

**Assessing the Capacity of African Burn Care:
The First Ever Survey of
African Burn Care Centers**

By

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ABSTRACT

OBJECTIVE: Burn injury is still an important cause of morbidity and mortality in low and middle-income countries (LMICs). Despite dramatic advances in burn care over the past 50 years, the standard of burn care in LMICs has lagged significantly behind that which exists in high-income countries. This first ever survey of the capacity, services, and mortality rates and causes in African burn centers allows an initial descriptive review of African centers' progress toward international best practices in burn prevention and burn care.

METHODS: A survey was conducted at the 5th Pan African Burn Society Congress in Accra, Ghana in November 2013. Experts in survey design methodology reviewed the survey tool. Survey questions were based on an expert consensus document on standards of burn care appropriate to LMIC settings and on personal experience with providing burn care in Africa. Results were analyzed with STATA statistical software.

RESULTS: Seventy-nine attendees participated in the survey. Thirteen countries from four African regions were represented. Eighty-seven percent of the respondents worked in urban settings and 80% in tertiary referral centers. Among those surveyed, 52% were nurses and 34% were physicians. Burns/plastic surgery was the leading specialty represented (47%). The majority of respondents reported adequate access to blood and blood products (63%). More than half of providers had access to most specialized burn support services (pediatric providers 54%, dedicated burn nurses 66%, nutritional support 76%, physiotherapy 87%, reconstructive surgery 80%, and post-hospital follow-up 62%) but fewer had access to rehabilitation (44%). Treatment protocols were noted to be in place by the majority of respondents (fluid resuscitation 85%, pain control 68%, wound care 78%, and splinting/positioning 60%). Adequate burn operative time was not widely available, with only 30% of respondents reporting a dedicated burn operating room and 74% reporting an average of 5 or fewer burn operative cases per week. The most common procedures were skin grafts, mentioned by 61% of respondents, and debridements, mentioned by 44% of respondents. Regarding burn survival, the most commonly

cited estimated mortality rate was 10-29%, mentioned by 45% of respondents, with infection and delayed presentation being reported as most common causes of death by 46% and 27% of respondents, respectively. Closed wound care predominated in this context, with open wound care being reserved for facial and perineal burns. Sixty-three percent of respondents reported initiation of antibiotics on admission, while only 34% reported the practice of early excision in their center. The majority of respondents reported that their center is involved in research (61%) and burn training for staff (66%) but less than half provided burn training for staff at district hospitals (43%) or participated in community outreach (43%). Sixty-two percent of respondents were not aware of any public health policies for burn prevention in their countries and 91% of respondents did not believe their government provides adequate funding for burn care.

CONCLUSION: While much work remains to be done before a full picture of the status of burn care in Africa is obtained, this paper provides an initial view into the challenges and opportunities faced by burn care providers across the continent. Our survey shows that despite availability of facilities, specialized providers, and treatment protocols, accepted standards of antibiotic use and early burn excision have yet to be universally adopted. Furthermore, outreach, policy, and support for burn prevention are lacking. These barriers must be addressed to make evidence-based burn care in Africa a reality.

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Introduction and Significance

Burn injury is still an important cause of morbidity and mortality in low and middle-income countries (LMICs), where 90% of the world's burn deaths occur.¹ In addition to the hundreds of thousands of lives claimed yearly, millions more survive and are left to deal with the sequelae of burn injury, which account for the over 19 million disability-adjusted life years attributed to fire and hot substances in 2010.¹ Despite dramatic advances in burn care over the past 50 years, the standard of burn care in LMICs has lagged significantly behind that extant in high-income countries. Understanding the drivers of burn care disparity is crucial to improving the lives of millions burdened by burn injury throughout the world.

This work aims to redress the paucity of information about African burn care capacity and practice by characterizing the current status of burn care in Africa in order to identify and share best practices feasible in the African context.

Background

The primary goal of quality burn care is reduction in morbidity and mortality from burn injury. We can divide the primary drivers of this goal into prevention of injury, improvement of acute care, and improvement of aftercare. A sample of secondary and tertiary drivers is illustrated in Figure 1. Although not comprehensive, this diagram provides an idea of the dimensions of high quality burn care. This study investigates the drivers derived from the “Hospital Care” arm of this diagram.

(FIGURE 1)

The standard of burn care has improved dramatically in the past 60 years. Specialized burn care organized in dedicated burn facilities dates to the 1940s, with the opening of the first two burn centers at the U.S. Army Institute for Surgical Research in Fort Sam Houston, Texas and Virginia Commonwealth University in Richmond, Virginia in 1947.² Since that time, improvements in quality of care have increased the LA50, the total percent body surface area burned that has a 50% chance of death, for a 21 year-old from 40% in 1950 to 90% in 2009.³ The most important of these advances have occurred in fluid resuscitation, topical antimicrobial treatments, surgical technique, nutritional supplementation, understanding of burn pathophysiology, infection control, and multidisciplinary burn care.^{3,4} Advances in the key elements contributing to reductions in burn mortality are described in Table 1.

(TABLE 1)

In LMICs many of these practices have yet to be universally adopted. The World Health Organization and the International Society for Burn Injuries along with other non-governmental organizations, academic institutions, public-private partnerships, and charities have tried to

bridge this gap through education, training, innovations, and research (Appendix 1). In 2012 the international volunteer organization Interburns published “Setting Standards for Burn Care Services in Low and Middle Income Countries”, a comprehensive recommendation of minimal standards of care in LMICs.⁵ The document was developed through consensus by an international panel of burn experts and was intended to serve as a guide specifically for burn care providers in resource-poor settings to equipping and staffing their facilities. “Setting Standards” was used as a guide for the development of the survey used in this project to measure burn care capacity.

Methods

A straightforward survey of stakeholders is the most appropriate research strategy for this descriptive study of the current status of burn care facilities and practices in Africa. To ensure content validity, I designed the questionnaire based on Interburn's expert consensus document on standards of burn care appropriate to LMIC settings and on the author's personal experience with providing burn care in Africa, in close collaboration with the author's two readers and advisors. The result was a 31-item questionnaire with a combination of yes/no and multiple choice questions. Multiple choice questions for which certain answers were expected to be most common but other responses were possible and could provide further insight contained an additional "other" answer choice with space to write in free text. Experts in survey design methodology from the University of North Carolina's Gillings School of Global Public Health and Howard W. Odum Institute for Research in Social Science reviewed the survey tool for comprehensibility, language, and formatting. The project was approved by the UNC Institutional Review Board and by representatives of the Pan-African Burn Society. The cover letter and survey instrument can be seen in Appendix 2.

The survey was conducted among participants at the 5th Pan African Burn Society Congress in Accra, Ghana in November 2013. The Pan African Burn Society was founded in 2004 with the mission of preventing burns; encouraging the highest standards of burn care; disseminating knowledge and encouraging involvement in each African country; and offering leadership and advice that is appropriate for African countries (PABS website <http://www.pabs.co.za/index.html>). Members include physician and non-physician burn care providers from across the African continent as well as those from other nations who support the PABS aims, making the PABS Congress the largest gathering of burn care providers in Africa. Furthermore, 2013 was the first year the nations of Francophone Africa were in attendance. For these reasons, PABS Congress participants are a representative convenience sample of burn care providers in Africa. To maximize the response rate, the author distributed the paper survey

along with an explanatory cover letter describing the purpose, process, and consent details of the survey to all conference attendees as they checked in at registration on the first day of the conference. The survey was announced by the conference organizer during the conference sessions and in the between-session informational slide presentation in the conference room. Respondents returned completed surveys into an envelope kept by personnel at the registration desk. As an incentive for participation, participants returning completed surveys were entered into a raffle to win an iPod Shuffle.

The survey does not collect any personally identifying or sensitive data. The surveys were handled personally by the study author only. The author entered the data into an online version of the survey instrument using Qualtrics (Qualtrics. 2009. Qualtrics version 12,018. Provo, Utah.). The electronic database was password protected and kept on a secure laptop. The author then exported and analyzed the data with Stata/C 13 statistical software (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP.). The author created the map of participating countries in ArcMap 10 (ESRI (Environmental Systems Resource Institute). 20011. ArcMap 10. ESRI, Redlands, California.).

Findings

Participants: The survey was distributed to all attendees. Thirteen countries from four African regions were represented. Among those surveyed, 52% were nurses and 34% were physicians. Burns/plastic surgery was the leading specialty represented (47%), with general surgery being second-most common (16%). Participants had varying levels of experience, from less than 5 years to over 20 years in practice.

(FIGURE 2, TABLE 2)

Facilities: Eighty-seven percent of the respondents worked in urban settings. Hospital size varied widely, from fewer than 100 beds to over 1000 beds. Eighty percent of participants reported their hospital was a tertiary referral center. Number of burn patients treated at their institution per year varied among respondents, with 42% reporting less than 200 patients, 30% reporting 200-500 patients, 16% reporting 500-750 patients, and 7.6% reporting over 750 burn patients treated. Number of burn admissions per year varied similarly, with 46% reporting less than 200 admissions, 36% reporting 200-500 admissions, 10% reporting 500-750 admissions, and 2.5% reporting more than 750 burn admissions per year. Patient population also varied among participants, with 13% reporting mostly children, 23% reporting mostly adults, and 63% reporting they saw roughly equal numbers of adults and children.

(TABLE 3)

Services: The majority of the respondents worked at a facility with a dedicated burn unit (70%) and the majority of these (82%) were medium in size, with 6 to 24 beds. The majority of respondents reported adequate access to blood and blood products (63%), but most did not have an intermediate-level care unit (53%), an intensive care unit (51%) or a dedicated burn

operating room (70%). More than half of providers had access to most specialized burn support services (pediatric providers 54%, dedicated burn nurses 66%, nutritional support 76%, physiotherapy 87%, reconstructive surgery 80%, and post-hospital follow-up 62%) but fewer had access to rehabilitation (44%). Treatment protocols were noted to be in place by the majority of respondents (fluid resuscitation 85%, pain control 68%, wound care 78%, and splinting/positioning 60%).

(TABLE 4)

Wound care: Closed wound care predominated in this context, with 90% of participants reporting less than 10% open wound care in their center, which was reserved for facial and perineal burns. Sixty-three percent of respondents reported initiation of antibiotics on admission, followed by 28% reporting antibiotic initiation on clinical evidence of infection. Only 34% of participants reported the practice of early excision in their center. The timing of the early excision ranged from 24-48 hours (10%), to 48-96 hours (3.8%), to 5-7 days (10%), to within two weeks (10%).

Adequate burn operative time was not widely available, with only 30% of respondents reporting a dedicated burn operating room and 74% reporting an average of 5 or fewer operative burn cases per week. The most common procedures were skin grafts, mentioned by 61% of respondents, and debridements, mentioned by 44% of respondents.

(TABLE 5, FIGURE 3, FIGURE 4)

Mortality: The most commonly cited estimated mortality rate was 10-29%, mentioned by 45% of respondents, followed by less than 10% estimated mortality (28%) and 30-50% estimated mortality (24%). Infection and delayed presentation were reported as most common causes of

death by 46% and 27% of respondents, respectively. Other causes of death mentioned by participants were inadequate resuscitation (9.3%), malnutrition (6.2%), financial constraints (6.2%), multiple organ failure (3.1%), and inhalation injury (2.1%). The majority of respondents (65%) considered over 50% of total body surface area burned as being an unsalvageable injury.

(FIGURE 5, FIGURE 6, TABLE 6)

Public health: The majority of respondents reported that their center is involved in research (61%) and burn training for staff (66%) but less than half provided burn training for staff at district hospitals (43%) or participated in community outreach (43%). Sixty-two percent of respondents reported the presence of a director in charge of quality improvement for burn patients at their center. Sixty-two percent of respondents were not aware of any public health policies for burn prevention in their countries. Ninety-one percent of respondents did not believe their government provides adequate funding for burn care.

(TABLE 7)

Discussion

The results of this survey provide a useful description of the status of burn care in Africa. A few items deserve special mention. A plurality of the burn care providers surveyed had plastic surgery or burn training. This finding is in keeping with burn care patterns in Europe, where plastic surgeons are primarily responsible for burn centers. More surprising was the finding that a few of those surveyed responsible for burn units were anesthesiologists or critical care specialists, with no surgical training and limited access to surgical specialists, which curtails the ability to provide timely surgical burn care. The abundance of specialized services and scarcity of advanced amenities is consistent with a region with greater human resources than material ones. Existence of treatment protocols in the centers of a majority of the respondents indicates wide recognition of accepted burn care practices. However, early antibiotic administration and paucity of early excision reflect departures in hospital culture and environment from the practices of other regions. Respondents' most commonly cited estimated mortality of 10-29% is consistent with actual mortality rate of 18.5% calculated at the burn center of the author's affiliation,(Tyson) and is in sharp contrast to burn mortality in the United States, most recently estimated at 3.3%.(NBR 2014) Although it is not surprising that respondents cited infection as the most common cause of death, it is notable that enough participants spontaneously added "financial constraints" in the "other" category of this question to allow it to tie for fourth most common cause of death. Despite not being a direct cause of death, this response is indicative of the struggles underlying burn mortality in this region. The low level of involvement in outreach, lack of knowledge about public health policies for burn prevention, and perception of inadequate funding for burn care among participants further underscore the need for community-level and structural-level public health interventions in this region.

In order to take the results of this study a step beyond descriptive analysis, it would be necessary to draw a comparison between the practices observed in this population and accepted standards of burn care. In the United States, standards of burn care quality have

largely been the purview of the American Burn Association (ABA). Established in 1967, the ABA is “dedicated to improving the lives of everyone affected by burn injury.”⁶ The ABA published Practice Guidelines for Burn Care in 2001.⁷ Since 2001, a handful of updates on specific topics have been published as separate manuscripts in the Journal of Burn Care and Research,⁸⁻¹⁵ with the ultimate goal of publishing updates on all 13 original standards as well as standards on six additional topics.¹⁶ A caveat about these guidelines, however, must be considered.

Evidence-based medicine can be defined as “the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients.”^{17(p71)} Since its widespread adoption into the professional medical ethos, different fields and subspecialties have incorporated EBM into their practice with varying degrees of success. Burn care is one of the fields, however, in which EBM has struggled to take root. Fully realizing this, and in hopes of stimulating future high-quality research in burn care, the authors of the ABA’s 2001 Practice Guidelines follow many of the best practices required in the development of trustworthy guidelines.^{7,18} Nonetheless, of the 18 topics on which practice guidelines have been published from 2001 to the present, only two of these were deemed as having sufficient evidence to formulate a standard (Appendix 3).⁷⁻¹⁴ Taking into account these limitations even in the United States, it is easy to understand the difficulties of developing and adhering to practice standards in the African context, and makes a fair comparison unfeasible. Furthermore, the ABA standards are more specific and refer to many topics not pertinent in African burn centers, such as inhalation injury, electrical injury, and ventilator-associated pneumonia.

In the absence of strong evidence-based standards, an alternative is to draw a comparison to burn care practices and outcomes in burn centers in other LMIC settings. A focused systematic review of the literature reveals that burn care practices vary somewhat throughout the developing world, but are by and large consistent with what was found in this survey study. While many burn centers adhere to protocols for fluid resuscitation and wound care, few centers have been able to implement early excision, and grafting and mortality rates

are similar to those estimated by the participants in this study. Further details of the comparison and the complete focused systematic review are included in Appendix 4.

This study has some limitations. The primary limitations extend from the survey methodology itself. In fact, surveys have been called a research strategy rather than a research method by some critics, who claim that surveys are intrinsically unable to control experimental conditions¹⁹, although this view is by no means widely shared. Potential disadvantages of surveys can include lack of generalizability and difficulty in interpreting the data. The present survey does not seek to control or manipulate respondent characteristics.¹⁹ Because this study does not involve an intervention, or variations in condition, it is not, of course, appropriate to consider questions of randomization, allocation, or blinding. It is, however, reasonable to note that this study is a descriptive snapshot of the context of burn care in Africa at a particular point in time. Due to time constraints and the impractical nature of finding a suitable pilot population when we sought a response from the entire universe of conference attendees, the questionnaire was not pre-tested. The survey instrument did not seek to demonstrate psychometric properties of reliability (consistency from one measurement to the next) or validity (accurate measurement of the concept); rather, it is only a compendium of self-reported, descriptive data.

Other limitations are the limited ability to identify centers represented in the responses, and that the majority of participants were from Ghana and Nigeria, the host country and largest neighboring country. Additionally, although English was the lingua franca of the conference, there were likely still language barriers at play due to regional differences in grammar and usage. On the other hand, an advantage of survey methodology is that it can provide a large amount of real-world data for a relatively small investment of time and money. The greatest strength of these data is that they were collected at all. A previous sample study that attempted to contact burn care providers through a postal questionnaire had no responses from the African continent.²⁰

Conclusion

This work represents a first attempt at characterizing burn care facilities across Africa through a survey of burn care providers. While much work remains to be done before a full picture of the status of burn care in Africa is obtained, this paper provides an initial view into the challenges and opportunities faced by burn care providers across the continent. Our survey shows that despite availability of facilities, specialized providers, and treatment protocols, accepted standards of antibiotic use and early burn excision have yet to be universally adopted. Furthermore, outreach, policy, and support for burn prevention are lacking. These barriers must be addressed to make evidence-based burn care in Africa a reality.

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Tables

Table 1. Advances in burn care (Adapted from Branski, L. K., Herndon, D. N., & Barrow, R. E. (2012). A brief history of acute burn care management. In D. N. Herndon (Ed.), Total Burn Care (4 ed., pp. 1-7). Edinburgh: Elsevier Health Sciences UK.)

	Early excision	Skin grafting	Topical antibiotics	Nutrition	Fluid resuscitation	Inhalation injury	Hypermetabolism
1900-1930s	Delayed serial excision	Humby knife developed STSG gains popularity (1930s)	Dakin's solution standardized and protocolized (1915)	High caloric feeding	Fluid loss as driver of mortality recognized (1921)		Catabolic response described (1905)
1940s	Advantage of EE recognized but use limited due to issues with infection and blood loss	Adjustable dermatome developed			Lund & Browder diagram developed Fluid requirements per area burned quantified Rule of 9s described		
1950s	Immediate fascial excision used successfully				Fluid resuscitation formulas developed Fluid formulas adapted for children		Increased metabolic rate quantified Continuous feeding for catabolism advocated
1960s	Tangential excision developed	Meshed graft introduced	Mafenide acetate adapted for burns Silver sulfadiazine developed Silver nitrate described	Need for adequate nitrogen and calories described	Parkland Formula	Inhalation injury described	
1970s	Early excision gained popularity in U.S.	Cryopreservation and storage for allograft developed		High caloric needs quantified		Xe-133 scanning employed Bronchoscopy used for diagnosis and therapy	Catecholamines defined as mediators of lipolysis and protein catabolism Effects on metabolism

							, negative nitrogen balance, glucose intolerance , insulin resistance described Benefit of increased ambient temperature recognized
1980s		Artificial skin substitutes introduced		Benefits of enteral nutrition over parenteral nutrition described		Increase in fluid requirement identified	Cortisol and glucagon implicated in hyper-metabolism
1990s						High-frequency oscillating ventilation used	

Table 2. Participant characteristics

	Frequency	Percent	Cumulative Percent
Practice location			
Ghana	45	57.0	57.0
Nigeria	20	25.3	82.3
Other countries	12	15.2	97.5
Missing	2	2.5	100.0
Current position			
MD Consultant	16	20.2	20.2
Resident	11	13.9	34.2
Clinical Officer/Physician Assistant	6	7.6	41.8
Nurse	41	51.9	93.7
PT/OT	3	3.8	97.5
Research	1	1.3	98.7
Missing	1	1.3	100.0
Current specialty			
General surgery	13	16.5	16.5
Plastic surgery	29	36.7	53.2
Burns	8	10.1	63.3
Anesthesia	2	2.5	65.8
Critical Care	2	2.5	68.4
OR/Perioperative	4	5.1	73.4
General practice	6	7.6	81.0
Missing	15	19.0	100.0
Years of experience			
5 or fewer	23	29.1	29.1
6-10	22	27.8	57.0
11-20	18	22.8	79.8
More than 20	15	19.0	98.7
Missing	1	1.3	100.0

Table 3. Facility characteristics

	Frequency	Percent	Cumulative Percent
Setting			
Urban	69	87.3	87.3
Rural	8	10.1	97.5
Missing	2	2.5	100.0
Hospital Size			
Less than 100 beds	19	24.0	24.0
100-500 beds	21	26.6	50.6
500-1000 beds	18	22.8	73.4
More than 1000 beds	20	25.3	98.7
Missing	1	1.3	100.0
Type of Facility			
District Hospital	13	16.5	16.5
Tertiary/Referral Center	63	79.8	96.2
Private/Independent Burn Facility	2	2.5	98.7
Missing	1	1.3	100.0
Burn patients treated per year			
Less than 200	33	41.8	41.8
200-500	24	30.4	72.2
500-750	13	16.5	88.6
More than 750	6	7.6	96.2
Missing	3	3.8	100.0
Burn patients admitted per year			
Less than 200	36	45.6	45.6
200-500	29	36.7	82.3
500-750	8	10.1	92.4
More than 750	2	2.5	94.9
Missing	4	5.1	100.0
Age of patients			
Mostly adults	10	12.7	12.7
Mostly children	18	22.8	35.44
About equal numbers	50	63.3	98.7
Missing	1	1.3	100.0

Table 4. Services available at burn facilities

	Yes % (n)	No % (n)	Missing % (n)
Burn Facility Amenities			
Dedicated burn unit	69.6 (55)	29.1 (23)	1.3 (1)
Size of burn unit:			
5 beds or fewer	3.9 (2)		
6-24 beds	82.4 (42)		
25 or more beds	13.7 (7)		
HDU	30.4 (24)	53.2 (42)	16.5 (13)
ICU	44.3 (35)	50.6 (40)	5.1 (4)
Adequate access to blood products	63.3 (50)	34.2 (27)	2.5 (2)
Dedicated burn operating room	30.4 (24)	69.6 (55)	0.0 (0)
Burn Facility Services			
Specialized pediatric providers	54.4 (43)	43.0 (34)	2.53 (2)
Dedicated burn nurses	65.6 (51)	26.6 (21)	8.9 (7)
Nutritional support	76.0 (60)	21.5 (17)	2.5 (2)
Physiotherapy	87.3 (69)	10.1 (8)	2.5 (2)
Plastic/reconstructive surgery	79.8 (63)	16.5 (13)	3.8 (3)
Post-hospitalization follow-up	62.0 (49)	31.6 (25)	6.3 (5)
Rehabilitation services	44.3 (35)	43.0 (34)	12.7 (10)
Treatment Protocols			
Fluid resuscitation	84.8 (67)	7.6 (6)	7.6 (6)
Pain control	68.4 (54)	21.5 (17)	10.1 (8)
Wound care	78.5 (62)	11.4 (9)	10.1 (8)
Splinting/positioning	59.5 (47)	25.3 (20)	15.2 (12)

Table 5. Wound care practices

	Frequency	Percent	Cumulative Percent
Percent of open wound care			
0%	38	48.1	48.1
1-10%	33	41.8	89.9
11-25%	1	1.3	91.1
More than 50%	2	2.5	93.7
Missing	5	6.3	100.0
Timing of antibiotic initiation			
Routinely upon admission	50	63.3	63.3
After 48 hrs	3	3.8	67.1
On clinical evidence of infection	22	27.9	94.9
After burn biopsy	1	1.3	96.2
Missing	3	3.8	100.0
	Yes % (n)	No % (n)	Missing % (n)
Early excision	34.2 (27)	59.5 (47)	6.3 (5)
Timing of early excision:			
24-48 hrs	10.1 (8)		
48-96 hrs	3.8 (3)		
5-7 days	10.1 (8)		
Within 2 weeks	10.1 (8)		
After 2 weeks	1.3 (1)		
	Frequency	Percent	Cumulative Percent
Estimated cost of burn care per patient per day in US dollars			
10 USD or less	8	10.1	10.1
11-25 USD	15	18.9	29.1
26-50 USD	20	25.3	54.4
More than 50 USD	25	31.6	86.1
Missing	11	13.9	100.0

Table 6. Mortality

	Frequency	Percent	Cumulative Percent
% TBSA at which a burn is unsalvageable			
Under 20%	4	5.1	5.1
31-35%	1	1.3	6.3
36-40%	3	3.8	10.1
41-45%	2	2.5	12.7
46-50%	10	12.7	25.3
Over 50%	51	64.6	89.9
Missing	8	10.1	100.0

Table 7. Public health issues

	Yes % (n)	No % (n)	Missing % (n)
Outreach in past 12 months			
Participated in research	60.8 (48)	25.3 (20)	13.9 (11)
Provided burn training for staff	65.8 (52)	19.0 (15)	15.2 (12)
Provided burn training for staff at other centers or district hospitals	43.0 (34)	35.4 (28)	21.5 (17)
Participated in community outreach/education/prevention activities	43.0 (34)	32.9 (26)	24.0 (19)
Quality improvement			
Is there a director in charge of quality improvement for burn patients?	62.0 (49)	31.6 (25)	6.3 (5)
Prevention			
Are there public health policies for burn prevention in place in your country?	29.1 (23)	62.0 (49)	8.9 (7)
Government support			
Does your government provide adequate funding for burn care?	7.6 (6)	91.1 (72)	1.3 (1)

Figures

Figure 1. Drivers of burn care quality

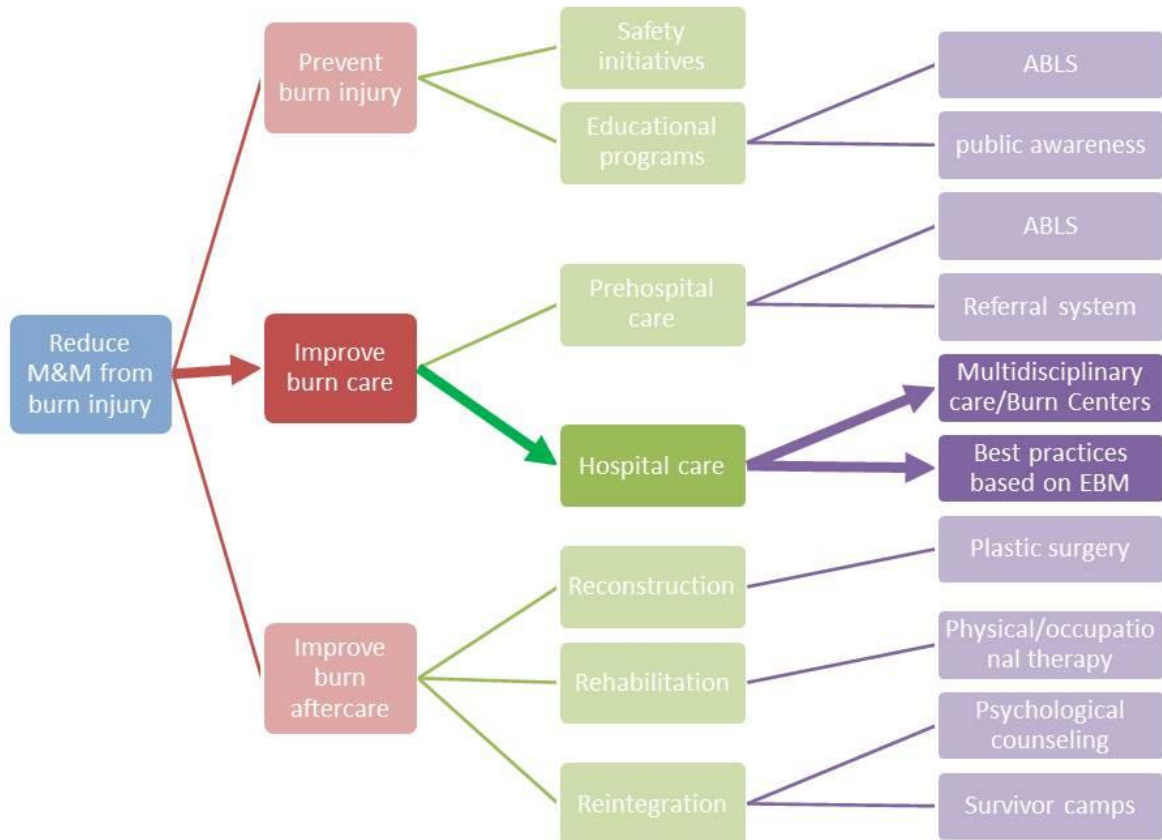


Figure 2. Participating countries

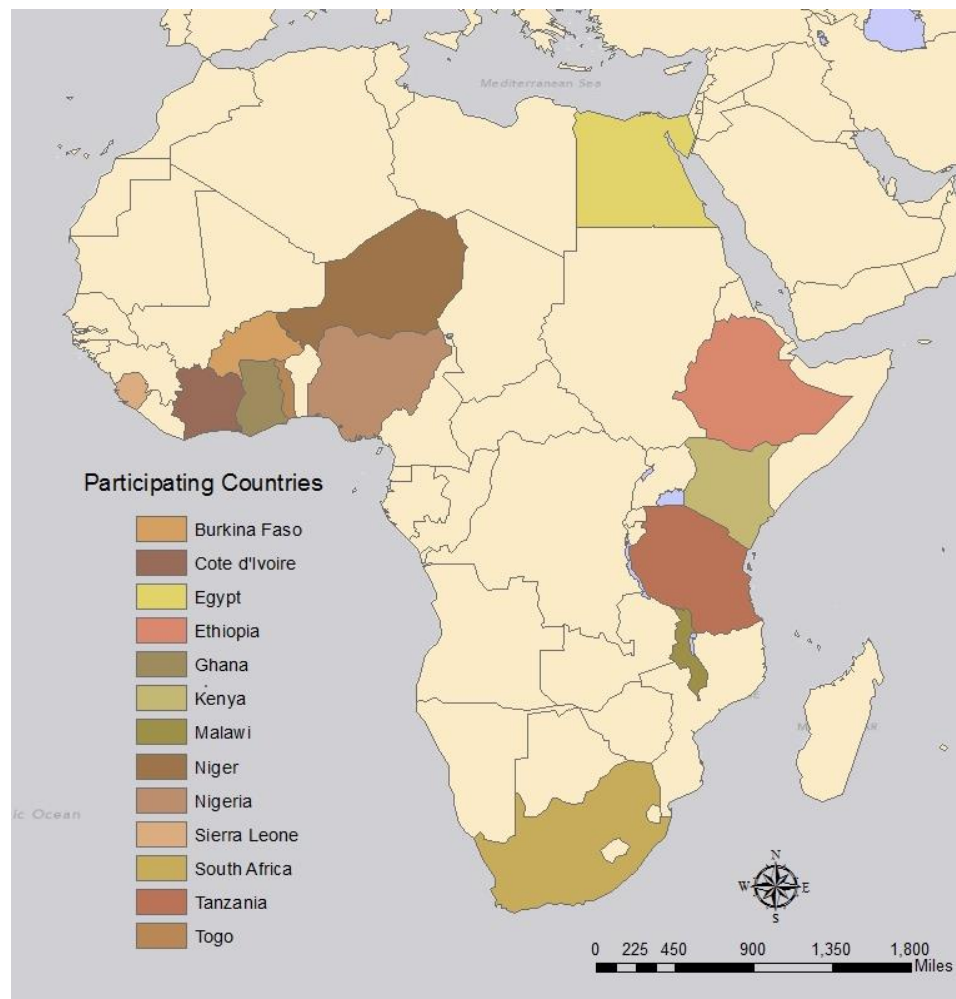


Figure 3. Number of burn cases per week

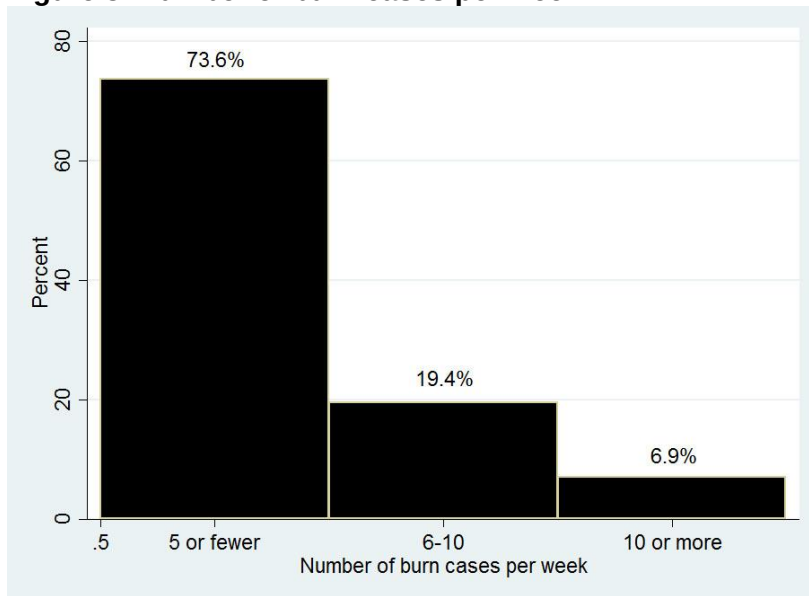


Figure 4. Most common procedure performed

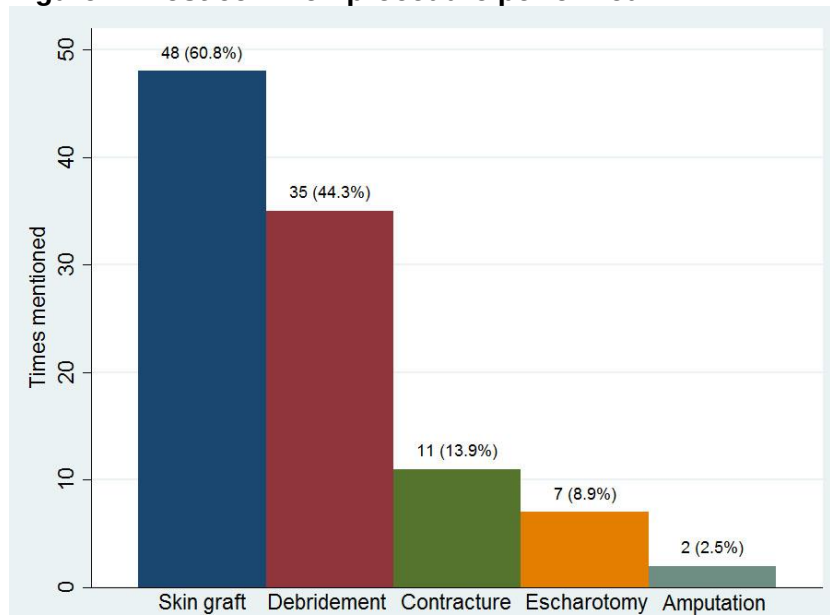


Figure 5. Estimated mortality

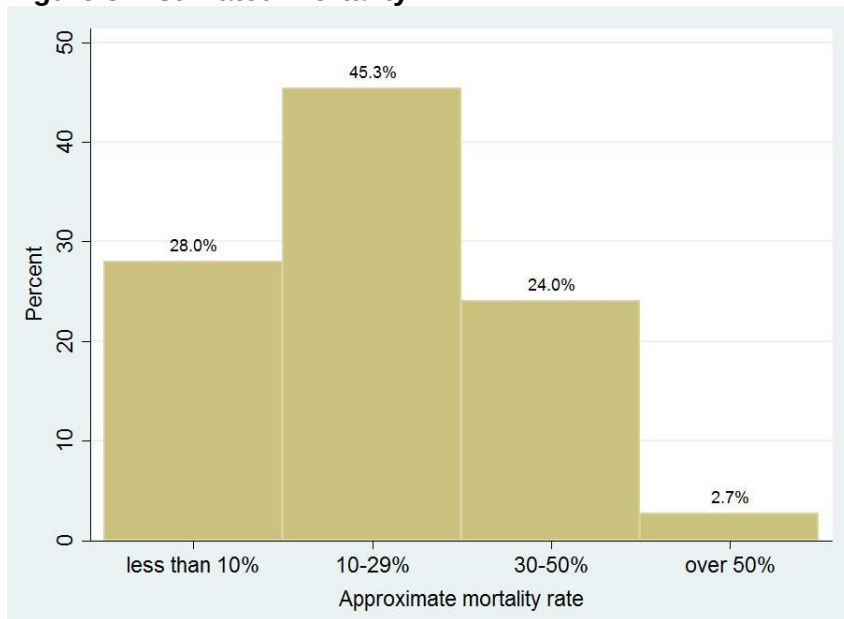
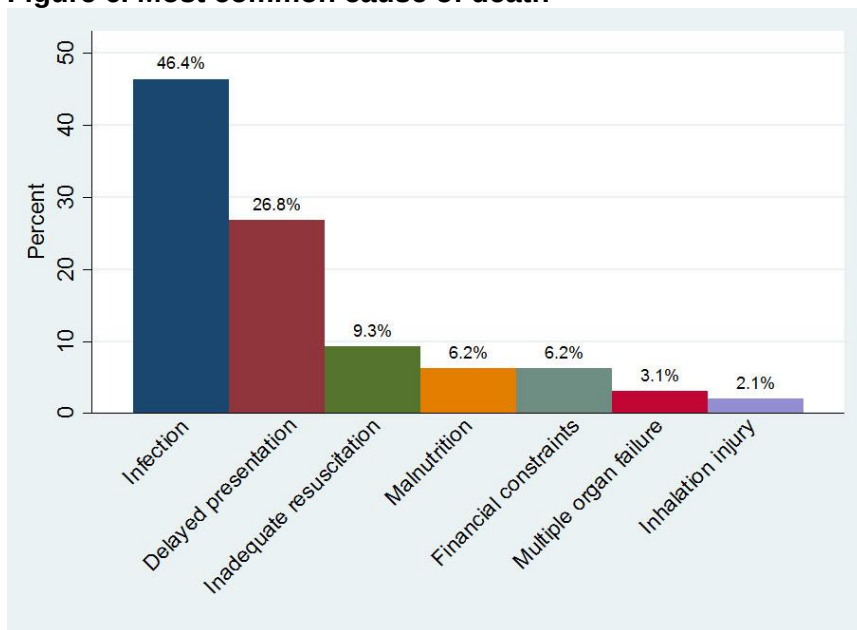


Figure 6. Most common cause of death



Appendix 1. Selected organizations involved in global burn care

Name	Type	Reach	Mission
World Health Organization Department of Violence and Injury Prevention and Disability http://www.who.int/violence_injury_prevention/en/	NGO	Global	To prevent injuries and violence, to mitigate their consequences, and to enhance the quality of life for persons with disabilities irrespective of the causes. It does so by: • Raising awareness about the magnitude and consequences of injuries, violence and disability, • Analyzing and disseminating information, • Fostering multisectoral networks and partnerships, and • Supporting national, regional and global efforts to: ○ Improve data collection ○ Develop science-based approaches to injury and violence prevention, control and rehabilitation ○ Disseminate proven and promising interventions ○ Improve services for persons with disabilities, as well as victims and survivors of injuries and violence, and their families ○ Enhance teaching and training programmes ○ Create multidisciplinary policies and action plans
International Society for Burn Injuries http://www.worldburn.org/	NGO	Global	To disseminate knowledge and stimulate prevention in the field of burns.
Safe Bottle Lamp Foundation http://www.safelamp.org/index.html	Campaign and NGO	Sri Lanka	Free replacement of unsafe lamps with inexpensive safe lamps
Global Alliance for Clean Cookstoves http://www.cleancookstoves.org/	Public-private partnership	Global	To save lives, improve livelihoods, empower women, and protect the environment by creating a thriving global market for clean and efficient household cooking solutions
Interburns http://interburns.org/	International volunteer network of expert health professionals	Global	To transform global burn care and prevention through education, training, research and capacity-building. Guided by the philosophy that all burns patients can be provided with good quality care <i>despite</i> limited resources.
Johnson & Johnson		South Africa	Saving and improving the lives of women and children; building the skills of people who serve community health needs, primarily through education; and preventing disease and reducing stigma and disability in underserved communities where J&J has a high potential for impact.
University of North Carolina School of Medicine/North Carolina Jaycee Burn Center	Academic	Malawi	Improving the capacity of surgical care by opening a dedicated burns theatre, improving nutritional status in the burns unit, expanding the role of physiotherapy, and investigating possible prevention and burn training strategies within the central region of Malawi.
Various regional and local burn societies, e.g. Pan African Burn Society, Federacion Latinoamericana de Quemaduras, ABA (International Outreach Committee)	NGO	Regional, local	Various
Doctors Collaborating to Help Children	Non-profit organization	Ukraine	To improve lives in underserved nations through education and training to increase medical capability

Appendix 2. Cover letter and survey

Status of Burn Care in Africa Survey Consent Form

My name is Laura Boschini, MD. I am a Physician at the University of North Carolina at Chapel Hill. We are conducting a survey for the Pan African Burn Congress. If you are at least 18 years old, you are eligible to participate in the survey.

The survey involves answering some general demographics questions and some questions about burn care and burn infrastructure at your center. The survey takes about 10 minutes to complete. The purpose of the survey is to help burn care providers in Africa understand the status of burn care in Africa and share best practices. Your participation is completely voluntary, and your responses will be completely anonymous. The data we collect will be analyzed at the group level only. You do not have to answer any question you would rather not answer. There are no consequences if you decide not to complete the survey.

If you agree to complete the survey, please do NOT write your name on it. After you finish filling it out, please put the survey in the box provided. By filling out the survey you are consenting to participate.

If you do not want to complete the survey, just return the blank form and envelope to me now.

This survey is approved by the Pan African Burn Society. The UNC Institutional Review Board has approved this project. The results of this survey will be available and disseminated by the Pan African Burn Society after July 1, 2014.

Please keep this letter for your records. Thank you for your participation.

Thank you for completing this survey. Please circle responses or fill in as the questions require.

1. Please tell me the country where you are practicing:

2. Is your burn practice location...?

- a. Urban
- b. Rural

3. What is the size of your hospital?

- a. less than 100 beds
- b. 100-500 beds
- c. 500-1000 beds
- d. more than 1000 beds

4. What level of facility is your hospital?

- a. Rural facility
- b. District Hospital
- c. Tertiary/Referral Center
- d. Private/Independent Burn Facility

5. How many burn patients are **treated** at your facility in a typical year?

- a. less than 200
- b. 200-500
- c. 500-750
- d. more than 750

6. How many burn patients are **admitted** to your facility in a typical year?

- a. less than 200
- b. 200-500
- c. 500-750
- d. more than 750

7. Do you have a dedicated Burn Unit?

- a. Yes
- b. No

IF YES: How many beds?

- a. 5 or fewer
- b. 6-24
- c. 25 or more

8. Does your burn facility treat:

- a. mostly adults
- b. mostly children
- c. about equal numbers of adults and children

9. Do you have specialized pediatric physicians, nurses or clinical officers?

- a. Yes
- b. No
- c. No, we do not take care of children in our facility

10. Does your facility have:

- | | | |
|----------------------------|-----|----|
| a. a High Dependency Unit? | Yes | No |
| b. an Intensive Care Unit? | Yes | No |
| c. dedicated burn nurses | Yes | No |

11. Do burn patients in your facility have access to:

- | | | |
|------------------------------------|-----|----|
| a. nutritional support? | Yes | No |
| b. physiotherapy? | Yes | No |
| c. plastic/reconstructive surgery? | Yes | No |
| d. post-hospitalization follow-up? | Yes | No |
| e. rehabilitation services? | Yes | No |

12. Does your facility have protocols in place for:

- | | | |
|---------------------------|-----|----|
| a. fluid resuscitation? | Yes | No |
| b. pain control? | Yes | No |
| c. wound care? | Yes | No |
| d. splinting/positioning? | Yes | No |

13. Does your facility have adequate access to blood products for burn patients?

- a. Yes
- b. No

14. Do you have a dedicated burn operating theatre/operating room?

- a. Yes
- b. No

IF YES: How many rooms?

- a. 1-2
- b. 3-4
- c. more than 4

IF NO: How many operating days per week do you have for burn cases?

- a. 1-2
- b. 2-4
- c. more than 4

15. How many operative burn cases do you perform in the OR per week?

- a. 5 or fewer
- b. 6-10
- c. 10 or more

16. What is your most common procedure?

- a. Debridement
- b. Escharotomy
- c. Skin graft
- d. Contracture release
- e. Amputation

17. What is the approximate mortality rate of burn patients in your facility in a typical year?

- a. less than 10%
- b. 10-29%
- c. 30-50%
- d. over 50%

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18. At what % TBSA would you consider a burn patient unsalvageable?

- a. under 20%
- b. 20-25%
- c. 26-30%
- d. 31-35%
- e. 36-40%
- f. 41-45%
- g. 46-50%
- h. over 50%

19. To what do you attribute the majority of burn deaths in your facility?

- a. Under resuscitation
- b. Infection
- c. Malnutrition
- d. Delayed presentation
- e. Other, Please specify _____

20. In what percentage of admitted patients do you practice open wound care (leave the wound open to the atmosphere)?

- a. 0%
- b. 1-10%
- c. 11-25%
- d. 26-50%
- e. more than 50%

21. When do you start antibiotics in your unit?

- a. Routinely upon admission
- b. After 48 hrs
- c. Clinical evidence of infection
- d. After burn biopsy

22. Do you practice early excision?

- a. Yes
- b. No

IF YES: When do you typically excise?

- a. 24-48 hrs
- b. 48-96 hrs
- c. 5-7 days
- d. Within 2 weeks of presentation
- e. After 2 weeks of presentation

23. Do you utilize non clinician providers for care of burn patients?

- a. Yes
- b. No

IF YES: How are they utilized?

- | | | |
|--------------------------|-----|----|
| a. Bedside management | Yes | No |
| b. In the burn clinic | Yes | No |
| c. Assisting in the OR | Yes | No |
| d. Independent in the OR | Yes | No |

24. In the past 12 months, has your facility:

- | | | |
|--|-----|----|
| a. participated in research? | Yes | No |
| b. provided education/training to burn care providers within your facility? | Yes | No |
| c. provided education/training to burn care providers in other facilities in your region/district? | Yes | No |
| d. participated in community outreach/ education/ prevention activities? | Yes | No |

25. Does your facility have a medical director or administrator in charge of ensuring quality of care and/or quality improvement for burn care?

- a. Yes
- b. No

26. Does your facility receive adequate funding from your government/Ministry of Health for care of burn patients?

- a. Yes
- b. No

27. Please estimate the **average cost per day per patient** of inpatient burn care at your facility (e.g., cost per patient per day in US dollars).

- a. 10 US dollars or less per day
- b. 11-25 US dollars per day
- c. 26-50 US dollars per day
- d. more than 50 US dollars per day

28. Are there public health policies in place in your country focused on burn prevention?

- a. Yes
- b. No

Finally, a few questions about your background:

29. How many years have you been in practice?

- a. 5 or less
- b. 6-10
- c. 11-20
- d. more than 20

30. What is your current position?

- a. MD Consultant Surgeon
- b. Surgery resident
- c. Clinical officer
- d. Nurse
- e. Other, Please specify _____

31. What is your surgical specialty?

- a. General Surgery
- b. Plastic surgery
- c. Other Please specify _____

Thank you for your participation!

Appendix 3. Standards of Burn Care in the U.S.

Introduction

Quality of care has become a catchphrase in medical practice and research over the past several decades. The paradigmatic definition of quality of care is “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.”^{1(p21)} Implicit in this definition is the idea that quality of care necessitates the best current professional knowledge. In the absence of the best evidence, high standards of quality are unattainable. Evidence-based medicine (EBM) is one way to achieve this goal.

Discussions of improving the quality of health care lead directly to the concept of EBM. As part of its recommendations in *Crossing the Quality Chasm: A New Health System for the 21st Century*, the Institute of Medicine states, “Patients should receive care based on the best available scientific knowledge. Care should not vary illogically from clinician to clinician or from place to place.”^{2(p8)} This phrase encapsulates the goal and rationale of EBM. Despite having been scientifically based for centuries, the practice of medicine remained anecdotal and reliant on individual physician judgment until well into the 20th century. It was not until the 1990s, helped by advances in biostatistics and epidemiology, that the term evidence-based medicine was first used in the literature.³⁻⁵ Evidence-based medicine can be defined as “the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients.”^{5(p71)} Since its widespread adoption into the professional medical ethos, different fields and subspecialties have incorporated EBM into their practice with varying degrees of success. One of the fields in which EBM has struggled to take root is the surgical and critical care subspecialty of burn care.

Evidence-based medicine in burn care

In a 1997 article in *Burns*, Childs described the state of burn research at that time by performing searches of medical databases and hand searches of burn journals for randomized

controlled trials (RCTs).⁶ Childs found the number of RCTs to be increasing, but her search turned up only two systematic reviews between 1991 and the date of her own study.⁶ The author concluded that with so few studies to guide practice, burn care could not be considered to be evidence-based at that time. To obtain an idea of this trend in more recent years I performed an informal search in PubMed. The MeSH term “burns” revealed 158 entries with publication type “randomized controlled trial” and 2 entries with publication type “meta-analysis” for the time period 1993 through 2002. For 2003-2012 the results were 258 and 35 for “randomized controlled trial” and “meta-analysis”, respectively. This indicates a similar pattern to that found by Childs, although perhaps with a promising trend upward in number of meta-analyses in recent years.

Despite the increase in numbers of studies on burns, quality seems to continue to be a concern. In a follow up to Childs’ articles, in 2009 Knobloch, Gohritz, Spies, et al. performed a similar search of studies published in Burns from January 2005 to April 2008.⁷ The authors found that 2.8% of original reports were RCTs, compared to 7% in Plastic Reconstructive Surgery.⁷ Furthermore, none of these articles mentioned the CONSORT statement or provided a CONSORT flow diagram.⁷ The CONSORT statement was published in 1996 and provides a checklist, participant flow diagram, and format to be used for the optimal reporting of RCTs.⁸ The CONSORT recommendations have been widely espoused by medical journal editors as an indicator of quality in RCT reporting.⁷ In 2011, Knobloch, Yoon, Rennekampff, et al. investigated the quality of presentations at the 2000 and 2008 American Burn Association annual meetings.⁹ The authors assigned quality scores based on the CONSORT criteria as well as the STROBE criteria, which is similar to CONSORT but for observational studies, and the Timmer quality instrument, and found that there was marked room for improvement in both oral and poster RCT and non-RCT presentations.⁹ In order to gain a perspective of the effect of these issues with scarcity and lack of quality on practice guidelines, I studied the Cochrane Library’s Evidence Aid Special Collection for burns. This special collection lists 27 systematic reviews on 6 main burn-

related topics.¹⁰ Of those reviews, only 3 were determined to provide adequate evidence to guide clinical practice. The rest were deemed to provide insufficient or no evidence for practice. These findings provide a bleak view of the state of affairs in burn research.

Conclusion

One way in which EBM can be achieved is with the development of clinical practice guidelines. In the 2011 document, *Clinical Practice Guidelines We Can Trust*, the Institute of Medicine details the standards to be followed for the development of trustworthy guidelines. These include transparency in how the guidelines were developed; management of conflicts of interest; balance and multidisciplinary expertise within the group developing the guidelines; use of high quality systematic reviews; explanation of the evidence foundation and rating of the strength of recommendations; clear and standardized statement of the recommendations; and timely updating of the guidelines.¹¹ The ABA published Practice Guidelines for Burn Care in 2001.¹² The document's authors followed many of the best practices described by the IOM report in the development of these guidelines. Despite the group consisting entirely of burn surgeons and the scarcity of RCTs to inform the guidelines, the authors were transparent in the composition of the guideline development group and the process involved; were upfront about the sources of data used and acknowledged the need for more research; and provided rationale and ratings for each guideline addressed.¹² Since 2001, a handful of updates on specific topics has been published as separate manuscripts in the *Journal of Burn Care and Research*,¹³⁻²⁰ with the ultimate goal of publishing updates on all 13 original standards as well as standards on six additional topics.²¹ Of the 18 topics on which practice guidelines have been published from 2001 to the present, only two of these were deemed as having sufficient evidence to formulate a standard. Further details can be seen in Table 1. These findings highlight the need for quality burn research in the future.

Table A3.1. Current American Burn Association standards and guidelines for burn care

Topic	Update	Standard	Guidelines
Organization and delivery of burn care	2001	Insufficient evidence	All regions should have an organized system of care for injured persons.
Initial assessment of the burn patient	2001	Insufficient evidence	Insufficient evidence
Outpatient management of burn patients	2001	Insufficient evidence	The routine administration of prophylactic antibiotics does not protect against cellulitis or sepsis in the burn wound, and their use is not recommended.
Management of CO and cyanide exposure	2001	Insufficient evidence	Insufficient evidence
Inhalation injury: diagnosis	2001	Insufficient evidence	Insufficient evidence
Inhalation injury: initial management	2001	Insufficient evidence	Insufficient evidence
Burn shock resuscitation: initial management and overview	2008	Insufficient evidence	1) Adults and children with burns >20%TBSA should undergo formal fluid resuscitation using estimates based on body size and surface area burned. 2) Common formulas used to initiate resuscitation estimate a crystalloid need of 2-4 ml/kg/%TBSA during the first 24 hrs. 3) Fluid resuscitation, regardless of solution type or estimated need, should be titrated to maintain a urine output of approximately 0.5-1.0 ml/kg/hr in adults and 1.0-1.5 ml/kg/hr in children. 4) Maintenance fluids should be administered to children in addition to their calculated fluid requirements caused by injury. 5) Increased fluid requirements can be anticipated in patients with full-thickness injuries, inhalation injury, and a delay in resuscitation.
Hypertonic fluid resuscitation	2001	Insufficient evidence	Insufficient evidence
Fluid resuscitation: colloid	2001	Insufficient evidence	Insufficient evidence
Fluid resuscitation: monitoring	2001	Insufficient evidence	Insufficient evidence
Escharotomy	2009	Insufficient evidence	1) Extremities or the anterior trunk that have circumferential or near circumferential burns may develop ischemia from increased compartment pressures caused by fluid resuscitation within a nondistensible eschar. Escharotomies are performed as a releasing skin incision allowing the subcutaneous tissues to be decompressed. 2) Absence of Doppler pulses is an indication for escharotomy. The presence of Doppler pulses does not necessarily indicate adequate perfusion. 3) Compartment pressures can be measured and escharotomy should be performed for pressures >40mmHg and considered for those >25mm Hg. 4) Escharotomy incisions are made in a longitudinal fashion through the burned skin avoiding underlying neurovascular structures. If recovery of blood flow is not obtained in the extremities, additional opposing longitudinal incisions are made. Escharotomies of digits and neck remains controversial. 5) Burns in conjunction with other trauma such as electrical or crush injuries, may require other decompressive therapies such as fasciotomies or nerve releases. It is unusual for a thermal burn to require a fasciotomy. 6) Escharotomies of the chest may help relieve respiratory and hemodynamic dysfunctions.

			7) Intra-abdominal hypertension can lead to abdominal compartment syndrome (ACS), either in the presence of abdominal eschar or as the result of large volume resuscitation in the absence of significant abdominal burn. Decompression with an intra-abdominal decompression catheter or decompressive laparotomy can be considered. 8) Measurement of intraocular pressure should occur for burns in the region of the eye or in the presence of increased edema from fluid resuscitation and decompressive therapies including a lateral canthotomy may need to be performed.
Initial nutritional support	2001	Insufficient evidence	Nutritional support should be provided during the acute phase of recovery. Enteral nutritional support should be used in preference to parenteral support when possible. A calorie/nitrogen ratio of 110:1 or less with provision of adequate calories to meet energy needs should be used for patients with burns >20% TBSA. Post-pyloric enteral feedings can be safely continued through the pre-, intra-, and postoperative periods without increased risk of aspiration.
DVT	2007	Insufficient evidence	Insufficient evidence
Electrical injury: cardiac monitoring	2006	EKG should be performed on all patients who sustain electrical injuries (high and low voltage)	1) Children and adults who sustain low-voltage electrical injuries, have no ECG abnormalities, no history of loss of consciousness, and no other indications for admission can be discharged from the emergency room. 2) All patients with history of loss of consciousness or documented dysrhythmia either before or after admission to the ER should be admitted for telemetry monitoring. Patients with ECG evidence of ischemia should be admitted and placed on cardiac monitors. 3) Creatinine kinase enzyme levels, including MB fraction, are not reliable indicators of cardiac injury after electrical burns and should not be used in decisions regarding patient disposition. Insufficient data exists on troponin levels to formulate a guideline.
Electrical injury: upper extremity injury	2006	Insufficient evidence	1) Patients with high-voltage electrical injury to the upper extremity should be referred to specialized burn centers experienced with these injuries as per ABA referral criteria. 2) Indications for surgical decompression include progressive neurologic dysfunction, vascular compromise, increased compartment pressure, and systemic clinical deterioration from suspected ongoing myonecrosis. Decompression includes forearm fasciotomy and assessment of muscle compartments. The decision to include a carpal tunnel release should be made on a case-by-case basis.
Pain management	2006	Insufficient evidence	1) All burn centers should have an organized approach to the treatment of burn pain that considers background, procedural, and breakthrough pain. 2) The aim should be for the patients to be awake and alert but comfortable. 3) Pain should be differentiated from anxiety
TEN	2008	1) Cessation of causative medications 2) Early transfer to burn or similarly qualified unit	1) Tissue diagnosis by full-thickness punch biopsy is recommended for the diagnosis of TEN 2) Systemic corticosteroids are not recommended in the treatment of TEN 3) The use of empiric prophylactic antibiotics is not recommended in patients with TEN 4) Coverage of areas of desquamated skin may be attained with a number of dressings, including biological, biosynthetic, and silver or antibiotic-impregnated dressings. Frequent dressing changes with topical antimicrobial ointments or solutions are not recommended 5) Enteral nutrition is recommended for patients with TEN 6) The clinical scoring system SCORTEN may be useful in predicting mortality of patients with TEN, particularly when

			repeated daily 7) Long-term outpatient follow-up is important in TEN survivors to manage late complications and identify at-risk patients for post-discharge mortality 8) Ophthalmologic consultation is highly recommended for patients with conjunctival involvement. Dermatology/dermatopathology consultation may be considered to rule out non-TENS diseases.
VAP	2009	Insufficient evidence	Mechanically ventilated burn patients are at high risk for developing VAP, with the presence of inhalation injury as a unique risk factor in this patient group. VAP prevention strategies should be used in mechanically ventilated burn patients. Clinical diagnosis of VAP can be challenging in mechanically ventilated burn patients where systemic inflammation and acute lung injury are prevalent. Therefore, a quantitative strategy, when available, is the preferable method to confirm the diagnosis of VAP. An 8-day course of targeted antibiotic therapy is generally sufficient to treat VAP; however, resistant <i>Staphylococcus aureus</i> and Gram-negative bacilli may require longer treatment duration.
Glucose control	None		
Skin substitutes	None		
Early ambulation	2012	Insufficient evidence	1) An early postoperative ambulation protocol should be initiated immediately, or as soon as possible, after lower extremity grafting unless any exclusion criteria are encountered. 2) External compression must be applied before ambulation. 3) If the graft crosses a joint, the joint should be immobilized continuously until the first dressing change.

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Appendix 4. Focused systematic review of status of burn care in LMICs

Introduction

This focused systematic review is intended as an adjunct to the study of the status of burn care in Africa within which it is embedded. In order to situate the main study within a larger context, it is necessary to evaluate the status of burn care in Africa both from other sources and as compared to other regions of the world.

Research Question

What is the status of current burn care practices in Africa? How does it compare to the status of burn care practices in other low and middle income countries (LMICs)?

Population

The population of interest was burn patients of all ages in burn units in LMICs.

Comparators

The goal of this systematic review was to serve as context for the African burn survey administered in this study, so specific best practices that were discussed in the burn survey were included as comparators in this analysis. These include:

- Dedicated burn center
- Fluid resuscitation protocol
- Appropriate topical antibiotics and wound care
- Early excision and grafting
- Prophylactic antibiotics not administered on admission
- Nutrition supplementation
- Early physiotherapy

Outcomes

The main outcomes of interest were mortality and lethal area 50 (LA50), the total percent body surface area burned that has a 50% chance of death.

Study Designs

Since the goal of the systematic review was to form a base of comparison for a descriptive survey study, retrospective or prospective descriptive study designs were included in the review.

Eligibility Criteria and Search Strategy

In order to identify the largest number of relevant studies the Mesh term “developing countries” was combined with “burns” and “burn units” and then each individual Mesh global region was combined with the term “burn unit”. This strategy yielded the search algorithms listed below.

PubMed search algorithms:

Search: ("Developing Countries"[Mesh]) AND "Burn Units"[Mesh]

Search: "Latin America"[Mesh] AND ("Burn Units"[Mesh])

Search: "Central America"[Mesh] AND ("Burn Units"[Mesh])

Search: "South America"[Mesh] AND ("Burn Units"[Mesh])

Search: "Africa South of the Sahara"[Mesh] AND ("Burn Units"[Mesh])

Search: "Africa, Northern"[Mesh] AND ("Burn Units"[Mesh])

Search: "Europe, Eastern"[Mesh] AND ("Burn Units"[Mesh])

Search: "Asia"[Mesh] AND ("Burn Units"[Mesh])

Search: ("Burns"[Mesh]) AND "Developing Countries"[Mesh]

All studies identified by employing the described search criteria were considered for analysis unless they could be immediately identified by title or abstract as having one or more of the exclusion criteria described below.

Exclusion Criteria

Since this review was intended to be an analysis of current burn care practices in low and middle income countries (LMICs), studies conducted in World Bank high income category countries as well as studies published prior to 2000 were excluded. Studies with narrow inclusion criteria, such as those limited to pediatric or geriatric burns, were excluded. Studies focusing on prevention programs, reconstructive surgery, burn disasters, or specific treatment modalities (e.g. amniotic membrane, papaya) were excluded due to incompatibility of topic. Commentaries and editorials were also excluded on the basis of weak scientific merit. Articles in languages other than English and Spanish were excluded. Articles identified by the search strategy and considered for review are listed in Table 1.

Data Collection

All articles were downloaded electronically from the University of North Carolina Health Sciences Library PubMed portal (<http://hsl.lib.unc.edu/>) or through interlibrary loan request for those articles not available directly through the website. Data were abstracted manually by the author by reading each article and entering the relevant items into an Excel table.

Data Items

This data are displayed in Table 2 for the articles included in the final review. As mentioned previously, countries were categorized as low or middle income according to the World Bank income group and were divided into regions based on World Health Organization member regions. The variable “burn unit” was defined as existence of a dedicated burn unit or

of a dedicated team of burn-trained providers. The variable “fluid protocol” was defined as fluid resuscitation performed in an organized manner using either a burn fluid resuscitation formula (e.g. Parkland, Brooke) or using urine output as a measure of adequate resuscitation. The variable “topical therapy” was defined as daily dressing changes with appropriate topical antimicrobials, such as silver sulfadiazine. “Early excision and grafting” was defined as self-reported early excision of the burn wound or excision performed routinely within two weeks of injury. “Antibiotics” was defined as the lack of routine administration of antibiotics on admission but rather administration based on clinical signs or symptoms of infection. “Nutrition” was defined as self-reported emphasis on high-calorie oral supplementation or enteral feeding through nasogastric tubes. “Physiotherapy” was defined as routine implementation of physiotherapy early in the hospitalization or post-operative period.

Summary Measures

The original outcome measures were intended to be mortality and LA50. However, so few studies reported LA50 (2 out of 16) that this measure was abandoned and mortality alone was considered. Summary mortality measures are reported as ranges and means.

Bias

This study is by nature descriptive rather than experimental, and as such all studies included in the systematic review were descriptive in nature. Bias in these individual studies is what would be expected of any study of this kind, with no randomization, controlling, blinding or adjustment of any kind, but merely a description of the patient population available at the time of the study. No attempt was made to control for bias in the individual studies, but in situations where the individual study outcome was deemed biased with respect to creation of the summary measures this has been mentioned in the data table.

Synthesis of Results

A summary of the results can be seen in Table 3. As can be seen, mortality rates vary widely throughout the LMICs assessed in this study, but the closes correlation seems to be with availability of early excision and grafting. This finding is in keeping with burn care practices in the developed world.

Table A4.1. Articles under consideration for review

Citation	Country	Year	Study Selection
Africa			
Fatusi, Fatusi, Olabanji, & Alatise, 2006	Nigeria	1998-2003	Yes
Dale, Mueller, Want, et al., 2013	Kenya	2006-2010	No – operative population only, so not comparable
Allorto, Clarke, & Thomson, 2011	South Africa	2006-2008	No - costing study, so not enough management data
Bauling, Kruger, van der Vyver, van Rooyen, & Lombard, 1992	South Africa		No – prior to 2000
Gosselin & Koppers, 2008	Sierra Leone	2003-2006	Yes
Heard, Latenser, & Liao, 2013	Zambia		No – prevention article
Justin-Temu, Rimoy, Premji, & Matemu, 2008	Tanzania		No – pediatric only
Komolafe, James, Makoka, & Kalongeolera, 2003	Malawi	1994-1999	Yes
Manktelow, 1990	Liberia	1987-1988	No – prior to 2000
Mulat & Salemark, 2006	Ethiopia	2001-2002	Yes
Mzezewa, Jonsson, Aberg, & Salemark, 1999	Zimbabwe		No – prior to 2000
Otteni, Saruni, Duron, Hedges, & White, 2013	Kenya	2006-2010	Yes
Starley, Mohammed, Schneider, & Bickler, 1999	Gambia		No – not applicable, pediatric only
Stevenson, Borgstein, Van Hasselt, & Falconer, 1999	Malawi	1993-1995	Yes
Syed-Abdul, Scholl, Chen, et al., 2012	Sao Tome		No – not applicable; about telemedicine
Virich & Lavy, 2006	Malawi	four week period sometime before 2006	No – insufficient data
Tyson, Boschini, Kiser, et al., 2013	Malawi	2011-2012	Yes
Boschini, Tyson, Samuel, et al., 2014	Malawi	2011-2012	Yes
Americas			
Benaïm & Artigas Nambrard, 1999	South America (mult)		No – prior to 2000 and historical piece
Piccolo, 2002	Brazil		No – invited lecture with minimal data
Soares de Macedo & Santos, 2006	Brazil	2004	Yes
South-East Asia			
Ahuja & Goswami, 2013	India	2011-2012	Yes
Ahuja & Bhattacharya, 2002	India	1993-2000	Yes
Lau, 2006	Sri Lanka		No – review article, not about a specific burn unit
Liu, Khatri, Shakya, &	Nepal	some 3 year period	No – prior to 2000

Richard, 1998		prior to 1997	
Munster, 1994	India		No – prior to 2000
Prasanna, Singh, & Kumar, 1994	India	1990-1992	No – prior to 2000; feasibility of EE&G study
Europe			
Çoban, Erkilic, & Analay, 2010	Turkey	2007-2008	Yes
Kisslaogglu, Yüksel, Uccar, & Karacaogglu, 1997	Turkey		No – prior to 2000 and not applicable
(Kut et al., 2006	Turkey	1997-2003	No – not applicable
Ottomann, Kleinschmidt, Gohlke, Biedermann, & Hartmann, 2009	Kyrgystan		No – not applicable, about development of a burn unit
Senel, Yasti, Reis, et al., 2009	Turkey	1998-2006	No – pediatric only
Fuzaylov, Anderson, Knittel, & Driscoll, 2014	Ukraine		No – not applicable; about an outreach program
Yavuz, Ayse, Abdullah, & Belkiz, 2011	Turkey	2008-2010	No – pediatric only
Eastern Mediterranean			
Cancio, 2007	Iraq	2005-2006	Yes
Fadaak, 2002	Yemen	1996-1999	No – qualitative only
Gibraiel, 1973	Egypt/Jordan	prior to 1973	No – prior to 2000 and not applicable
Corkill & Haselden, 1970	Libya	1969-1970	No – prior to 2000
Hashmi & Kamal, 2013	Pakistan	2002-2011	Yes
Iqbal, Saaq, & Ali, 2013	Pakistan		Yes
Nasser, Mabrouk, & Wafa, 2009	Egypt		No – pediatric only
Rajabian, Aghaei, & Fouladi, 2007	Iran	2000-2004	Yes
Western Pacific			
Lam & Dung, 2008	Vietnam		No – first aid, not applicable
Mendelson, 1997	Vietnam		No – prior to 2000
Multiple			
Hodgins, Hodgins, Potokar, & Price, 2011	Pakistan, India, Botswana and Zambia		No – prevention

Table A4.2. Systematic review data table

Citation	Country	Year	Population	Best Practices	Age/TBSA	Mortality/ LA50
Africa						
Fatusi, Fatusi, Olabanji, & Alatise, 2006	Nigeria	1998-2003	139 patients admitted to Ile-Ife Burns Unit	dedicated unit; debridement and daily dressing; abx; pain control; physiotherapy	median age 18.5 for facial involvement, 22 without; median TBSA 19% for facial involvement vs. 25% without	mortality 30.9%
Gosselin & Kuppers, 2008	Sierra Leone	2003-2006	264 patients admitted to surgical center in Freetown	open and closed dressings; daily changes; high-protein, high-calorie diet; ppx abx for 24-48 hrs; no burn unit; early mobilization and daily physiotherapy	mean age ~16 (15.9 closed, 16.5 open); mean TBSA ~20 (21.5 closed, 19.5 open)	mortality ~22% (23 closed, 21 open)
Komolafe, James, Makoka, & Kalongeolera, 2003	Malawi	1994-1999	1825 patients admitted to Queen Elizabeth Central Hospital Burns Unit, Blantyre	burns unit; abx; silver sulfadiazine	median age 7 (0-73); mean TBSA 12% (0.5-96);	mortality 12%
Mulat & Salemark, 2006	Ethiopia	2001-2002	121 burn patients admitted to Yekatit Hospital, Addis Ababa	burns unit; 23% only wound care; 74% delayed grafting; 3 pts primary grafting;	median age 22 (0-70); mean TBSA 17.1%;	mortality 11.6%
Otteni, Saruni, Duron, Hedges, & White, 2013	Kenya	2006-2010	269 inpatient burn patients admitted to Tenwek Hospital	no unit; 43% patients had surgical debridement; 37% STSG; abx to 55%; Parkland Formula; EE&G generally not employed; daily dressing changes c/ available ointment; delayed grafting	59% <5, 14% 5-20, 18% 21-50, 7% >50; TBSA 8% <5, 58% 5-19, 28% 20-40, 6% >40;	mortality 12%
Stevenson, Borgstein, Van Hasselt, & Falconer, 1999	Malawi	Sep 1993-Sep 1995	290 patients admitted to burns unit	burn unit; low grafting rate, all delayed	age distribution; tbsa distribution;	mortality 16.9%

Tyson, Boschini, Kiser, et al., 2013	Malawi	June 2011-Dec 2012	454 pts admitted to KCH burn unit	burn unit; operative procedure	median age 4; mean TBSA 18.5;	mortality 18%; LA50 39%
Boschini, Tyson, Samuel, et al., 2014	Malawi	July 2011-Dec 2012	435 pts admitted to KCH	burn unit	mean age 10; mean TBSA 19;	mortality 18.5%
Americas						
Soares de Macedo & Santos, 2006	Brazil	2004	278 burn patients consecutively admitted to Burn Unit of Hospital Regional da Asa Norte	modified Parkland; plasma; EE&G within first 5 days in full thickness burns; no ppx abx	median age 24 (1-82); median TBSA 14% (1-100);	mortality 5%
South-East Asia						
Ahuja & Goswami, 2013	India	1 Feb 2011 - 31 Jan 2012	797 patients c/ acute burns admitted to Lik Nayak Hospital and Maulana Azad Medical College, New Delhi	Dedicated unit; physio; burn theatre; Intravenous fluid resuscitation, topical therapy (silver sulphadiazine/framycin) with daily dressing change, routine blood investigations, bacteriological monitoring and good nutrition are highlights of the treatment protocol; excisional surgery practiced very selectively	mean age 23.04 (0-83); mean TBSA 42.26 (2-100)	mortality 32.4%
Ahuja & Bhattacharya, 2002	India	1993-2000	11,196 admissions to Lok Nayak Hospital and Maulana Azad Medical College, New Delhi	dedicated staff; PT/OT; Parkland formula + colloid; daily dressing changes c/ silver sulphadiazine, framycin, and povidone iodine; tangential excision only occasionally for teaching purposes exclusively for deep dermal <40tbsa and electrical; prophylactic	all ages (80% 16-55y)/mean TBSA 50.35%	mortality 51.8%

				penicillin on admission x5d, then systemic abx as needed clinically; high protein, high calorie diet as far as possible;		
Europe						
Çoban, Erkilic, & Analay, 2010	Turkey	1 May 2007 to 10 October 2008	411 cases admitted to Cengiz Gökcek State Hospital Burn Center	electronic burn database, OR, dressing room, ICU, surgeons, burn trained practitioners and nurses, fluid resuscitation, early escharectomy, early tube feeding		mortality 5.6%
Eastern Mediterranean						
Cancio, 2007	Iraq	June 2005-Sep 2006	95 non-U.S. personnel treated at Ibn Sina Hospital	topical antimicrobials, bed-side nursing care, excision and grafting of deep burns, silver dressings/biobrane/ negative pressure used in selected cases; absence of bathing facilities, burn-trained OT/PT and nurses	mean age 24/mean TBSA 27%	mortality 27%
Hashmi & Kamal, 2013	Pakistan	1 Sep 2002-31 Aug 2011	1597 patients admitted to Suleiman Dawood Burns Unit	ICU; dedicated burns team (plastic surgeon, anesthesi, intensiv, microbiol, infxn control, nursing, physio, dietitian); protocols for fluid resusc, mangmt inhalation inj, nutrition, wound mngmt, and analgesia; stress ulcer ppx, DVT ppx, tetanus ppx, NO ppx abx; continuous enteral nutrition; vit C & multivit; closed dressings; early tangential excision and grafting for a few pts	median age 22 (0-90)/mean TBSA 32.5%/	mortality 41.3%

Iqbal, Saaiq, & Ali, 2013	Pakistan		13259 patients presented to Burns Care Centre (BCC), Pakistan Institute of Medical Sciences (PIMS), Islamabad; PRESENTE D >24hrs EXCLUDED	ABLS initial assessment; topical abx and occlusive dressings; analgesia and tetanus ppx; fluid resuscitation per Mt Vernon formula; transfusion; early tangential excision and grafting performed	mean age for adults 33.63+-10.76, mean age for children 6.71+-3.47; mean TBSA 10.64+-11.45 overall, 38.04+-15.18 for hospitalized;	mortality 14% for hospitalized, 1.48% overall
Rajabian, Aghaei, & Fouladi, 2007	Iran	Aug 2000-Aug 2004	2057 consecutive admissions for thermal burn injury treated at two university burn units in Shiraz	from their lit review inadequate multidiscip burn teams and no EE&G generally in Iran, not specific to this burn center	mean age 19; mean TBSA 30% (1-100);	mortality 38.1%; LA50 per age group (0-14:16.5; 15-44:15; 45-64:17; >65:12.24)

Table A4.3. Adherence to best practices, grouped by WHO region

WHO Region	Burn Center	Fluid protocol	Topical tx	EE&G	Abx	Nutrition	Physio-therapy	Mortality (%)
Africa (n=8)	+	-	++	--	=	-	-	11.6-30.9
Americas (n=1)	++	++	n/a	++	++	n/a	n/a	5
South-East Asia (n=2)	++	++	++	--	=	++	=	32.4-51.8
Europe (n=1)	++	++	n/a	++	n/a	++	n/a	5.6
Eastern Mediterranean (n=4)	++	=	+	=	-	-	=	14-41.3
Western Pacific (n=0)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

-- none, - less than half, =half, +more than half, ++all, n/a not mentioned

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