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Impact of COVID-19 on global burn care

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ABSTRACT

Background: Worldwide, different strategies have been chosen to face the COVID-19-patient surge, often affecting access to health care for other patients. This observational study aimed to investigate whether the standard of burn care changed globally during the pandemic, and whether country´s income, geographical location, COVID-19-transmission pattern, and levels of specialization of the burn units affected reallocation of resources and access to burn care.

Methods: The Burn Care Survey is a questionnaire developed to collect information on the capacity to provide burn care by burn units around the world, before and during the pandemic. The survey was distributed between September and October 2020. McNemar`s test analyzed differences between services provided before and during the pandemic, $\chi 2$ or Fisher's exact test differences between groups. Multivariable logistic regression analyzed the independent effect of different factors on keeping the burn units open during the pandemic.

Results: The survey was completed by 234 burn units in 43 countries. During the pandemic, presence of burn surgeons did not change ($p = 0.06$), while that of anesthetists and dedicated nursing staff was reduced (< 0.01), and so did the capacity to manage patients in all age groups ($p = 0.04$). Use of telemedicine was implemented ($p < 0.01$), collaboration between burn centers was not. Burn units in LMICs and LICs were more likely to be closed, after adjustment for other factors.

Conclusions: During the pandemic, most burn units were open, although availability of standard resources diminished worldwide. The use of telemedicine increased, suggesting the implementation of new strategies to manage burns. Low income was independently associated with reduced access to burn care.

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1. Introduction

Since the first outbreak at the end of 2019, the SARS-Corona Virus-2 spread quickly around the world, causing the so-called COVID-19 pandemic, a global public health care emergency [1]. In the effort to constrain the spread, many countries embraced measures to guarantee social isolation, limiting outdoors activities, and thereby creating the risk of increasing domestic accidents leading to burn injuries [2,3]. However, preliminary data on global trends in burn injuries are inconsistent [4–8], as the pandemic is still ongoing.

Countries around the world have chosen different ways of dealing with the pandemic while endeavoring to ensure access to health care, often changing surgical priorities [9], and burn care has not been exempt [10]. Which factors influenced the strategies chosen to face the surge has yet to be evaluated; has geographical proximity led to similar measures or was the spreading pattern of the COVID-19 the deciding factor? Was the ability to provide burn care protected by the wealth of the countries or the skill level of their burn units?

This study aimed to investigate these questions during the pandemic: whether country´s income, geographical location, transmission pattern of the virus, and levels of specialization of the burn units changed the standard of burn care, were associated with the reallocation of resources at burn units and were independently associated with keeping the burn units open.

2. Method

2.1. *Development and distribution of the Burn Care Survey*

For this observational study, a survey in English was developed between June and September 2020 after one-on-one interviews with burn experts from all the World Health Organization (WHO) regions, co-authors in this study. Preliminary drafts of the survey were shared with the co-authors for pretesting feasibility and ensure that queries were understood by respondents, and the final form was outlined once majority consensus was reached. The Burn Care Survey includes 84 questions on 4 items: standard of burn care before the pandemic, standard of burn care during the pandemic, reallocation of resources during the pandemic, and strategies to monitor the COVID-19 spread at the burn unit (Supplementary Table S1).

In the absence of official lists reporting all burn units in the world, snowball sampling was chosen as an affordable distribution method, such that research participants were asked to contribute to the recruitment of further respondents suggesting potential subjects among their acquaintance. With the effort to control the sample composition and reduce bias, an email containing the link to the survey and the instructions for the distribution method, was sent by the study-coordinator to the contacts suggested by the co-authors. The Burn Care Survey was distributed between the 1st of September and the 1st of October 2020, and deadline for completing the survey was the 15th of October 2020. However, since the survey was anonymous, it was not possible to track whether the link was shared independently by the respondents to other burn units, and the response rate was calculated on the number of links sent by the study coordinator. We excluded those surveys where only the geographical location was reported. In case of doublet (surveys regarding the same country and city, completed by the same IP-address), we included the one with the most completed data and/or the latest completed survey. The responses included in the analysis were unweighted.

The respondents were categorized in:

- WHO-regions: African Region, European Region, Eastern Mediterranean Region, Region of the Americas, South-East Asia Region, and Western Pacific Region [11].
- World Bank income groups based on the gross national income per capita (GNI) of their country in 2020: low-income countries (LICs, GNI≤$1035 in 2019), lower middle-income countries (LMICs, $1036 ≥GNI≤$4045), upper middle-income countries (UMICs, $4046 ≥ GNI≤$12,535), and high-income countries (HICs, GNI≥$12,536).
- Transmission patterns of the COVID-19, based on the data reported by the WHO 11 October 2020, according to which countries were listed as those with no cases, sporadic cases (few locally detected), clusters of cases (clustered in time, geographic location and/or by common exposures), and community transmission (larger outbreaks in unrelated clusters, in several areas of a country) [12]. Nation´s reassignments are performed regularly according to the most recent data reported to the WHO, which means that a country can change grouping over time.
- Specialization level of the burn units: we classified as specialized burn units, those with dedicated burn ward and burn intensive care unit, and as not specialized, those without dedicated burn ward or/and burn intensive care unit.

2.2. *Statistical analysis*

All variables were categorical and descriptive statistics were presented in frequency tables. Differences between groups were tested using Chi square or Fisher's exact test, as appropriate. Differences between access to resources and services provided before and during the pandemic were tested using McNemar`s test. The primary outcome of interest was keeping the burn unit open during the pandemic, and the predictors included in the multivariable logistic regression were income group, specialization level and transmission pattern of the virus. The area under the Receiver Operating Characteristics curve (AUC) for this model was calculated. Probabilities of less than 0.05 were accepted as significant and all tests were double sided. Statistical analyses were completed using Stata 15.1 (Stata Corp: College Station, TX, USA).

This study was exempted from Institutional Review Board by University of Iowa.

3. Results

The survey was sent to 971 burn units worldwide and 340 of (35%) them responded. After exclusion of those containing only geographical information (n = 90) and of duplicates (n = 16), 234 surveys from 43 different nations were included (Fig. 1, Table 1). Among the WHO-Regions, European Region had the lowest response rate (9%, 44 completed surveys of 500 sent), Western-Pacific Region the highest (58%, 47 of 81). Most respondents were in countries with community spreading (155/234), one third had cluster of cases (78/234), and only Fiji reported sporadic cases; none of the burn units were in countries without cases. Kuwait and Spain shifted their spreading pattern from cluster of cases to community

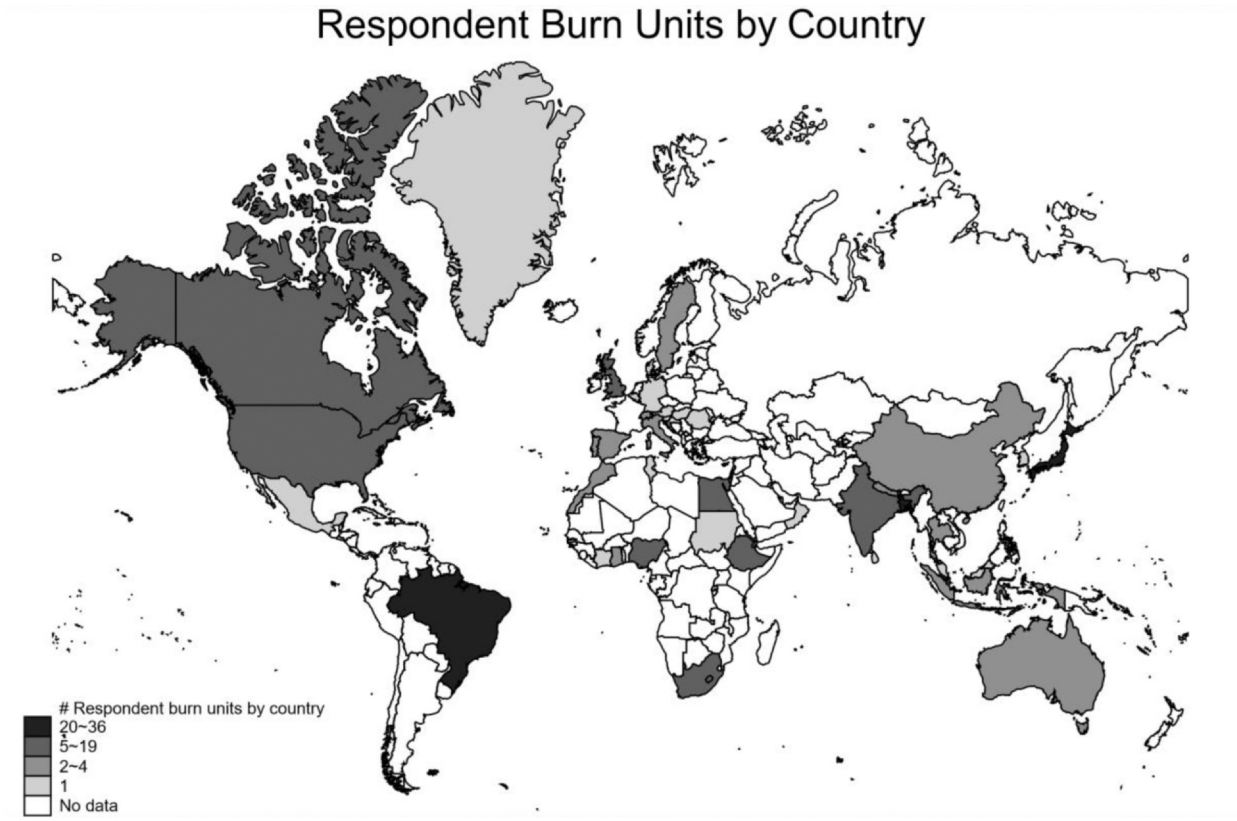

Fig. 1 – Respondent Bun Units by country.

transmission during the study period, and in this study were listed among countries with community transmission. Most burn units were not specialized (132/234), and because specialization level was established based on resources available before the pandemic, no obvious association between transmission was seen in pattern and specialization.

Of the 97 specialized burn units, 50 were in HICs, 25 in UMICs, and 22 in LMICs. All burn units in LICs (n = 14) were not specialized. Burn care was most frequently provided by specialized units in the Eastern Mediterranean Region (8/12), whereas in the African Region the not specialized dominated (32/38). Overall, the pandemic reduced access to resources and capacity to manage burns, but without evidence of improved collaboration between centers (Fig. 2). However, most of the burn units (n = 177) were kept open (Fig. 3).

Although the presence of burn surgeons was preserved at burn units at any level of specialization, provision of early surgery diminished significantly. Access to physiotherapy was reduced overall, although it remained constantly high in HICs, diminished significantly in UMICs and LMICs, and persisted as poor in LICs. Management of out-patients declined, while the use of telemedicine significantly increased in HICs and LMICs, remained unchanged in UMICs, and absent in LICs. Supplementary Tables S2-S5 compare burn care services provided before and during the pandemic.

Reallocation of resources differed significantly among WHO-Regions. All measures of reallocation of resources differed significantly among income groups, except for keeping open the burn units, access to PPE and collaboration among centers. Countries with community spread were hit hardest by the reduction of personnel and access to OR than those with cluster transmission and invested more in telemedicine. Access to ICU-beds was more likely reduced in not specialized facilities, whereas specialized facilities implemented more telemedicine and collaboration with other centers. Supplementary Tables S6-S9 show reallocation of resources during the pandemic.

Specialization level and transmission pattern of the virus were not independently associated with keeping open the burn units, whereas burn units in LMICs and LICs were more likely to be closed after adjustment for the other factors (Table 2). Among the 21 units closed during the pandemic, 12 were in LMICs, 17 were not specialized, 9 were converted to COVID-19 units, and none of them was in the European Region.

4. Discussion

The Burn Care Survey was developed as a tool to provide background information to understand changes in burn care capacity during the pandemic, worldwide. To our knowledge, this is the first attempt to describe the global standard of burn care.

Table 1 – Characteristics of the respondents burn units, n = 234.

Country	Burn units, n	WHO-Regions	Income groups[a]	CoV-19 transmission pattern[b]
Ethiopia	12	African Region	LICs	Community
Rwanda	1	African Region	LICs	Cluster
Ghana	2	African Region	LMICs	Community
Ivory Coast	1	African Region	LMICs	Community
Nigeria	14	African Region	LMICs	Community
South Africa	8	African Region	UMICs	Community
Egypt	5	Eastern Mediterranean Region	LMICs	Cluster
Sudan	1	Eastern Mediterranean Region	LICs	Community
Morocco	3	Eastern Mediterranean Region	LMICs	Cluster
Tunisia	1	Eastern Mediterranean Region	LMICs	Cluster
Kuwait	1	Eastern Mediterranean Region	HICs	Community
Oman	1	Eastern Mediterranean Region	HICs	Community
Austria	1	European Region	HICs	Community
Belgium	1	European Region	HICs	Community
Croatia	1	European Region	HICs	Community
Denmark	1	European Region	HICs	Community
Hungary	1	European Region	HICs	Community
Israel	5	European Region	HICs	Community
Romania	1	European Region	HICs	Community
Spain	4	European Region	HICs	Community
Sweden	2	European Region	HICs	Community
Switzerland	2	European Region	HICs	Community
United Kingdom	19	European Region	HICs	Community
Germany	1	European Region	HICs	Cluster
Italy	2	European Region	HICs	Cluster
Portugal	3	European Region	HICs	Cluster
Brazil	27	Region of the Americas	UMICs	Community
Mexico	1	Region of the Americas	UMICs	Community
Canada	5	Region of the Americas	HICs	Community
United States	16	Region of the Americas	HICs	Community
Bangladesh	26	South-East Asia Region	LMICs	Community
Nepal	4	South-East Asia Region	LMICs	Cluster
Sri Lanka	1	South-East Asia Region	LMICs	Cluster
India	8	South-East Asia Region	LMICs	Cluster
Indonesia	2	South-East Asia Region	UMICs	Community
Thailand	3	South-East Asia Region	UMICs	Cluster
Fiji	1	Western Pacific Region	UMICs	Sporadic
China	4	Western Pacific Region	UMICs	Cluster
Malaysia	1	Western Pacific Region	UMICs	Cluster
Australia	3	Western Pacific Region	HICs	Cluster
Japan	36	Western Pacific Region	HICs	Cluster
Singapore	1	Western Pacific Region	HICs	Cluster
South Korea	1	Western Pacific Region	HICs	Cluster

Total respondent countries = 43.

[a] Updated country income classifications for the World Bank's 2020 fiscal year. High-income countries = HICs, Upper middle-income countries = UMICs, Lower middle-income countries = LMICs, Low-income countries = LICs.

[b] According to data on the cumulative cases of COVID-19 per 1 million population published by the WHO at the 11 October 2020: sporadic cases (one or more, imported or locally detected), clusters of cases (clustered in time, geographic location and/or by common exposures), community transmission (larger outbreaks of local transmission in unrelated clusters, in several areas of the country).

Most of the 234 burn units included were open during the pandemic and overall, the presence of burn surgeons and burn specialized nursing staff was maintained. However, the access to operating theaters was limited, as was the provision of early surgery. The surgical delay might be partially explained by the reduction of anesthesiologists, ICU beds and access to blood products, all elements essential to guarantee safe surgery. International guidelines agreed on postponing elective procedures during the pandemic surge, prioritizing time-sensitive conditions, and suggested non-operative management, when possible and safe [13–15]. Despite the fact that early excision is considered the gold standard in modern burn care, it is not consistently available in most LMICs, because of multiple factors including lack of training, lack of resources, patient refusal, etc [16,17]. The International Society of Burn Injuries (ISBI) indeed suggests a more conservative approach in constrained settings, if surgical excision is not feasible [16]. During the pandemic, reduction of early excision was shown in all WHO-Regions, income-groups, specialization level, and spread type. One possible explanation is that strategies to face the surge led to less severe injuries, or also that patients reached care later.

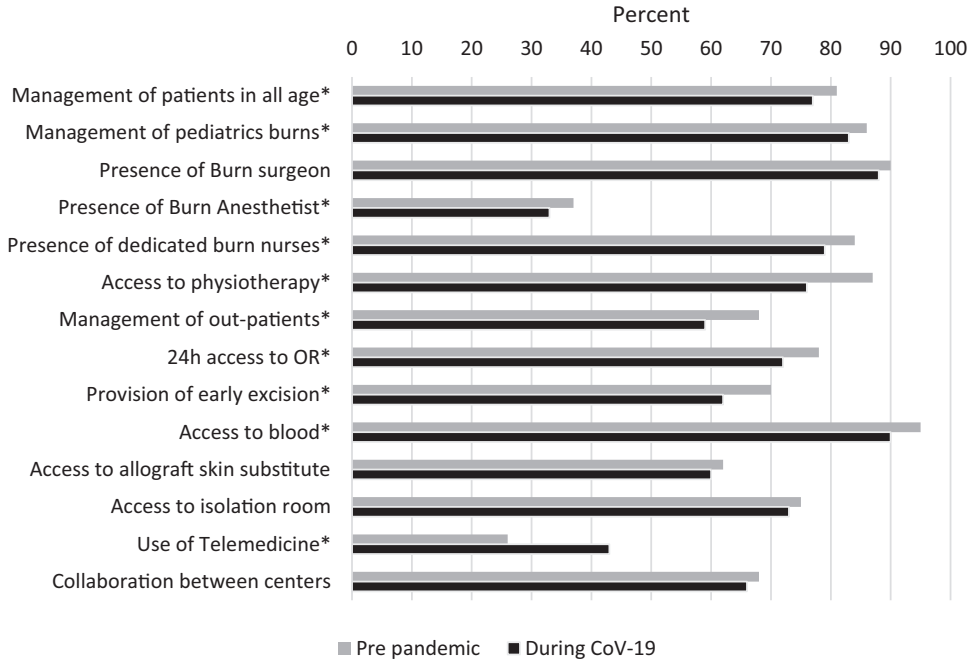

Fig. 2 – Services provided by the respondents burn units before and during the pandemic. * = $p < 0.05$.

However, access to individual patient data would be necessary to test these hypotheses. Another possible explanation is that conservative management of burns is still considered an appropriate alternative when resources are limited. Although early excision is associated with better outcomes, it requires appropriately trained staff and a minimum level of resources that are often not available, such as access to blood transfusion [18].

Out-patient clinical activities were not recommended during the pandemic, but telemedicine was [13,15,19], and units all over the world followed these recommendations. Also rehabilitation with close contact was not recommended

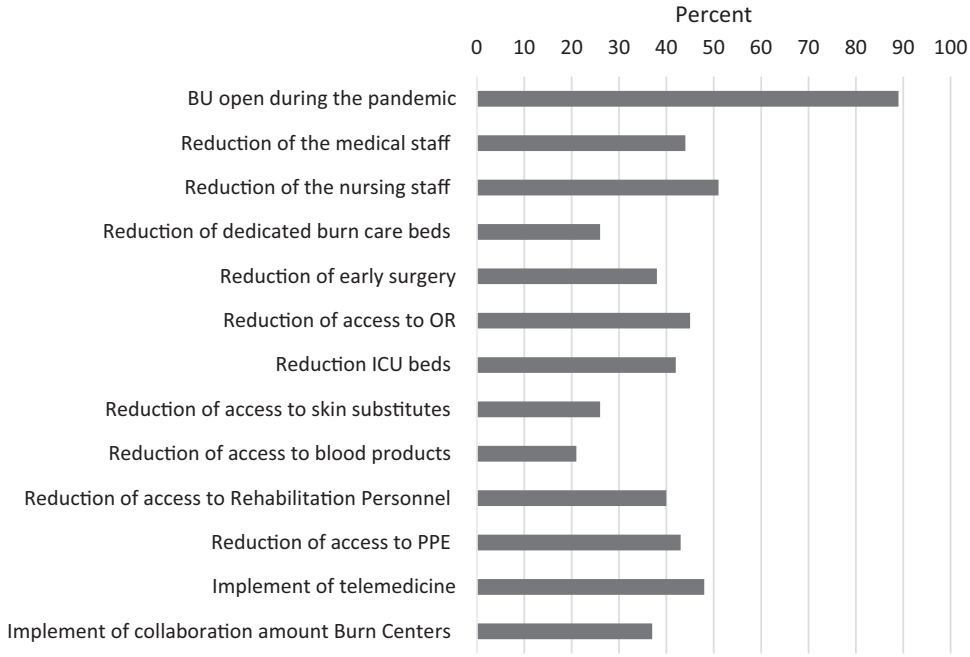

Fig. 3 – Reallocation of resources among the respondents burn units during the pandemic.

Table 2 – Factors independently associated with keeping a burn unit open during the pandemic.

Factors	Adjusted OR	95% CI	p
Not specialized Burn Units	REF		
Specialized Burn Units	2.52	0.78–8.10	0.12
HICs and UMICs	REF		
LMICs and LICs	0.26	0.09–0.72	0.01
Cluster + sporadic transmission	REF		
Community transmission	2.21	0.82–6.00	0.15

n = 197. Area under the Receiver Operating Characteristics curve (AUC) = 0.73 (CI: 0.65–0.82). Odds Ratio= OR. Confidence Interval= CI.

[19,20]; access to physiotherapy was significantly reduced in all burn units, both specialist and not specialist, in particular in middle income countries, whereas it remained unchanged high in HICs, and low in LICs. Telemedicine requires additional investment and efforts, such as access to technological resource and education of care providers and patients [21], and specialized burn units (most of which were in HICs) were more likely to implement it than the not specialized. Nevertheless, the use of telemedicine in burn care is not only available in richer countries, but has also taken hold in middle income countries [22,23], whereas it is still unknown how widespread it is in the poorest settings. Nations with community transmission promoted telemedicine more than those with clusters of cases, suggesting that in countries with less extensive virus-diffusion, burns could probably be referred to facilities in areas less affected by COVID-19.

The implementation of telemedicine has been a widespread solution embraced to minimize interpersonal contact and limit the spread of the virus. It remains to be seen whether this approach will be maintained once Covid-19 is no longer a threat for global health and health care organization returns to standard. While this may indeed be an improvement in care through increased access, future studies are still necessary to analyze association between the use of telemedicine and outcomes, but also to investigate the quality of care as experienced by patients. Without an objective consequence analysis a risk is present that emergency solutions adopted to face the surge will be included in the standard of care, with unknown effects on patients.

Twenty-one units in 8 countries were closed during the pandemic; in 7 of these countries, burn care was supported by keeping open other burn units. Surprisingly, the overall reduction of services and reallocation of resources did not lead to significantly improved exchanges within countries or cross-border [10,24]. A possible explanation is that collaboration among hospitals was not implemented centrally, by national health departments, but left as the responsibility of each individual center. However, as recommended by the ISBI, burn surgeons "should maintain active decision-making responsibility and control of the care" [16] and should be consulted by policy maker to guarantee adequate management of burns during outbreaks.

4.1. *The perspective of respondents from the African Region*

In the African countries, the peak of the first pandemic-wave was reached in the middle of July, with South Africa and Ethiopia reporting the highest incidence and mortality per Million population [25], and both countries were well represented in this study, with 8 and 12 respondents, respectively. Overall, children are the largest risk group for burns, with the highest mortality rates in Sub-Saharan Africa [26] and indeed, all the respondents burn units of this region provided burn care to both adults and children, before and during the pandemic, despite they were not specialist centers. Early surgery was not routinely performed, confirming previous findings [27]. Epidemics are no stranger to Africa, with West-Africans countries, such as Liberia, Sierra Leone, and Guinea, having recently dealt with Ebola outbreaks [28]. However, as they did not participate in the survey, we cannot assess whether these countries were better prepared than others to face COVID-19 because of their recent experiences in managing Ebola-outbreaks. The failure for the responses may in part be due to the limited specialized teams managing burns in the region [27].

4.2. *The perspective of respondents from the Eastern Mediterranean Region*

Despite sharing borders and cultural similarities, this region is heterogeneous when it comes to income, which reflects on health expenditure, and in turn on the level of specialization of burns services. All respondents reported a reduction of resources during the pandemic, and 3 out of 12 units were closed. One of them, the only Sudanese burn unit included in this study, was a not specialized burn service in Khartoum, and we don´t have information to verify whether burn care was provided by other Sudanese hospitals. In the other Eastern Mediterranean countries, burn care was guaranteed, because at least one burn service was open on national territory. Standardized burn management was affected, with reduction of early surgery provision and outpatient clinics services. This was the only region where the access to physiotherapy was significantly reduced, but continued in three specialized units, two of them in HICs (Oman and Kuwait). Respondents from HICs in the region were least affected, and mainly showed reduction in healthcare staff rather than reduction in supplies or dedicated burn spaces. While some countries have local burns associations or societies, most lack effective organization at an international, national, or regional level and consequently the survey was distributed through personal contact, which hindered to reach all countries in the region, but even led to establish contact for the first time. In addition to the global burden of the pandemic, some countries have also been areas of conflict and disasters during the study, such as Syria and Lebanon, and that probably impacted the representation of the region in the study.

4.3. *The perspective of respondents from the European Region*

All European burn units included in this study were in HICs, were open during the pandemic independently from the transmission pattern of the virus, and 60% of them (26/44) were classified as specialized. The use of telemedicine was significantly increased, and the one-on-one interview with the coauthors indicated the will to continue with this approach in the future, although it is still premature to assess its long-term effects in terms of efficiency and effectiveness. The European Burns Association (EBA) has been working for the standardization of burn care in Europe, and our findings suggested availability to high quality-standard burn care in this region. However, the response rate from Europe was the lowest among the WHO-Regions (44 completed surveys among 500 sent) and we can just speculate about the causes of the low participation. First, many European burn units are not connected to the EBA, so the lack of a broad and inclusive organizational network could have played a role. Moreover, it is possible that an excess of COVID-related surveys, or a perception of these questions having been asked before might have contributed to a feeling of administrative overloading in the face of a busy clinical schedule.

4.4. *The perspective of respondents from the Region of the Americas*

The Region of Americas has been the most affected by the pandemic during the first year, counting for half of the global cases and deaths [25]. All respondents were in UMICs and HICs with community spreading and included the full gamut of burn centers from low to high specialization. In USA, Brazil and Mexico, cities experienced exponential surges with novel reallocation of resources away from burn care, or even necessitated the closure of burn units for conversion to COVID-care. Based on our findings, the resources were reallocated to a lesser extent in this sample, as compared to other WHO-Regions. More than half of the respondents were from Brazil, where the questionnaire was distributed by the Brazilian Society of Burns, whereas in other countries development of collaborative systems at the national level is an ongoing challenge.

4.5. *The perspective of respondents from the South-East Asia Region*

The South-East Asia Region is home to over a quarter of the world's population and the pandemic has been a challenge for this densely populated region. During the first wave, the transmission pattern of the virus differed among the countries: Nepal, Sri Lanka, India, and Thailand reported cluster of cases, while in Bangladesh and Indonesia the transmission was on community level, and only Timor-Leste reported sporadic cases. Burns are a major public health concern in this region and access to adequate care is the biggest challenge in countries where the need exceeds the supply. Furthermore, where incidence of injuries is high, strong networking among health services may facilitate access to care. Bangladesh is an excellent example of good intranational collaboration among burn centers: 26 of the 44 completed questionnaires from this region were from here, due to the well-established network of burn centers across the country. Whereas the overall number of physicians and nurses were reduced during the pandemic, the presence of burn dedicated staff was not. This region was the only one where the significant reduction of the out-patients activities corresponded to a significant increase in telemedicine.

4.6. *The perspective of respondents from the Western Pacific Region*

Compared to the other WHO-Regions, the Wester Pacific Region has shown the lowest COVID-19 cumulative cases, with a mainly cluster transmission of the virus [25], and the highest response rate to this survey (47 completed among 81 sent). Nevertheless, the generalizability of the findings may be biased by the fact that 36 of the 47 completed surveys from this region, were from Japan. The Disaster Network Committee of Japanese Society for Burn Injuries had previously conducted a questionnaire to inventory the accessible burn facilities during the pandemic, which facilitated the distribution and the high participation to our survey. In China instead, the survey was sent to burn centers participating to a burns-focused group at *Wechat*®, a Chinese multiplatform messaging app. Only 4 responses were returned, and one reason may be related to language difficulties (the form was in English). Singapore has one designated burn center, which answered the survey. Since it faced the SARS outbreak in 2003, this center has two modules, so that one can be reserved for the management of infected patients. Another example of strategic approach was at the burn unit at the Ruijin Hospital of Shanghai (China), which was kept strictly COVID-free and where all burn patients with suspect infection were directed to specialized clinics for testing [10].

4.7. *Limitations*

The first limitation of this study was the method chosen to distribute the survey, the snow-ball sampling, which excludes *a priori* distribution to burn units that had no previous contacts with the team of co-authors. However, all the co-authors in this study are involved in national and/or international burn associations and organizations and have a broad network among burn care providers around the world, which contributed to the large diffusion of the survey. Yet, since the survey was anonymous, it was not possible to track whether the link was shared independently by the respondents with other burn units. Anonymity was chosen to facilitate honest feedback. The reported response rate was assessed considering the surveys sent by the study coordinator.

Second, not all countries participated to the survey, limiting the generalizability of our findings. The participation was larger in country with well-established intranational network organizations. However, the collected data enabled information from burn units in countries from all WHO-Regions, all income-groups, and those differently impacted by the virus to be studied, which strengthens our findings and makes them more comprehensive.

Third, we chose arbitrarily the presence of dedicated burn ward and of burn intensive care units as criteria to classify the level of specialization. However, other methods of classifying burn services should be specifically evaluated, which would not have been possible within the context of this study [29].

Fourth, the incidence of COVID-19 changed markedly during the past months, affecting progressively the reallocation of resources and reorganization of burn care. Because the pandemic began at different times in different countries, for the purpose of this study, data collection was enrolled between September and October 2020, when most of the world's nations were at the end of the first epidemic wave [25].

Finally, we found a risk that the different questions in general were perceived differently by different respondents. To reduce this risk, the questionnaire was pretested before the distribution of its ultimate form, and uncertain concepts were clearly explained in the survey. The questions were quite concrete and were designed so that they captured the current situation compared to before the pandemic, or the reallocation during the pandemic. This is a strength for the study as each burn center serves as its own control.

5. Conclusions

During the pandemic, burn care was ensured in most countries. Even though burn units preserved the presence of burn surgeons, availability of resources for safe provision of burn care was reduced worldwide, and thus the access to timely surgery. Burn units in lower income countries were more likely to be closed during the pandemic. The use of telemedicine was increased in countries with higher income, while lack of cooperation among burn centers may have hindered efficiency and equity of the large-scale strategic response. Networks and strategies created *ad hoc* in response to COVID-19 might be a valuable starting point for the development of systems to address health crises on a national and international scale.

Disclosures

All authors contributed to the conceptualization of the study, the statement of the goals, the development and distribution of the survey, the drafting of the discussion, the revision and editing of the manuscript. All authors had full access to the full data in the study and accept responsibility to submit for publication.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.burns.2021.11.010.

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