mechanism of burns was categorised as hot water (including hot porridge and rice), hot oil, flame and electrocution.

Statistical analysis

Data were entered into a spreadsheet and analysed using Statistica version 13.0 (TIBCO Software Inc., USA) and Stata version 15.1 (StataCorp LLC., USA). Continuous variables are reported as medians, ranges and interquartile ranges (IQRs) and categorical variables as percentages. Statistical differences between groups were analysed using log-rank analysis and Kaplan–Meier curves were determined for each variable per group to determine the survival per group. A significance level $p<0.05$ was used.

Ethical considerations

Approval for the study was obtained from the Human Research Ethics Committee of the University of the Witwatersrand prior to data retrieval and analysis of patient records (ref. no. M170411).

Results

The total number of admissions into the paediatric burns' unit (inclusive of ICU admissions) over the study period was 2 506 patients. Of these, 428 were admitted to the PBICU, with 312 (72.90%) as direct admissions from the emergency department and 116 (27.10%) as transfers. A total of 109 deaths occurred, which equates to 25% of total PBICU admissions (*N*=428). Of these deaths, 58 were from direct admissions (*n*=312; 18.59%) and 51 were from transferred cases (*n*=116; 43.97%). The admission and outcome profile is shown in Table 1. The median age across all admissions to the PBICU was 23 months (IQR 12 - 36 months). The median extent of burns was 24% (IQR 15 - 30%) and the median length of stay was 14 days (IQR 6 - 26 days) in both direct admissions and transfers. The $\chi 2$ statistic showed a significant difference in survival rate between direct admissions and transferred patients ($p<0.01$). As shown in Table 2, scalds accounted for most injuries (*n*=338/428; 78.97%) and were associated with 27 (7.99%) mortalities among transferred patients and 46 (13.61%) mortalities among direct admissions ($p<0.01$). In the unknown category, 2 (22.22%) mortalities in the direct admissions category and 1 (11.11%) mortality in the transferred category occurred. Of the 67 patients admitted with flame burns, 21 (31.34%) deaths were recorded among transferred patients and 9 (13.43%) among the directly admitted patients.

Table 1. Admission and outcome profile of patients admitted to the PBICU at the CHBAH, 2013 - 2017 (*N*=428)

Characteristic	Total admissions (*N*=428)	Direct admissions (*n*=312)	Transfers (*n*=116)	*p*-value
Age (months), median (IQR)	23 (12 - 36)	22 (15 - 48)	24 (12 - 36)	0.02
TBSA of burns (%), median	24	20	26	<0.01
LOS (days), median	14	13	15	0.75
Mortality, *n* (%)*	109	58 (18.59)	51 (43.97)	<0.01

PBICU = paediatric burns intensive care unit; CHBAH = Chris Hani Baragwanath Academic Hospital; IQR = interquartile range; TBSA = total body surface area; LOS = length of stay.
*Percentages are calculated from the number of admissions per group.

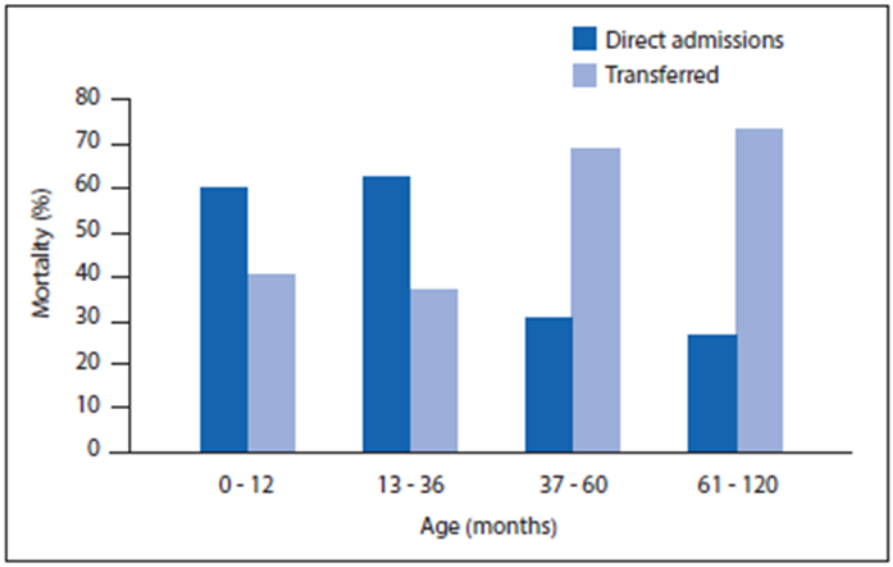

Fig. 1. Mortality of burns patients according to age group.

Table 2. Breakdown of outcomes according to mechanism of injury per patient group

Mechanism of injury	All patients (*N*=428), *n* (%)	Direct admissions		Transfers		*p*-value
		Survived, *n* (%)	Died, *n* (%)	Survived, *n* (%)	Died, *n* (%)	
Hot water	338 (78.97)	216 (63.91)	46 (13.61)	49 (14.50)	27 (7.99)	<0.01
Hot oil	4 (0.94)	1 (25.00)	1 (25.00)	2 (50.00)	0 (0)	0.32
Flame	67 (15.65)	27 (40.30)	9 (13.43)	10 (14.93)	21 (31.34)	<0.01
Electrocution	10 (2.33)	6 (60.00)	0 (0.00)	2 (20.00)	2 (20.00)	0.16
Unknown	9 (2.10)	-	2 (22.22)	-	1 (11.11)	-

There was an increasing trend in the number of transferred admissions across the 5-year study period whereas the number of direct admissions remained more stable, except in 2015 when the number of direct admissions declined to 51 (Table 3). In the direct admissions cohort, the highest number of deaths (*n*=15/65; 23.08%) was observed in 2016, followed by a subsequent decline to prior levels. Mortalities among transferred patients were consistently and substantially higher than among direct admissions. As shown in Fig. 1, a higher number of mortalities was reported among direct admissions between the ages of 0 and 36 months (combined numbers from the age groups 0 - 12 months and 13 - 36 months) compared with mortalities in this age group among transferred patients, with scalding reported as the most common mechanism of injury (Table 2). The highest mortality was seen in transferred patients between 61 and 120 months old, possibly owing to the nature of burns sustained.

As shown in Table 4, burns affecting >40% TBSA were associated with higher mortality among transferred patients (61.76%) than directly admitted patients (38.24%). A higher

percentage of mortalities was recorded among the direct admissions cohort (70.00% and 53.33%) than among transferred patients (30.00% and 46.67%) when the extent of burns affected <40% TBSA. Significantly more mortalities were recorded among transferred patients across all injury extents than among directly admitted patients (p<0.01). The outcome of patients who had sustained scalding and flame injuries (p<0.01) was significantly different in both cohorts (Table 2). Transferred patients with flame and scald burns (n=21; 67.74% and n=27; 35.53%, respectively) had a worse outcome compared with those who were directly admitted (n=9; 25.00% and n=46; 17.56%, respectively).

Table 3. Trends in burn-related admissions and mortalities between 2013 and 2017 according to admission type

	2013		2014		2015		2016		2017		Total	
Variable	D/A	T/F	D/A	T/F	D/A	T/F	D/A	T/F	D/A	T/F	D/A	T/F
Admissions, *n*	69	11	67	17	51	20	65	26	60	42	312	116
Mortalities, *n* (%)	14 (20.29)	10 (90.91)	11 (16.42)	6 (35.29)	8 (15.69)	10 (50.00)	15 (23.08)	11 (42.31)	10 (16.67)	14 (33.33)	58 (18.59)	51 (43.97)

D/A = direct admission; T/F = transfer.

Table 4. Outcome according to extent of burn injuries per admission group (N=428)

Extent of burn injuries*	All admissions (N=428), *n* (%)	Direct admissions		Transfers		
		Survived, *n* (%)	Died, *n* (%)	Survived, *n* (%)	Died, *n* (%)	*p*-value
<20% TBSA	215 (50.23)	159 (85.95)	21 (70.00)	26 (14.05)	9 (30.00)	0.16
21 - 40% TBSA	157 (36.68)	83 (74.11)	24 (53.33)	29 (25.89)	21 (46.67)	0.15
>40% TBSA	47 (10.98)	7 (53.85)	13 (38.24)	6 (46.15)	21 (61.76)	0.57
Total	428	249 (58.18)	58 (13.55)	61 (14.25)	51 (11.92)	<0.01

*The extent of the burn injuries was unknown in 9 of the 428 total admissions (2.10%).
TBSA = total body surface area.

Discussion

Six recognised centres for managing burns of an extensive nature were available in the SA public healthcare sector in 2011, and 17 centres by 2018.[9] These facilities provided 511 beds, with reported annual admissions exceeding 8 140.[2,5,9] At CHBAH, a seven-bed PBICU caters for an estimated population of 4 million (both adults and children), as well as for patients referred from various institutions elsewhere in the Gauteng province and its surrounds.[10] In our unit, the number of direct admissions was significantly higher than transferred patients (n=312 v. n=116), although the mortality of transferred patients was significantly higher (18.59% among direct admissions v. 43.97% among transfers, p<0.01). These differences may be attributed to various factors, including delays in presentation to the hospital, patient referral, ambulance transport, wound cover and treatment of underlying

sepsis, and fluid resuscitation with resultant hypothermia, acidosis and shock.[11] The current study did not focus on analysing the effects of these factors on patient outcomes, but literature suggests that they may be associated with negative effects.

The process of interhospital transfer of critically ill patients carries a risk of morbidity.[8,12] In addition, long transfer distances and other transport-related challenges often result in a prolonged time between acceptance of patients to arrival at the tertiary institution, which is often associated with less favourable outcomes.[13] Scribante and Bhagwanjee[11] reported significant differences in transfer of critically ill patients to intensive care units (ICUs) in SA (0.3 - 6 hours on average), highlighting the need for improvement in this regard.[11,13]

We observed an upward trend in the number of transferred patients admitted to our unit over the 5-year study period, which may be attributed to a lack of specialised burns and critical care facilities being available or a lack of skills or resources to manage such patients elsewhere.[14] In an audit by Rode *et al.*,[14] secondary hospitals in the Western Cape reported a lack of surgical time, problems with equipment (often old or dysfunctional), a shortage of ICU facilities and no access to burn wound technology and dressings in treating burns patients, compounded by no capacity to isolate patients and both adults and children having to be accommodated in a common surgical ward. Similar observations were noted in other studies in developing countries in Africa, which reported that patients admitted into general wards in primary or secondary healthcare institutions will most likely experience compromised burns care owing to a lack of isolation, a risk of infection, a shortage of drugs, delayed skin grafting and a lack of resuscitation equipment. [3,15] These resource constraints lead to poorer outcomes.[2]

Age, extent of the burn injuries, mechanism of injury, burn depth, presence of inhalational injury, sepsis and clinical status at the time of referral are all individually associated with mortality.[6,16] Age below 5 years is a risk factor for mortality in our unit,[6] which is supported by observations from international studies citing age below 4 years as a considerable risk factor.[3,17-19] In our study, higher mortality was seen among directly admitted patients with hot-water burns who were younger than 36 months than among transferred patients in this category.[1] This can be explained by the postulated effects of urbanization seen in a densely populated area such as Soweto. It is well documented that serious burns render the paediatric patient more susceptible to various infection-related complications, whether brought on by local or systemic factors.[19] Local factors such as

thinner skin, open wounds, incompetent gut barriers, invasive devices (e.g. endotracheal intubation, central venous catheterisation, arterial lines and transurethral catheters) potentiate this risk.[15,19] Systemically, there is an overall reduced cellular immunity associated with burns, especially in the younger population.[19]

Sepsis has been reported as the leading cause of mortality in burns patients. [1,19,20] Although septic complications were not analysed in this study, we noted that sepsis management, especially of drug-resistant bacteria, is a challenge in our unit. Other risk factors related to mortality in the paediatric population may include delay in fluid resuscitation, which is measured as time to intravenous fluid administration.[15] A lesser physiological reserve, technical difficulties with intravenous access and a smaller margin for error in fluid administration have also been identified as contributing factors in increased mortality.[15]

In the age group 61 - 120 months, more admissions and associated mortalities were noted among transferred patients than in direct admissions and mostly among those affected by flame injuries. This pattern was also described by Van Niekerk *et al.* [21] at the Red Cross War Memorial Children's Hospital, noting an 'over-representation' of flame burns among older children. Aggressive resuscitative and ventilatory requirements, a greater extent or depth of injury, and a need for earlier and multiple surgical interventions are often associated with flame-induced burns.[16,22,23] In the acute phase, these injuries may require prompt intervention, including escharotomy or early excision with subsequent grafting.[23] Inhalational injury, which is often associated with flame burns, results in an inflammatory cascade predisposing to pneumonia and which directly affects the circulatory response, leading to increased resuscitative fluid requirements and subsequently morbidity and mortality.[22]

In 2012, Jugmohan *et al.* [6] concluded that at the PBICU at CHBAH, significant risk factors for burn-associated mortality included age <5 years, presence of inhalational injury, extent of burn injuries exceeding 30% and admission into the PBICU. Admission into the ICU itself is a risk factor due to the substantial associated severity of burns (with regard to total extent and depth), inhalational injury (which may require mechanical ventilation), acute respiratory distress syndrome, multi-organ dysfunction syndrome, sepsis and more aggressive operative intervention.[6] In our study, more flame-induced burns (with possible inhalation components) and a greater extent of injury (measured as TBSA affected) were seen in

transferred patients compared with directly admitted patients and were most likely to require critical care services and surgical intervention. This can be translated to the significant number of mortalities observed among transferred patients. It has been documented, both in our unit and in the literature, that patients with burns affecting >60% TBSA have a 100% mortality rate, irrespective of whether there is an associated inhalational component.[6,24] Similarly high mortality rates have been reported in a study from Brazil (80% mortality in patients with burns affecting >50% TBSA)[25] and Nepal (95% mortality in patients with burns affecting >40% TBSA).[26] These reports are in line with findings from a prospective analysis in a tertiary paediatric burns centre in India, in which Dhopte *et al.*[27] concluded that the greater the extent of burn injury (expressed in terms of TBSA), the higher the risk of mortality. This was also observed in our study among transferred patients.

However, a higher risk of mortality was seen among directly admitted patients with burns affecting <40% TBSA than in the transferred group. Patients younger than 48 months and with burns affecting >30% TBSA have been reported to have a higher mortality risk and do not tolerate such burns well.[15]

In our unit, multidisciplinary team involvement is paramount in improving outcomes and includes general surgery, plastic surgery, physiotherapy, speech therapy, occupational therapy, dietetic consultation and services by allied healthcare professionals.

Study limitations

The data reported here are from a single centre and the numbers in some categories were too small for drawing definitive conclusions. The higher mortalities seen among transferred patients were not analysed in relation to factors such as transport, resuscitation, early presence of systemic inflammatory response syndrome, sepsis or ventilatory factors, as it was not an objective of this study. However, we argue that the findings from this high-volume centre may reflect trends in other burns units nationally.

Conclusion

Our study showed a statistically significant difference in the outcomes between patients admitted directly from the emergency department and those referred from other institutions. Among transferred patients, those older than 60 months, presenting with burns affecting >40% TBSA or who had flame-induced burns were at higher risk for mortality. This contrasts

with risk factors for mortality seen among directly admitted patients, namely age <36 months, extent of injury <40% TBSA or burns caused by scalding.

Burn-related injuries are devastating, with lifelong consequences, and are largely preventable in the home environment. Intervention is required at this level, as well as at various levels of healthcare to avoid poor outcomes in patients who present with burn injuries. Further studies are required to identify individual risk factors for targeted intervention to improve these outcomes.

Declarations. None.

Acknowledgements. The authors acknowledge the staff of the CHBAH paediatric surgical unit, intensive care unit and the allied healthcare professionals for their care of patients and efforts to improve their outcomes.

Author contributions. All authors contributed to the study design, data collection, analysis and interpretation, manuscript development and its critical revision.

Funding. All research for this article was self-funded by the principal investigator and the Department of Paediatric Surgery, University of the Witwatersrand.

Conflicts of interest. None.

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APPENDIX

R14/49 Dr Noxolo Zekhethelo Mashavave

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M170411

NAME: (Principal Investigator)	Dr Noxolo Zekhethelo Mashavave
DEPARTMENT:	General Surgery Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	A Retrospective Study in Paediatric Burns Mortality and Morbidity Outcomes in ICU Patients from Referral Centres and Surrounding Centres in Soweto
DATE CONSIDERED:	05/05/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Linda Doedens
APPROVED BY:	Professor CB. Penny Co-Chairperson, HREC (Medical)
DATE OF APPROVAL:	19/09/2017

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 10004,10th floor, Senate House/3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially review April and will therefore be due in the month of April each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Protocol with extended literature review

TITLE: A retrospective study analysing mortality and outcomes in the paediatric burns intensive care unit at the Chris Hani Baragwanath Academic Hospital, Johannesburg

For the purpose of submission for the degree of MMed

Masters Candidate: Dr Noxolo Mashavave 0700226F

Supervisors:

Prof Jerome Loveland MB ChB, FCS (SA), Cert Paed Surg (SA). Paediatric surgeon CHBAH/ Sandton Mediclinic

B Jugmohan MB ChB, FCS (SA), MMed Surg (Wits), Cert Gastro Surg (SA). Sandton Mediclinic

A Withers MB BCh. Research division Paediatric Surgery CHBAH

L Doedens MB ChB, FCPaed (SA), Crit Care. Critical care specialist

1.1 INTRODUCTION

One of the leading causes of morbidity and mortality in the paediatric population can be attributed to burns-related injuries(1). In South Africa an estimated 1300 children die annually due to burns(2). Globally, the 4th most common cause of trauma is due to burns and children contribute more than 50% due to severe burn injury(3). Most frequently, the skin is involved, compromising its' integrity and function as a barrier to infection and for thermoregulation(4). It has been well-documented that in South Africa, a majority of burns are sustained in the household and poor socio-economic conditions are a contributory factor(5, 6).

The Johnson and Johnson Chris Hani Baragwanath Paediatric Burns Unit is a specialized, multidisciplinary 24-hour referral centre located in Soweto, Johannesburg. It caters for paediatric patients, both male and female from 0 to 10 years of age from Gauteng. The Paediatric Burns Unit (PBU) has 7 ICU beds and 24 general ward beds. The multidisciplinary team includes paediatric intensive care specialists, paediatric surgeons, trainee paediatric and general surgeons, physiotherapists, occupational therapists, dieticians, plastic surgeons and anaesthetists. The PBU admits walk-in patients from Soweto received from the emergency department and surrounding areas and referrals from Gauteng and the North-West Province.

Annually, the paediatric burns unit admits approximately 450- 600 patients, with an estimated 10% admitted into ICU(7). The main reason for referral to an intensive care unit includes management of moderate to critically ill burns patients requiring intensive care with specialized care where equipment, facilities and personnel for intensive monitoring and life-sustaining organ support are available until the patient recovers, wounds appropriately managed to discharge to be managed on an outpatient basis.

1.2 AIM

To compare outcomes of paediatric burns patients admitted into the Paediatric Burns Unit at the Chris Hani Baragwanath Academic Hospital from distant referral centres, and those admitted directly from casualty or from surrounding healthcare centres.

1.3 OBJECTIVES

1. To establish the aetiology and extent of injury of burns patients admitted into the PBICU
2. To determine mortality rates and outcomes of locally referred burns patients
3. To determine mortality rates and outcomes of burns patients referred from outside the region of Soweto

1.4 LITERATURE REVIEW

Survival outcomes in burns patients are mainly dependent on the age, severity (depth and percentage) of burn, presence of inhalational injury, fluid resuscitation, presence of sepsis and critical care management after the initial resuscitation period(8). Mortality from burns can occur immediately post injury or at a later stage, from sepsis and multiorgan failure(8, 9). There have been many advances in modern therapy but burns in infants and children more than 30% total body surface area (TBSA), particularly in low- and middle-income countries, have proven to be lethal (even in the absence of inhalational injury)(8).

Care at different levels before referral to a tertiary institution are crucial(10). If excessive burden is placed on to the next level in this tiered service system, resultant disintegration which is expressed in increased morbidity and mortality rates is inevitable(10). “Identification of a critically ill child, resuscitation, transfer and ICU admission” were stages that were observed before paediatric ICU admissions in Cape Town with 74% cases noted to have had shortcomings in their management(11). At secondary level hospitals, the major challenge encountered was shortage of intensive care unit beds(10).

At our centre, all cases are discussed with the paediatric intensivist before transfer from the base hospital. On arrival, the junior registrar/ medical officer reassesses the patient and decides on further management in conjunction with the paediatric intensivist. The total body surface area is calculated using the Lund and Browder chart or the palmar method(12). Discrepancies regarding patients' assessments have been noted from referral centres (7). Paediatric patients who have sustained more than 15% total body surface area burns require intravenous fluids as per our unit protocol. Care of such patients requires understanding of their physiology, anatomy and the extent of their injury(13).

Multiple factors prompt referral of patients to specialised treatment facilities and the criteria are extrapolated from the American Burns Association which include:

1. Partial thickness burns greater than 10 % total body surface area.
2. Burns that involve the face, hands, genitalia, perineum, or major joints.
3. Full thickness burns in any age group.
4. Electric burns, including lightning injury.
5. Chemical burns.
6. Inhalation injury.
7. Burn injury in patients with preexisting medical disorders that could complicate management.
8. Any patient with burns and concomitant trauma (such as fractures) in which the burn injury poses the greatest risk of morbidity or mortality. In such cases, if trauma poses a greater immediate risk, the patient may be initially stabilized in a trauma center.

9. Burned children in hospitals without qualified personnel or equipment for the care of children.
10. Burn injury in patients who require special social, emotional, or rehabilitative intervention.

Table 1: Burn management in Paediatric patients(14)

The admission criteria at Chris Hani Baragwanath Academic Hospital Paediatric Burns ICU includes: age groups from birth to 10/11 years, all inhalational burns within the first 48 hours, electrical burns, burns associated with a fracture or any other major injury or with evidence of more than one organ system dysfunction, children over one year of age with more than 20% partial thickness or greater burn and infants under one year of age with more than 15% partial thickness or greater burn. The respiratory criteria include: endotracheal intubation or potential need for emergency tracheal intubation; high supplemental oxygen requirement > 60% to maintain PaO2 more than 60mmHg; newly placed tracheostomy with or without need for ventilation and inhalational burns injury. The cardiovascular criteria include: Need for inotropes/ vasopressors; Life-threatening dysrhythmias; shock or need for support for circulatory instability. The renal criteria include: renal failure; rhabdomyolysis secondary to massive burn and hyperkalaemia requiring cardiac monitoring and therapeutic intervention.

The first 24-48 hours are the crucial for a burn patient to receive intensive fluid resuscitation- which is a major prognostic indicator(15). Initial assessment and treatment are instituted using Advanced Trauma Life Support guidelines of the American College of Surgeons Committee on trauma(15). It has been shown that patients receiving resuscitation within the first hour after the burn injury have significantly higher chances of survival(6, 16). Mortality increases and resuscitation becomes more complex if resuscitation is commenced more than 2 hours after a burn(17, 18). In severe burns, sepsis and respiratory failure account for 40-50% of all deaths(9). Fluid resuscitation remains the cornerstone but may not completely normalize physiology due to ongoing cellular and hormonal shifts(17). Therefore, resuscitation is tailored to individual needs to avoid fluid overload/ ongoing burn shock(19). Complications such as pulmonary oedema, heart failure, compartment syndrome and progression to full thickness burns occur when excessive fluid is administered(17, 19).

Multiple factors have been implicated to contribute to higher mortality rates in children. These would include lesser physiological reserve in children less than 3 years old, lesser

margin for error in fluid management, potential vascular access difficulties, thinner skin and reluctance to expose young children to stressful excisional burn operations(8, 9). It has also been noted that, children less than 2 years of age with large total body surface area burns do not tolerate such injuries as well as adults do(9). In general, gender, age, burn surface area, presence of inhalation injury, com-morbid disease, co-existing trauma, and pneumonia are regarded as risk factors for mortality in burns patients(9). In India, the higher mortality rates were attributed to low frequency of early excision and grafting, large number of admissions with higher TBSA burns, delayed arrival from referral centres, inadequate treatment during referral, higher number of thermal burns with or without inhalational injuries, and prevalence of multi-drug resistant Acinetobacter, Pseudomonas and Klebsiella species(20). At CHBAH PBU, risk factors for mortality include age less than 5yrs, burn injury more than 30% of TBSA, inhalational injury and admission into PBICU(7). Mortality rates of such patients have been reduced by the introduction of paediatric intensive care specialists and other allied health care practitioners(7). The predictors of outcome common to all studies include total body surface are and mechanism of injury(21).

Children below the age of 5 years account for 50-80% of all childhood burns with scalds dominating (60-70%), followed by flame and contact burns(9, 21). In a retrospective review by Jugmohan et al. from May 2009- April 2012 of 1372 patients admitted into PBU, 283 were managed in PBICU, a mortality rate of 7.9% (109 deaths) was established, most of which were from hot water burns(7). The median age of admission at CHBAH PBU was 3.0 years(7, 9). The mortality rate is noted to be greater in males mirroring the increased ratio of 2:1 to females(9).

Scald and flame burns are the most common mechanisms of injury as they are sustained in the household environment(6). Increased in-hospital mortality in patients with flame burns has been observed in LMICs(22). This is related to the larger and deeper body surface area involved and inhalational injuries sustained. Purcell et al concluded that flame burns resulted in almost a 3-fold increase in odds of in-hospital mortality compared to scald burns(23). The definition of inhalational injury includes presence of a positive history of being in an enclosed space, clinical features including singed eyebrows, soot in the nostril, laryngeal oedema and facial burns that indicate a possibility of inhalational injury(12). Dhopte et al noted that higher mortality rates were observed in patients with full thickness burns and those with inhalational injury(20). Inhalational injury is associated with higher mortality rates and can be viewed as an independent predictor of mortality in children(20). In a study by

Odeyinde et al, the mortality rate was 62.9% in patients with inhalational injury compared to 11.4% without inhalational injury(24). Forty to fifty percent of mortalities are attributed to acute lung injury and acute respiratory distress syndrome (ARDS)(21).

In patients with TBSA burns of 25-50%, the risk of mortality was found to increase 21 times and for those with TBSA of 50-75%, the risk of mortality increased by 136 times(20). Recent studies have demonstrated that patients with burns above 60% TBSA did not survive (only 2 cases have been documented since 2012) in this unit(7). Eighty-five percent of these deaths occurred in PBICU and the rest occurred in the general ward(7). The same observation was made by Dhopte et al that an increase in TBSA significantly increased mortality, with a mortality rate of 100% in patients with a TBSA of more than 70%(20). This study firmly established the role of TBSA in the mortality in children(20).

PROBLEM STATEMENT

Currently there is no literature comparing mortality and outcome trends of paediatric burns ICU patients referred from distant referral health centres to those treated ab-initio or referred from centres in close proximity.

RESEARCH METHODOLOGY

1. Design
    - This will be a retrospective study
2. Setting
    - The Johnson and Johnson Chris Hani Baragwanath Academic Hospital, Paediatric Burns Intensive Care Unit
3. Study population
    - Paediatric Burns patients from birth until 10 years of age
    - Exclusion criteria: incomplete records, patients who are re-admitted after being discharged
4. Study Period
    - January 2010 to December 2016

SAMPLE SIZE

- Approximately 300 patients in the 6-year period.

DATA COLLECTION

After obtaining ethical approval, data from the patient hospital records and those preserved by the units' statistician will be gathered. This will give information regarding patients' age, gender, demographics, health facility transferred from, percentage and depth of burns, length of stay in ICU, presence of inhalational burns, duration of mechanical ventilation, outcome in ICU thereafter.

DATA ANALYSIS

Data will be captured in an Excel spreadsheet. A statistician will assist with data analysis.

ETHICAL CONSIDERATIONS

- Written consent for data collection will be obtained from the Paediatric Surgery Head of Department at Chris Hani Baragwanath Hospital
- The Human Research Ethics Committee and postgraduate committee of Wits University will have to approve to this protocol prior to any further research or data collection.
- Patient confidentiality will be respected at all times. Only the researcher and supervisors will have access to patient records. No patient names or hospital reference numbers will be recorded in research reports. Once research has been completed, supervisors will be responsible for safe storage of these records.
- No informed consent will be obtained as this is a retrospective study
- Patient records will be kept for a period of 5 years pending publication or 2 years after publication.

LIMITATIONS

- Accessibility of patient records from the specified time period (2010- 2016)

- Detailed documentation of burns and first time of contact with a health facility or initial management may be difficult to obtain.

PROJECT OUTLINE

Funding

- All financial requirements for this study will be met by the researcher. These requirements will include printing, copying, filing of the proposal and research report. Statistical analysis will be captured electronically and assistance obtained from the Wits University Research Department- thus no additional costs will be incurred.

TIME FRAME

Data collection and further research will commence in 2017 after Ethics and postgraduate committees approve of this study.

TIME PLAN

Time line

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Literature review																				
Preparing protocol																				
Protocol assessment																				
Ethics application																				
Data collection																				
Data analysis																				
Report write-up																				
Report submission																				

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AUTHOR GUIDELINES

South African Journal of Child Health (SAJCH) author guidelines

The following author guidelines are quoted directly from the SAJCH website at http://www.sajch.org.za/index.php/sajch/about/submissions#authorGuidelines (Accessed in January 2021).

General article format/layout:

Submitted manuscripts that are not in the correct format specified in these guidelines will be returned to the author(s) for correction prior to being sent for review, which will delay publication.

General:

- Manuscripts must be written in UK English (this includes spelling).
- The manuscript must be in Microsoft Word or RTF document format. Text must be 1.5 line spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes). Pages and lines should be numbered consecutively.
- Please make your article concise, even if it is below the word limit.
- Qualifications, ***full*** affiliation (department, school/faculty, institution, city, country) and contact details of ALL authors must be provided in the manuscript and in the online submission process.
- Abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.
- Scientific measurements must be expressed in SI units except: blood pressure (mmHg) and haemoglobin (g/dL).
- Litres is denoted with an uppercase L e.g. 'mL' for millilitres).
- Units should be preceded by a space (except for % and ºC), e.g. '40 kg' and '20 cm' but '50%' and '19ºC'.
- Please be sure to insert proper symbols e.g. µ not u for micro, a not a for alpha, b not B for beta, etc.
- Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160.

- Quotes should be placed in single quotation marks: i.e. The respondent stated: '...'
- Round brackets (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes.

If you wish material to be in a box, simply indicate this in the text. You may use the table format –this is the *only* exception. Please DO NOT use fill, format lines and so on.

SAJCH is a Journal on child health, therefore for articles involving genetics, it is the responsibility of authors to apply the following:

- Please ensure that all genes are in italics, and proteins/enzymes/hormones are not.
- Ensure that all genes are presented in the correct case e.g. TP53 not Tp53.

** NB: Copyeditors cannot be expected to pick up and correct errors wrt the above, although they will raise queries where concerned.

- Define all genes, proteins and related shorthand terms at first mention, e.g. '188del11' can be glossed as 'an 11 bp deletion at nucleotide 188.'
- Use the latest approved gene or protein symbol as appropriate:
  - Human Gene Mapping Workshop (HGMW): genetic notations and symbols
  - HUGO Gene Nomenclature Committee: approved gene symbols and nomenclature
  - OMIM: Online Mendelian Inheritance in Man (MIM) nomenclature and instructions
  - Bennet et al. Standardized human pedigree nomenclature: Update and assessment of the recommendations of the National Society of Genetic Counselors. J Genet Counsel 2008; 17:424-433: standard human pedigree nomenclature.

Research

Guideline word limit: 3 000 words (excluding abstract and bibliography)

Research articles describe the background, methods, results and conclusions of an original research study. The article should contain the following sections: introduction, methods,

results, discussion and conclusion, and should include a structured abstract (see below). The introduction should be concise – no more than three paragraphs – on the background to the research question, and must include references to other relevant published studies that clearly lay out the rationale for conducting the study. Some common reasons for conducting a study are: to fill a gap in the literature, a logical extension of previous work, or to answer an important clinical question. If other papers related to the same study have been published previously, please make sure to refer to them specifically. Describe the study methods in as much detail as possible so that others would be able to replicate the study should they need to. Where appropriate, sample size calculations should be included to demonstrate that the study is not underpowered. Results should describe the study sample as well as the findings from the study itself, but all interpretation of findings must be kept in the discussion section, which should consider primary outcomes first before any secondary or tertiary findings or post-hoc analyses. The conclusion should briefly summarise the main message of the paper and provide recommendations for further study.

- May include up to 6 illustrations or tables.
- A max of 20 – 25 references

Structured abstract

- This should be no more than 250 words, with the following recommended headings:
    - **Background:** why the study is being done and how it relates to other published work.
    - **Objectives:** what the study intends to find out
    - **Methods:** must include study design, number of participants, description of the intervention, primary and secondary outcomes, any specific analyses that were done on the data.
    - **Results:** first sentence must be brief population and sample description; outline the results according to the methods described. Primary outcomes must be described first, even if they are not the most significant findings of the study.

- **Conclusion:** must be supported by the data, include recommendations for further study/actions.
- Please ensure that the structured abstract is complete, accurate and clear and has been approved by all authors. It should be able to be intelligible to the reader without referral to the main body of the article.
- Do not include any references in the abstracts.

Please ensure that your article includes:

- Abstract: unstructured, of about 100-150 words, explaining the review and why it is important
- Methods: Outline the sources and selection methods, including search strategy and keywords used for identifying references from online bibliographic databases. Discuss the quality of evidence.
- When writing: clarify the evidence you used for key statements and the strength of the evidence. Do not present statements or opinions without such evidence, or if you have to, say that there is little or no evidence and that this is opinion. Avoid specialist jargon and abbreviations, and provide advice specific to southern Africa.
- Personal details: Please supply your qualifications, position and affiliations and MP number (used for CPD points); address, telephone number and fax number, and your e-mail address; and a short personal profile (50 words) and a few words about your current fields of interest.

Illustrations/photos/scans

- If illustrations submitted have been published elsewhere, the author(s) should provide evidence of consent to republication obtained from the copyright holder.
- Figures must be numbered in Arabic numerals and referred to in the text e.g. '(Fig. 1)'.
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- All illustrations (graphs, diagrams, charts, etc.) must be in PDF form.
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- Scans/photos showing a specific feature e.g. *Intermediate magnification micrograph of a low malignant potential (LMP) mucinous ovarian tumour. (H&E stain).* –include an arrow to show the tumour.
- Each image must be attached individually as a 'supplementary file' upon submission (not solely embedded in the accompanying manuscript) and named Fig. 1, Fig. 2, etc.

Tables

- Tables should be constructed carefully and simply for intelligible data representation. Unnecessarily complicated tables are strongly discouraged.
- Large tables will generally not be accepted for publication in their entirety. Please consider shortening and using the text to highlight specific important sections, or offer a large table as an addendum to the publication, but available in full on request from the author.
- Embed/include each table in the manuscript Word file - do not provide separately as supplementary files.
- Number each table in Arabic numerals (Table 1, Table 2, etc.) consecutively as they are referred to in the text.
- Tables must be cell-based (i.e. not constructed with text boxes or tabs) and editable.
- Ensure each table has a concise title and column headings, and include units where necessary.
- Footnotes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || then ** †† ‡‡ etc.

References

NB: *Only complete, correctly formatted reference lists in Vancouver style will be accepted. If reference manager software is used, the reference list and citations in text are to be unformatted to plain text before submitting..*

- Authors must verify references from original sources.
- Citations should be inserted in the text as superscript numbers between square brackets, e.g. These regulations are endorsed by the World Health Organization,[2] and others.[3,4-6]
- All references should be listed at the end of the article in numerical order of appearance in the Vancouver style (not alphabetical order).
- Approved abbreviations of journal titles must be used; see the List of Journals in Index Medicus.
- Names and initials of all authors should be given; if there are more than six authors, the first three names should be given followed by et al.
- Volume and issue numbers should be given.
- First and last page, in full, should be given e.g.: 1215-1217 **not** 1215-17.
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1	N Z Mashavave, A Withers, L Doedens, B Jugmohan, J Loveland. "A retrospective study analysing mortality and outcomes in the paediatric burns intensive care unit at the Chris Hani Baragwanath Academic Hospital, Johannesburg", South African Journal of Child Health, 2020 Publication	88%
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