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Review

Epidemiology of burn injury and the ideal dressing in global burn care – Regional differences explored

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ABSTRACT

Purpose: Burn injuries are to this day a major cause of morbidity and mortality, especially within low- and middle-income countries. Understanding the etiology of burn injury and epidemiologic- and hospital-specific factors associated with burns is vital for allotting resources for prevention and treatment. Therefore, the purpose of this study was to develop a profile of epidemiological differences in burn care and the ideal burn dressing among the different continents based on a global online survey.

Objectives: This analysis evaluated trends in demographics, epidemiology of burn care, burn incidence, infection, related mortality and burn treatment (e.g., dressing changes and materials). The objective of this study was to investigate and compare the epidemiological profile of burn injury/care amongst the continents and a global control group to determine their utility for guiding evidence-based burn care and identify differences and/or similarities in their clinical practice.

Methods: A retrospective analysis of data was performed that was acquired during a previous study investigating the ideal burn dressing on a global perspective. The data was analyzed depending on the continent, on which the respondent indicated their hospital to be (Africa, Australia & New Zealand, Asia, Europe, Middle and South America, North America). Statistical analysis was performed to evaluate patient and hospital demographics and variables associated with burn injuries and their treatment. Outcomes of interest also included infections, mortality, length of stay on the ICU and important burn dressing characteristics.

Results: Healthcare providers in different areas of the world share similar views and needs regarding burn care management and on what constitutes an ideal burn dressing. We

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found significant differences in the various continents regarding hospitalization and length of stay on the ICU, with Australia taking the lead. Africa, with a high proportion of low-income-countries, reported the highest rate of burn infections, mortality, and a disproportionately high number of burn incidences amongst children. In general, men were mostly obtaining burn injuries amongst all continents. We found no significant differences regarding the most important characteristics of an ideal burn dressing.

Conclusion: Our results suggest significant epidemiological differences regarding burn injuries and care amongst the continents, possibly resulting from the different infrastructure and/or circumstances on the various continents. Future scientific studies need to focus on adequate pain management and designing longer lasting materials that contain the “ideal” properties, by also taking individual regional needs/desires and the patient’s perspective and economic boundaries into account. This analysis has delivered valuable insights into the epidemiological differences and/or similarities amongst the various continents.

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1. Introduction

Burn injuries are still among the global public health problems. Age, occupation, and socio-economic circumstances influence not only the incidence of burn injuries but also the risk of death due to burns [1]. The risk of burn death and/or burn injury are greatest among the low-development countries due to older buildings, lower safety standards, absence of smoke detectors, faulty electricity among others [2,3]. Socioeconomic development and different health care systems with varying access to medical supplies and resources result in different treatment strategies and thus outcomes, which need to be explored and addressed [4,5].

The treatment of burns is very complex as it involves not only the application of various topical creams or dressings, but also includes a high-level of right decision-making throughout the entire treatment process [6]. This is to avoid infection and other complications, which might prevent a quick healing process. For the last ten years, interest has risen in the advancements of global burn care. Due to the invention of multiple new dressings, treatment has proved to be very effective in a way that healing is promoted as well [7,8]. However, epidemiological differences and needs still have to be explored and addressed. The purpose of this study is to get a better understanding of burn incidences and burn treatment measures and the idea of the “ideal” burn dressing and what constitutes it on the various continents. Considering the vast amount of research in burn care, gaps are still inevitable. But it is the aim of the paper to demonstrate that amongst more recent studies such as “Global Burn Care and the ideal burn dressing reloaded – a survey among global experts” a general proper global perspective can be achieved, and thus also a glimpse into the state-of-the art on the different continents can be provided. In the study the results of a global survey about the optimal dressing material were published [5]. This follow-up investigation now serves to identify epidemiological/geographical differences regarding the different continents e.g., Europe, North America, Asia, Australia and New Zealand, Middle and South America, and Africa.

2. Materials and methods

The study design and protocol were approved by the ethical review committee of the Medical University of Graz (EK: 31–232 ex 18/19). The basic structure of the study has already been described in the publication by Nischwitz et al. [5] “Global Burn Care and the ideal burn dressing reloaded – a survey among global experts” [5]. Hence, merely a short summary of the materials and methods can be found in the following section.

2.1. Study design

The original questionnaire of a study in 2012 was taken, adapted, and expanded in the previous study from Nischwitz et al. [5]. Apart from adding questions about characteristics of a dressing material, sections of in-hospital management and epidemiology in the hospital were included. For the

purpose of this study, the gathered data has been re-organized and re-analyzed looking at each individual continent in order to be able to identify differences and/or similarities in burn care. A total of 901 experts have been contacted via email with 101 e-mails unsuccessfully delivered. Of the remaining 800 experts 196 persons started and 135 completed the questionnaire, resulting in a response rate of 24.5 % and a total response rate of 16.9 % [5].

2.2. Data protection

All data was collected anonymously through SurveyMonkey, and no confidential or sensitive information was shared.

2.3. Statistical analysis

The data was sorted by continent and evaluated on an intercontinental basis using means, standard deviation, and other means of descriptive analysis and ANOVA. Data analyses were conducted via Microsoft Excel and SPSS. Numerical scores were pooled and averaged. Level of significance was set to $p = .05$.

3. Results

A total of 901 experts have been asked via email to participate in this online survey with 101 e-mails yielding an unsuccessful delivery. Of the remaining 800 addressees, 196 respondents from 49 countries took part in this survey in a four-week period, equaling a response rate of 24.5 %. The here presented results are part of the previous study by Nischwitz et al. but have been reviewed and re-analyzed per continent [5].

3.1. Epidemiology

3.1.1. Characteristics of respondents

Of all responders, $n = 196$, 14 (7.14 %) were from North America, 10 (5.10 %) from Australia and New Zealand, 29 (14.79 %) Middle and South America, 43 (21.94 %) Europe, 14 (7.14 %) Africa, and 86 (43.37 %) were from Asia. Detailed results are displayed in Table 1 and Fig. 1.

Responders declared their profession as follows: surgeons 152 (77.55 %), anesthesia or emergency department 15 (7.56 %), nursing staff 4 (2.04 %), physiotherapist 7 (3.57 %), other medical professions 18 (9.18 %). Detailed results showing distribution on each continent are given in Fig. 2.

Table 1 – List and frequency distribution of participants sorted by region/continent in (N = 196).

Continent	N	%
North America	14	7.14
Australia and New Zealand	10	5.10
Middle and South America	29	14.79
Europe	43	21.94
Africa	14	7.14
Asia	86	43.37
Total	196	100

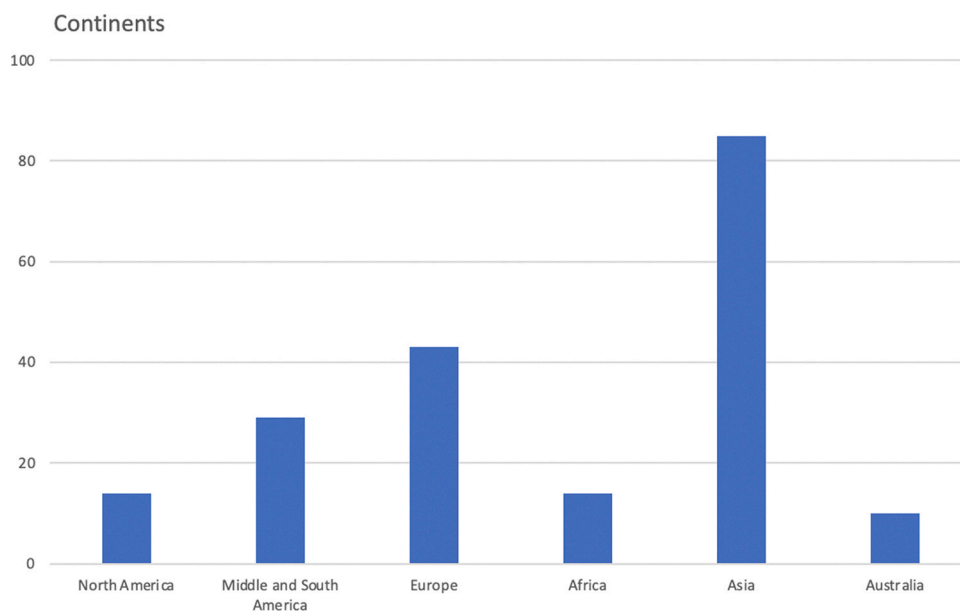


Fig. 1 – Bar chart of the participants sorted by continents.

140 (71.4 %) of the respondents were male, 55 (28.1 %) female, and 1 (0.51 %) stated “Other” as their gender. The mean age was 41.76 years (SD: 10.76, range: 18–68) and the average work experience was 15.16 years (SD: 10.31, range: 1–40). [Table 2](#).

3.2. Burn cases

3.2.1. Trends in burn incidence and length of hospital stay (ICU)

On a global scale, the number of burn patients per year was indicated at 101–205 by most participants (19.62 %). 64.81 % of admitted patients were over the age of 18, with 56.38 % being male patients, while 35.19 % were children. The most chosen answer about the length of hospital stay was 11–14 days (29.75 %). The average patient (22.15 %) spent 21 or more days on the ICU.

3.2.2. North America

The number of burn patients per year was indicated at 501–1000 by most respondents (35.7 %). 74.55 % of burn patients were adults (37.37 % male patients), while 25.45 % of people admitted to the hospital were children (0–17 years). Most patients met the criteria of having major burn injuries and were cared for on the ICU, with an average stay of 8–10 days (35.7 %).

3.3. Australia and New Zealand

The majority (30 %) stated the number of admitted burn patients per year to be more than 2000, with on average 3 days or less on the ICU (40 %). 57.5 % of all burn incidences concerned adults, while 42.5 % of burn patients admitted were children between 0 and 17 years.

3.3.1. Africa

Most respondents (21.43 %) stated that on average less than 50 burn patients were treated per year, with an average of 3 days or less (28.57 %) on the ICU. While 57.95 % of burn injuries affected adults (43.75 % male patients), 63 % of patients admitted to the hospital were children and 37 % adults with a percentage of 58 % male patients.

3.3.2. Middle and South America

The most chosen number of burn patients annually admitted to the hospital was between 101 and 250 (24.14 %) and 20.69 % of respondents indicated that burn patients spent about 11–14 days on the ICU. On average 45 % of admitted patients were below the age of 18. 55 % were adults (41.20 % male patients).

3.3.3. Europe

Generally, the number of treated burn patients per year in Europe was indicated as 101–250 by most respondents (18.6 %). Regarding days on the ICU, most participants (each 16.28 %) stated 8–10 days or 15–20 days on the ICU. 32.4 % of burn patients admitted for treatment were children and 67.6 % adults (44 % male patients).

3.3.4. Asia

On average, the number of treated burn patients per year was between 501 and 1000 as indicated by most participants (17.64 %) with on average 21 or more days on the ICU (32.94 %). 35.4 % of all patients admitted were under the age of 18 %, and 64.6 % were adults, with a percentage of 54.94 % male patients.

In terms of the number of burn patients annually admitted to the hospital, Australia significantly differed from Middle and South America ($p = .003$), with more than 2000 burn patients admitted to the hospital each year. The average number of days in hospital significantly diverged compared

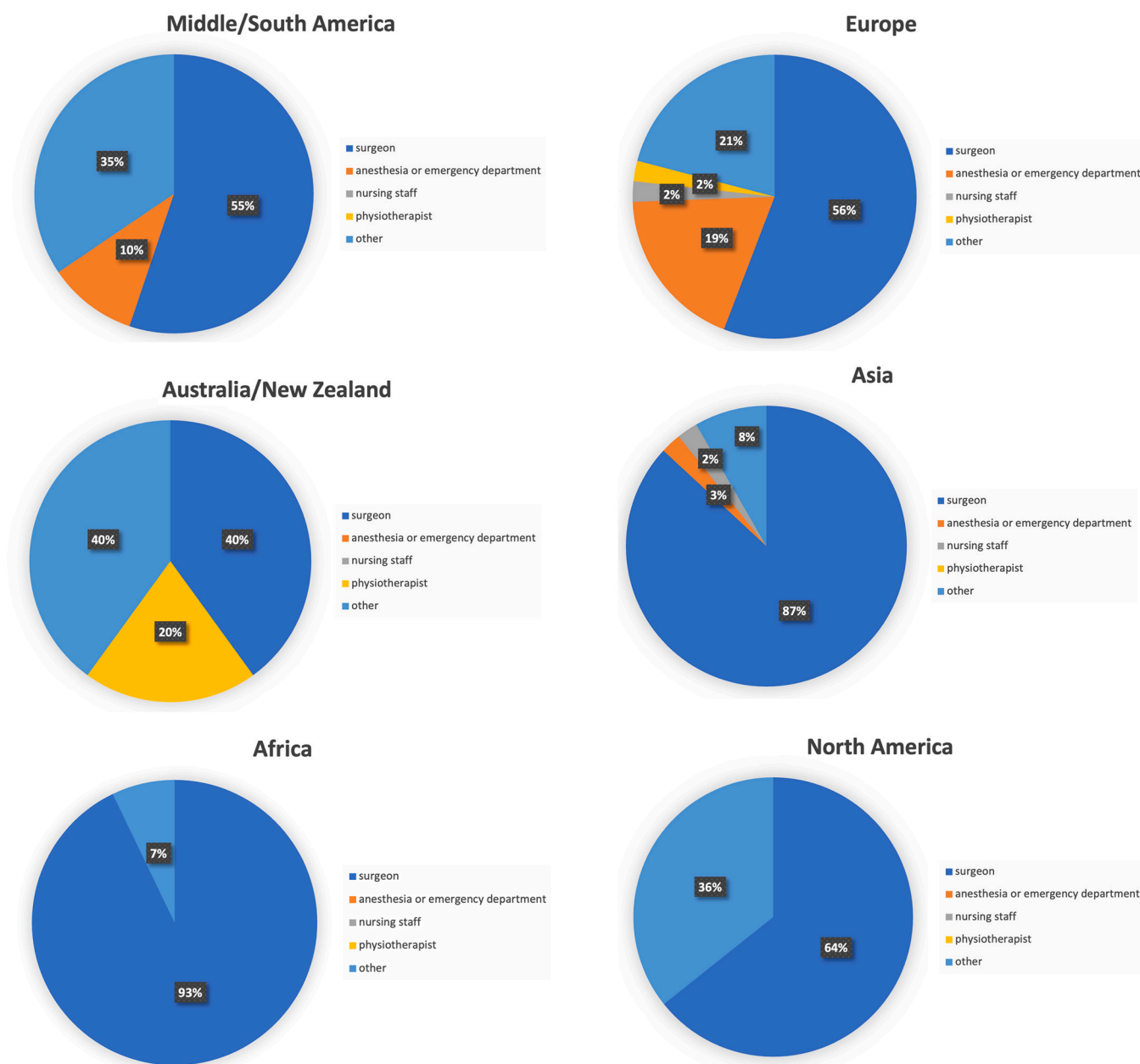


Fig. 2 – Distribution of Professions by Continent.

to the global control group ($p < .001$), while Australia showed a significantly lower number of days on the ICU compared to Asia ($p = .044$), Middle and South America ($p = .039$). North America significantly differed from Asia ($p = .029$) and Middle and South America ($p = .031$) with fewer days on the ICU.

Regarding burn injuries in children, we found no significant differences compared to the global control group, however, Africa showed a significantly higher rate of burn injuries in children than North America ($p = .008$), Europe ($p = .034$) and Asia ($p = .040$). No significant differences could be found amongst the other continents. In terms of inpatient/outpatient ratio and female/male gender, no significant

differences ($p < .05$) could be reported compared to the global control group. Further, no significant differences could be determined amongst the continents regarding the inpatient/outpatient ratio ($p = .090$). However, in terms of the male/female ratio, a significant difference could be described ($p < .001$) amongst the continents: North America admitted significantly fewer male patients in a year compared to Africa ($p = .005$) and Asia ($p < .001$). Regarding male patients admitted due to burn injuries, Europe showed a significantly lower rate compared to Asia ($p = .004$) and Africa ($p = .025$). Also, Middle and South America had a significantly low rate of male patients compared to Asia ($p < .001$) and Africa

Table 2 – Summary of the participant's origin sorted by continent.

North America	n	%	Africa	n	%
USA	8	4.08	Angola	1	0.51
Canada	6	3.06	Congo	2	1.02
Middle/SA	29	14.79	Kenya	1	0.51
Brazil	4	2.04	Malawi	1	0.51
Colombia	3	1.53	South Africa	4	2.04
Mexico	22	11.22	Tanzania	1	0.51
Europe	43	21.94	Uganda	3	1.53
Albania	2	1.02	Zambia	1	0.51
Austria	1	0.51	Asia	86	43.87
Belgium	3	1.53	China	64	32.65
Czech Republic	1	0.51	Hong Kong	1	0.51
Denmark	2	1.02	Indonesia	6	3.06
Finland	3	1.53	Iran	2	1.02
France	4	2.04	Iraq	1	0.51
Germany	2	1.02	Japan	2	1.02
Greece	2	1.02	Nepal	1	0.51
Ireland	1	0.51	Pakistan	1	0.51
Lithuania	1	0.51	Singapore	1	0.51
Netherlands	3	3.06	Taiwan	1	0.51
Poland	1	0.51	Thailand	1	0.51
Portugal	1	0.51	Afghanistan	1	0.51
Slovakia	1	0.51	India	4	2.04
Spain	6	3.06	Australia	10	5.10
Sweden	3	1.53	Australia	9	4.59
Turkey	1	0.51	Cocos (Keeling) Island	1	0.51
UK	5	2.55	Total	196	100 %

($p = .007$). In Africa, on the other hand, a significantly higher rate could be assessed compared to North America ($p = .005$), Europe ($p = .025$), Middle and South America ($p = .007$) and Asia also had a significantly higher rate of male patients compared to North America ($p < .001$), Europe ($p = .004$), and Middle and South America ($p < .001$).

3.4. Trends in burn infections

Globally, burn infections were notable in 26.93 % of the incidences. The largest proportion of local wound infection was noted in Africa with a total of 53.50 % in burn cases, followed by Europe (32.60 %), Asia (25.24 %), Middle and South America (23.80 %), North America (19.09 %), and Australia (13.75 %). No significant differences could be reported in burn Infections compared to the global control group (26.93 %) (see [Table 3](#)).

However, a significant difference in terms of the estimated share of local wound infections could be found amongst the following continents: Europe showed significantly fewer local wound infections than Australia ($p = .023$). However, in Africa a significantly higher rate of wound infections after burns could be detected compared to North America ($p < .001$), Australia ($p < .001$), Europe ($p = .007$), Middle and South America ($p < .001$) and Asia ($p < .001$).

Table 3 – Trends in Burn Infections compared to the global control group –.

Asia	$p = .76$
Africa	$p = .057$
Australia and New Zealand	$p = .84$
Europe	$p = .48$
Middle and South America	$p = .072$
North America	$p = .42$
(significant differences in bold; $p < .05$)	

Table 4 – Trends in Burn-Mortality compared to the global control group –.

Asia	$p = .0027$
Africa	$p = .69$
Australia and New Zealand	$p = .23$
Europe	$p = .31$
Middle and South America	$p = .23$
North America	$p = .045$
(significant differences in bold; $p < .05$)	

3.5. Trends in burn-related mortality

On a global scale, burn-related mortality was 18.27 %. Compared to the global control group a significant difference could be found ($p = .008$). The largest proportion of deaths was noted in Africa, with 23.5 % of burns with fatal consequences, which is higher than the global comparison (18.27 %), followed by Europe (12.40 %), South and Middle America (10.60 %), Australia (7.5 %), Asia (6.76 %) and North America (5.0 %). Compared to the global control group, significant differences could be reported for North America ($p = .045$) and Asia ($p = .0027$). All others did not show any significant differences compared to the global control group (see [Table 4](#)).

Amongst the continents, Africa showed a significantly higher mortality rate compared to North America ($p = .002$), Australia ($p = .015$), Europe ($p = .032$), Middle and South America ($p = .013$) and Asia ($p < .001$). No significant differences could be determined amongst all the other continents. [Table 5](#).

3.6. Burn treatment

3.6.1. Trends in burn treatment - dressing changes and materials

Globally, 35.14 % of respondents indicated their preferred dressing change interval to be “alternate days”, while 34.46 % quantified “twice weekly”, 22.30 % “weekly”, 6.76 % “daily” and 1.35 % indicated “other” without specifying. When dealing with superficial burns, 45.21 % of respondents opt for silver-based dressings, 26.71 % fatty gauze and 12.33 % dry materials. “Other” materials were stated in 15.75 %. 70.97 % of respondents indicated a dressing change time of 30 min or less, while 19.35 % stated 31 – 45 min, 1.61 % 46–60 min and 8.06 % answered over 60 min.

The most used dressings for deep burns are silver based (52.78 %), dry material (18.06 %), fatty gauze (15.97 %) and

Table 5 – Important dressing properties.

Global	North America	Australia/New Zealand	Middle/South America	Europe	Africa	Asia
1.lack of adhesion (80.54 %)	1. pain-reduction (92.8 %)	1. pain-reduction (97.2 %)	1.pain reduction (94.8 %)	1. pain-free dressing change (94 %)	1. requirement of fewer dressing changes (100 %)	1. pain-reduction (91.2 %)
2. pain-free dressing change (79.87 %)	2. requirement of fewer dressing change (91 %)	1. pain-free dressing change (97.2 %)	2. anti-infective (93 %)	2. anti-infective (91 %)	2. anti-infective (98 %)	2. anti-infective (89.4 %)
3. requirement of fewer dressing changes (72.48 %)	3. pain-free dressing change (89 %)	1. requirement of fewer dressing changes (97.2 %)	3. pain-free dressing change (92.2 %)	3. lack of adhesion (89 %)	2. pain-free dressing change (98 %)	3.pain-free dressing change (86.6 %)

miscellaneous “other” is indicated in 13.19 %. Mostly “other” corresponds to “surgery”. When treating deep burns, 37.5 % of respondents stated an average dressing time change of 30 min or less. 27.78 % indicated 31 – 45 min, followed by 20.82 % 46 – 60 min and 13.89 % over 60 min. On average, 5.51 dressing changes are performed until healing for superficial burns, while deep burns need an average of 8.02 changes.

3.6.2. North America

35.71 % of the respondents stated their desired dressing change interval to be “twice weekly”, while 21.43 % opted for “weekly”, 14.29 % “alternate days”, 7.14 % “daily”, and 21.43 % did not specify.

50 % of the respondents use silver-based dressings for superficial burns, followed by 28.57 % using fatty gauze, while no one stated to use dry material. 21.43 % did not specify. An average of 4.09 dressing changes are necessary until healing. An average dressing change time of 30 min was stated in 57.14 % of responses, followed by 14.28 % needing 31–45 min and 7.14 % 46–60 min 21.43 % did not answer the question.

When dealing with deep burns 35.71 % of the North American burn experts use silver-based dressings, while 14.29 % prefer fatty gauze, 7.14 % dry material, 14.29 % other, and 21.43 % did not give an answer. An average of 7.63 dressing changes are done until healing. An average dressing change time of 30 min or less was needed in 28.57 % of answers, while most take 31–45 min, 46–60 min or > 60 min (each 14.28 %) in the instance of deep burns.

3.6.3. Australia and New Zealand

30 % of the burn specialists preferred the desired dressing change interval to be “twice weekly”, while 20 % stated “weekly”, 10 % “alternate days”, 10 % other, and 30 % did not answer the question. When treating superficial burns 30 % generally use silver-based dressings, while in 20 % miscellaneous other materials (hydrocolloid or mepitel/cloth tape) are indicated. 10 % choose dry material and no one uses fatty gauze. 40 % did not answer the question. On average 3.17 dressing changes are needed until healing. A dressing change took about 30 min or less for 40 % of the respondents, while 10 % each required 31–45 min or 46–60 min. 40 % did not answer the question.

In the case of deep burns, 40 % usually use silver-based dressings, while 10 % prefer fatty gauze. 50 % did not answer the question. However, on average it involves 5.8 dressing changes until healing, each lasting 30 min or less in 20 % of the answers. 10 % each stated to involve 31–45 min, 46–60 min, or > 60 min per dressing change. 50 % did not answer the question.

3.6.4. Africa

Regarding the desired frequency of dressing change, 28.57 % of the respondents preferred their interval to be “twice weekly”, while 21.43 % stated “weekly”, 21.43 % “alternate days” and 21.43 % did not give any answer.

When dealing with superficial burns 21.43 % each uses silver-based dressings or fatty gauze, while 21.43 % opt for other materials such as banana leaf dressing and silver sulfadiazine cream. 7.14 % use dry material and 28.57 % did not answer the question. On average 6.3. dressing changes are

done until healing. An average dressing change time of 31–45 min was stated in 28.57 % of responses, followed by 30 min or less in 21.43 %, 46–60 min in 14.28 % and > 60 min in 7.14 %.

In the case of deep burns, 42.86 % use silver-based dressings, followed by 28.57 % applying fatty gauze. 28.57 % did not answer the question. It takes an average of 9.2 dressing changes until healing, while the time for a dressing change was between 31 and 45 min in 28.57 % of the responses. 21.43 % stated that it took them more than 60 min, 14.28 % 46–60 min and 7.14 % 30 min or less. 28.57 % did not answer the question.

3.6.5. Middle and South America

48.28 % of the respondents found a “weekly” dressing change interval worth striving for, while 13.79 % stated “twice weekly”, 13.79 % “alternate days”, 3.45 % “daily”, and 20.69 % did not answer the question.

Superficial burns are mainly treated with silver-based dressings (31.03 % of responses), while fatty gauze (20.69 %), and “other” (20.69 %) are equally used. 3.45 % of the respondents use dry material, while 24.14 % did not answer the question. On average it takes 4.04 dressing changes until healing. 41.38 % stated taking 30 min or less for a dressing change, while 20.69 % needed 31–45 min, 10.34 % 46–60 min or less, and 3.45 % more than 60 min. 24.14 % did not specify.

When dealing with deep burns silver-based dressings are mainly used in 37.93 % of responses. 13.79 % use fatty gauze and 24.14 % used “other” not specified materials. Dry materials are not typically used. 24.14 % did not state their preference. On average it involves 5.23 dressing changes until healing, lasting 30 min or less in 31.03 % of the responses. 20.69 % required 31–45 min, 13.79 % between 46 and 60 min and 10.34 % more than 60 min on average. 24.14 % did not specify.

3.6.6. Europe

20.93 % of the respondents desired a dressing change “twice weekly”, while 9.3 % stated “weekly”, 6.98 % “alternate days”, 4.65 % “daily”, 2.33 % “other”, and 55.81 % did not answer the question. To treat superficial burns silver-based dressings are primarily used in 18.6 % of the responses, followed by fatty gauze 13.95 %, and “other” 11.63 %. No one indicates to use dry materials and 55.81 % did not answer the question. On average it takes 4.95 dressing changes until healing, compared to 7.11 dressing changes when dealing with deep burns. 20.93 % stated to take 30 min or less for a dressing change, while 13.95 % needed 31–45 min, 4.65 % 46–60 min and 4.65 % more than 60 min. 55.81 % did not specify the time frame. When dealing with deep burns 23.26 % of the respondents use silver-based dressings, followed by 11.63 % fatty gauze, 4.65 % dry material, 4.65 % “other”, and 55.81 % did not answer the question. 16.28 % stated to require between 46 and 60 min for a dressing change, followed by 13.95 % 30 min or less, 9.3 % between 31 and 45 min, 4.65 % more than 60 min, and 55.81 % did not specify.

3.6.7. Asia

44.71 % of the respondents stated their desired dressing interval to be “alternate days”, while 31.76 % opted for “twice weekly”, 8.24 % “weekly”, 7.06 % “daily”, and 7.06 % did not specify/answer. In the instance of a superficial burn 42.35 % primarily use silver-based dressings, while 23.53 % opt for fatty gauze, 18.82 % dry material, 8.24 % “other”, and 5.88 % did not answer the question. On average 6.33 dressing changes are needed until healing. 63.53 % stated that it takes 30 min or less for a dressing change, while 20 % require between 31 and 45 min, 5.88 % more than 60 min, and 2.35 % between 46 and 60 min. 7.06 % did not specify. When dealing with deep burns, 47.06 % prefer silver-based dressings, followed by 27.06 % using dry material, 8.24 % fatty gauze, 8.24 % “other”. 8.24 % did not answer the question. 9.1 dressing changes are necessary on average until healing. 37.65 % stated 30 min or less for a dressing change, while 25.88 % require between 31 and 45 min, 16.47 % 46–60 min, and 10.59 % more than 60 min. 8.24 % did not specify.

3.6.8. Statistical significance

The amount of dressing changes until healing did not significantly differ from the global control group for superficial and deep burns. However, we found significant differences regional differences in the number of dressing changes till healing for superficial burns ($p < .001$). Africa had significantly more dressing changes compared to North America ($p = .047$), Australia ($p = .009$) and Middle and South America ($p = .011$). Asia also showed a significantly higher number of dressing changes compared to North America ($p = .006$), Australia ($p < .001$), Europe ($p = .019$) and Middle and South America ($p < .001$).

Further, the number of dressing changes till healing also significantly differed amongst the continents regarding deep burns ($p < .001$). Africa had significantly more dressing changes compared to Australia ($p = .012$) and Middle and South America ($p = .005$), while Asia also had significantly more changes compared to Australia ($p = .006$), Europe ($p = .030$) and Middle and South America ($p < .001$).

Regarding dressing material used in burn care for superficial burns, no significant differences were found amongst the continents ($p = .144$). However, for deep burns we found noteworthy differences ($p = .006$) as Asia uses more dry material compared to the other continents.

3.6.9. Wound care

In general, the most used antiseptic solution is iodine-based (36.88 %), while 23.40 % use polyhexanide and 2.13 % octenidine. 15.6 % do not use any antiseptic solution, while 21.99 % use miscellaneous other [5].

In North America, it was noted that miscellaneous “other” is used according to 28.57 % of the respondents, while 21.43 % stated to use polyhexanide, 7.14 % octenidine, 7.14 % iodine-based, and 7.14 % use none. 7.14 % did not answer the question. Similarly, in Australia, 30 % use “other” (e.g., chlorhexidine, plain soap), while 20 % prefer polyhexanide. 50 % did not answer the question.

However, in Africa, it was indicated that 71.43 % use “other” (e.g., chlorhexidine), while 42.85 % opt for an iodine-based antiseptic solution. 21.43 % stated to use polyhexanide, while 28.57 % did not provide any answer.

The most used antiseptic solution in Middle and South America is a miscellaneous “other”, followed by polyhexanide 20.69 %, iodine-based 10.34 %, while 24.14 % did not specify.

18.60 % of respondents stated to favor “other” solutions in Europe, followed by 13.95 % using polyhexanide, 4.65 % equally iodine-based solutions and octenidine. 58.14 % did not provide any answer.

47.06 % of respondents prefer an iodine-based antiseptic solution in Asia, while 15.29 % favored polyhexanide, 3.53 % miscellaneous other. 23.53 % stated to use no kind of antiseptic solution and 9.41 % did not answer the question.

3.7. Characteristics of the ideal burn dressing

3.7.1. Trends in “ideal” burn dressings

Globally the following three characteristics were considered as “extremely important” or “important” for an ideal burn dressing: 1. lack of adhesion (80.54 %), 2. pain-free dressing change (79.87 %), 3. fewer dressing changes (72.48 %).

Significant differences were found amongst the continents regarding the following characteristics: cooling effect ($p = .002$), diagnostic abilities ($p = .002$), non-bulkiness ($p = .017$) and fewer dressing changes ($p = .000$). Except for fewer dressing changes, all the other significantly differing characteristics were amongst those considered of less importance. We found no significant regional differences amongst the “extremely important” or “important” characteristics amongst the continents.

3.7.2. Ranked characteristics

On a global level, the characteristics of an “ideal” burn dressing were ranked as follows: 1. anti-infectiveness (average rank 3.11), 2. pain-free dressing change (average rank 3.30), and 3. pain-reduction (average rank 3.92). The lowest ranked characteristics were 10. self-adhesiveness (average rank 8.77), and 11. non-bulkiness (average rank 8.78) [5]. An overview of the ranking of each continent is presented in Table 6.

Africa and Asia considered Lack of adhesion to the wound to be amongst the top three characteristics, while in Africa anti-infective was regarded off less importance compared to the other continents/regions and the global control group. In general, the lowest ranked characteristics were non-bulkiness, cooling-effect, and self-adhesiveness, though the order differed from continent to continent. Results are detailed in Fig. 3 below.

4. Discussion

In this study, global burn experts shared their experience with burn care and epidemiology, allowing us to gather valuable data about clinical burn practices on the different continents and globally [5]. In the following, the results of the respective continents’ representatives are termed as the continent itself; this does not imply any generalization but is

Table 6 – Summary of the most important characteristics (1st–3rd) and least important (10th–11th) ranked for each continent.

	Global	North America	Australia/New Zealand	Middle/South America	Europe	Africa	Asia
1st	anti-infective (average rank 3.11)	anti-infective (average rank 2.44)	pain-free dressing change (average rank 2.15)	anti-infective (average rank 3.73)	pain-free dressing change (average rank 2.40)	pain-reduction (average rank 2.86)	anti-infective (average rank 2.66)
2nd	pain-free dressing change (average rank 3.30)	pain-free dressing change (average rank 3.44)	anti-infective (average rank 3.70)	pain-reduction (average rank 3.86)	anti-infective, pain-reduction (average rank each 3.70)	lack of adhesion (average rank 3.71)	pain-free dressing change (average rank 3.21)
3rd	pain-reduction (average rank 3.92)	pain-reduction (average rank 3.56)	pain-reduction (average rank 3.80)	pain-free dressing change (average rank 4.00)	lack of adhesion (average rank 5.40)	Pain-free dressing change (mean 4.86)	lack of adhesion (average rank 3.82)
10th	self-adhesiveness (average rank 8.77)	non-bulkiness (average rank 8.64)	cooling effect (average rank 8.00)	self-adhesiveness (average rank 8.48)	non-bulkiness (average rank 8.75)	self-adhesiveness (average rank 8.50)	self-adhesiveness (average rank 8.86)
11th	non-bulkiness (average rank 8.78)	cooling effect (average rank 10.00)	diagnostic abilities (average rank 8.57)	non-bulkiness (average rank 9.35)	self-adhesiveness (average rank 9.30)	non-bulkiness (average rank 9.10)	non-bulkiness (average rank 8.96)

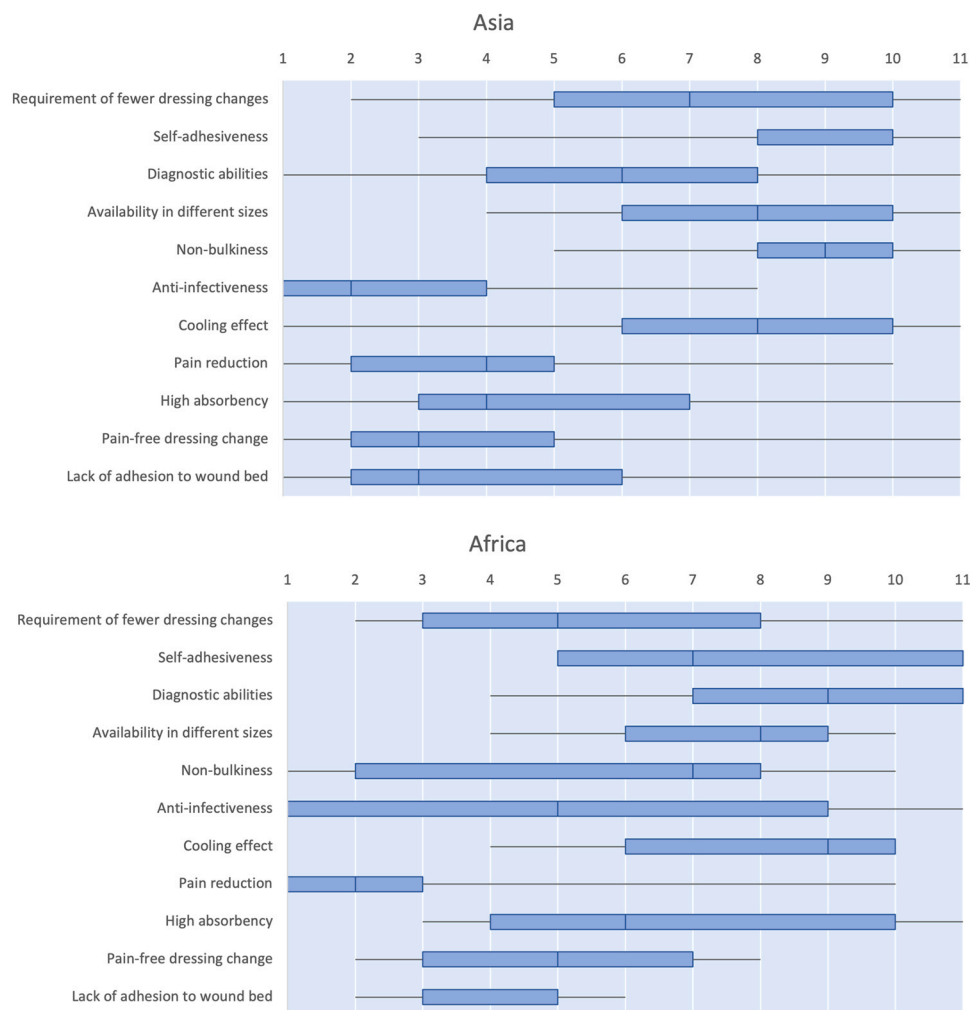


Fig. 3 – Dressing characteristics ranked by importance if no tie was possible, sorted by continent. The ranks of 1–11 could be assigned to the characteristics resulting in an average rank for every characteristic.

used to demonstrate our results more clearly. The precise global occurrence rate of burn injury is unknown but according to the World Health Organization at least 265,000 deaths are attributed to burns and fires per year. Burns are thus still responsible for a high mortality and long-term morbidity, leaving burn care a highly relevant clinical practice. The burden of burns disproportionately seems to fall to the world's poor residing in developing countries [9]. Severe burn injuries are not only physically debilitating but affect different organ systems leading to high morbidity and mortality rates and thus benefit from interdisciplinary treatment [7].

However, the lack of access to safe and affordable surgical treatment, on a global level, results in approximately 5 billion people without appropriate access to acute burn management [9].

In terms of burn incidents, our data shows that most of all severe burns occur in Africa and South-East Asian regions. Further, we found that children in low-income countries are more often burned than children in high income countries. A staggering 18.27 % of burn victims die from burns each year

according to our data. The mortality rate from burns is disproportionately higher in developing countries (e.g., Africa 23.5 %). These findings agree with those in the literature [9–13]. As Stokes and Johnson suggest risk factors for burns vary between regions, age groups and sexes [9]. Adult males are most at risk for burns at the workplace (faulty electrical wiring, flames, scalds), whereas women are at higher risk of burns at home, particularly in the kitchen given that these gender-related stereotypes are still “alive” in many regions. The unsupervised usage of e.g., homemade fireworks by children during festivities might also result in an increase of burn incidence in low-income countries. Babies and children under the age of one are at most risk from burns from bed netting and sleepwear, but also due to faulty electrical wiring or simple devices such as mosquito coils [14]. Local traditional practices e.g., hot water baths after childbirth, which are unique to some African countries and/or South American countries add to the risk of burns respectively scalds. In general, being unemployed, a low socioeconomic status, alcohol and tobacco use, drug consumption or being a victim of crime or assaults are independent risk factors for burns

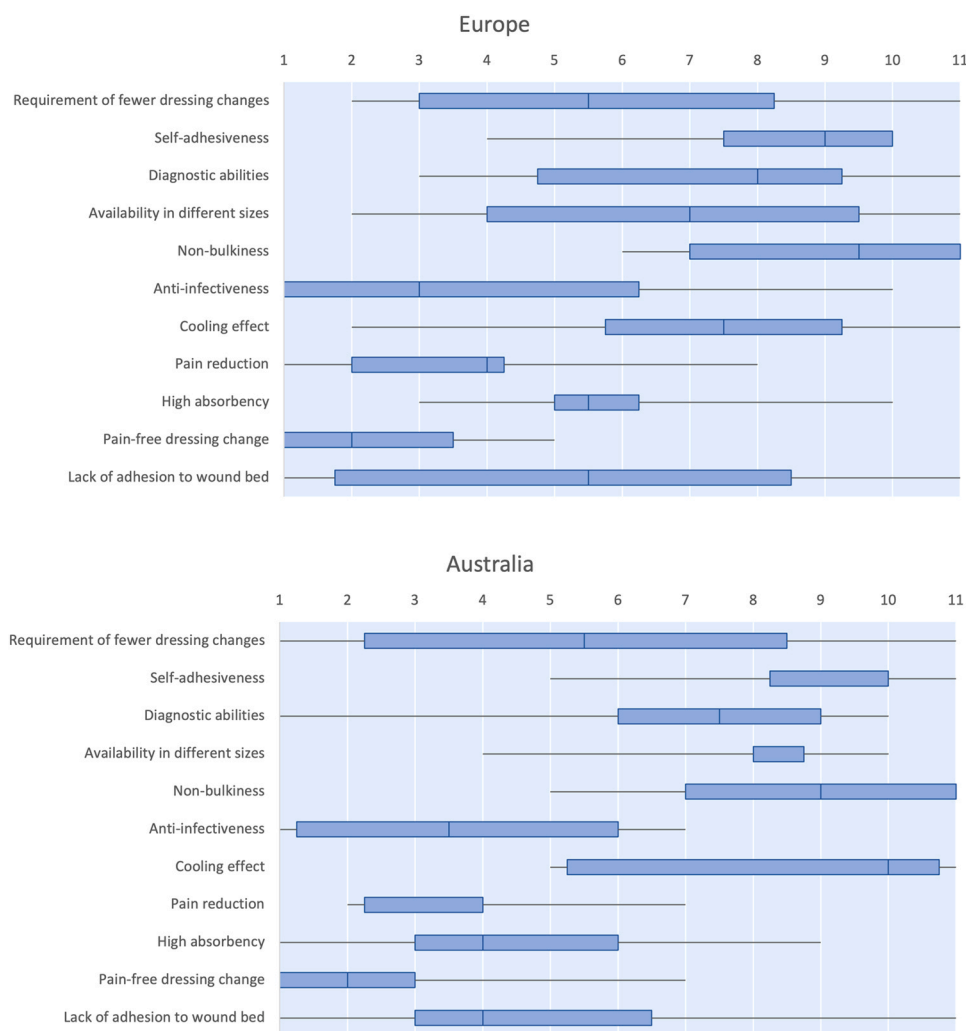


Fig. 3 – (continued)

throughout all regions [9,14]. Limited data have been published that offer a clear picture of the epidemiology of burn care. On a global scale overall morbidity and mortality of burn wound infections, secondary sepsis or tissue invasion have decreased in recent years as the growth of bacteria on a wound surface can be controlled and eradicated more effectively [15]. However, major advances in burn care have reduced burn morbidity and mortality. Standard-of-care regimes have been established, which allowed for an introduction of new wound-healing modalities in the clinical setting [16,17].

Regarding hospitalization and length of stay on the ICU, Australia significantly differed from Middle and South America with more than 2000 burn admissions to a hospital each year, followed by Asia and North America with each 501–1000 admissions, and Middle & South America and Europe each stating 101–250 annual admissions. Surprisingly, most respondents in Africa stated to have less than 50 admissions a year due to burn injury. This is a rather low number, which is not coherent with findings in the literature. However, this can be due to the low rate of African participants or possibly hospitals not being adequately equipped

with burn beds/wards. On average, patients spent the most time on the ICU in Asia (approximately 21 or more days), followed by Europe (approximately between 8 and 20 days), Middle and South America (11–14 days), North America (8–10 days). Africa and Australia reported only 3 days or less on the ICU. This could be because of lower incidences of severe burn injuries. However, data on severity of burn injuries was not collected as part of this study.

In Africa children are the most common victims of burn injury. In our study it was found that burns in children made up 63 % of reported burn injuries in Africa, while North America, Europe, and Asia show significantly lower numbers. No significant differences could be found amongst the other continents. This could be because children have access to unsupervised usage of e.g., homemade fireworks during festivities, faulty electrical wiring, or simple devices such as mosquito coils or they are scalded in the home kitchen or cooking area as stated in the literature [9]. No differences could be reported regarding inpatient/outpatient ratio. However, North America reported the lowest rate of male patients (37,37 %) admitted per year, while Africa had a significantly higher rate (58 %) compared to the other continents or the

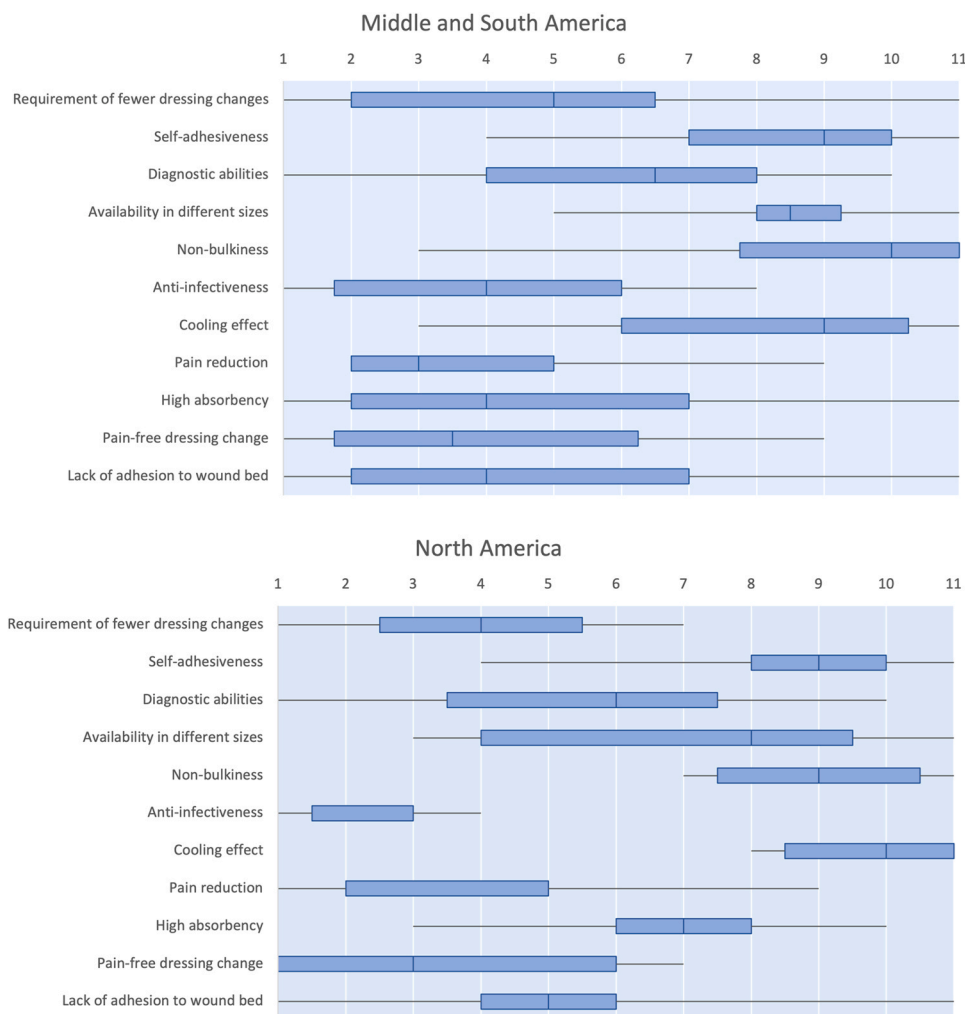


Fig. 3 – (continued)

global control group. In general, more men than women (56.58 %) were admitted to hospitals due to burn injuries. These findings are coherent with the literature. [18–22]. Burn-related mortality rates were also disproportionately high in Africa (23.5 %), which is higher than the global comparison (18.27 %). This could again be due to a lack of or only minimal access to infrastructure and appropriate burn care management (including pre-hospital management), but also since relatively many countries in Africa are to be attributed to the low-income-countries with worse equipped hospitals. Further, Africa had the highest rate of burn infections, stating 53.50 %. The reason could be that most burn victims' households might not be well equipped in terms of water supply to enable administration of recommended initial care. However, this could also be due to a lack of appropriate prevention and education programs at the pre-hospital stage, especially in terms of what to do immediately after the injury occurred [23,24]. Further reasons might be a lower availability of sanitation facilities and poorer standards in terms of housing, burn education, safe appliances, and legislation [20,24,25].

Regarding burn treatment our findings suggest that amongst all continents silver-based burn dressings were preferred in superficial and deep burns. Asia uses significantly more dry material for deep burns compared to the other continents. Significant differences regarding number of dressing changes till healing for superficial burns could be detected in Africa, where more dressing changes were needed until healing. Asia also noted a higher number of dressing changes. This could again be due to different treatment standards in different regions.

We found no significant regional differences amongst the “extremely important” or “important”. However, pain-reduction and/or pain-free dressing changes are considered “extremely important” or “important” by most continents. One of the reasons could be that the majority of respondents are from regions where the supply of pain medication/anesthesia is not sufficient at this point, which might result in painful dressing changes [5]. The use of fewer dressing changes as an “extremely important” or “important” aspect might imply the need for long-term dressings. Generally, the findings

amongst the different continents were coherent with the global results of Nischwitz et al. Despite the relatively high numbers in Africa, there seems to be a highly effective infection control regime in place, drawing the attention to rather other more urgent issues such as pain management at this point.

The on average highest ranked characteristics on a global scale were 1) anti-infective (average rank 3.11), 2) pain-free dressing change (average rank 3.30), and 3) pain-reduction (average rank 3.92). Interestingly, in Africa anti-infective was not ranked amongst the top three characteristics. This might have lower priority due to poorer sanitation and hygiene standards. This is also supported by the higher rate of burn wound infections (53.50 %) and a higher mortality rate (23.5 %). Africa and Asia considered Lack of adherence to the wound to be amongst the top three characteristics. We found significant differences amongst the continents regarding the following characteristics: cooling effect ($p = .002$), diagnostic abilities ($p = .002$), non-bulkiness ($p = .017$) and fewer dressing changes ($p = .000$). Except for fewer dressing changes, all the other significantly differing characteristics were amongst those considered of less importance.

Our findings emphasize significant epidemiological differences regarding burn care amongst the continents, possibly resulting from the different infrastructure and/or circumstances on the various continents. As Nischwitz et al. have already pointed out 85 % of respondents think the choice of wound dressing can reduce the number and length of hospital stay, and thus reduce the treatment costs. This would be especially beneficial in middle- or low-income countries, where medical resources are a scarcity or inadequate, and burn incidence is high. [5].

5. Strengths and limitations

With a complete response rate of 16.9 % and a response rate of even 24.5 % an increase of the rate from the previous study (12.1 %) could be achieved. [5,17] The characteristics of the respondents and affiliated hospitals as given in detail in the Result section indicate an overall good coverage of participating countries and regions (see Table 1). To the authors' knowledge, this is the first analysis of the epidemiology in burn care and clinical practice among the different continents. We were able to broaden the scope and gather valuable data and insights into the status of burn management in the regions, and thus, it was possible to compare the data, based on the records previously gathered by Nischwitz et al. While Nischwitz et al. have reported on their study to investigate the question of what constitutes the ideal burn dressing and gain valuable information about burn practice on a global level, the present study primarily focused on epidemiological and geographical differences regarding burn management. By doing so, this paper allows for a country/continent specific comparison in burn care.

However, the present study also does not take the patient's perspective into account; therefore, all answers merely represent the professional's account. Further, the number of participants is unevenly distributed amongst the different continents, and thus more general statements are

limited especially regarding numerically underrepresented regions, which leads to a certain under-power. For this reason, future studies should focus on an appropriate and evenly distributed number of individuals enrolled to also lower the possibility of biased conclusions. The reported results should not be considered in a competitive, but a complementing manner.

Further limitations of the present analysis include the fact that an online-based survey of this length is time-consuming and thus might lead to participation bias. For this reason, the answers should be considered only an estimate and cannot be fully verified. Additionally, some of the questions might have been misunderstood or misinterpreted by some respondents, and consequently answers might be solely based on their assumptions. Also, it is possible we too might have misinterpreted the results/misunderstood the answers as often only categorical answers were possible, which could create a distortion. A final limitation is that underlying reasons for burn injuries need to be identified, in order to inform policy makers and engage in discussion focused on alleviating the exposure to these type of injuries for certain areas.

Future research and studies need to focus on the detailed needs of specific regions, especially developing countries, to lay a solid foundation for further improvement of clinical practice in burn care, taking into consideration legislation and burn education as well, and additionally the opening of markets that have not been reached by industrial partners yet. Also, large scale studies with longitudinal follow-up is indicated, which not only showcase the experts' experiences and opinions but also the patients' account.

6. Conclusion

In conclusion, this study shows that significant advancements have been made in burn trauma management and research in the past few years. As a result, the infection and mortality rates have been improved with significantly reduced hospital stays, and thus a decrease in costs for patients and medical services. However, some questions and challenges still need to be addressed to improve current burn care. This study was originally conducted to investigate the question of what constitutes the ideal burn dressing on a global scale. However, this paper focused on the epidemiological and geographical differences and/or similarities regarding burn care and gives valuable insights on recent trends in burn treatment and clinical practice, while taking into consideration the similarities and/or differences in different areas of the world. Data from low development countries was more heterogeneous compared to highly and medium developed countries. Legislative changes, successful prevention programs, and increased workplace safety measures might contribute to the decreasing number of burn admissions and the overall reduction of mortality rates. However, data are lacking in developing countries. This study suggests an increasing focus on appropriate pain management or patient comfort in general, which includes pharmacologic and non-pharmacologic approaches, as a central component of the complex issues which are involved in the treatment of burn patients. Future research and product development should

therefore focus even more on this matter. To address this knowledge gap, the importance of further research on global burn care needs to be conducted, especially focussing on the epidemiology of the continents and the current available infrastructure in burn management pointing out individual needs (e.g., pain management) to lay the groundwork for further improvement of burn care, thereby also considering the patient's perspective, which has been left out up to now.

Conflict of interest statement

No conflict of interest is declared.

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