

## Management of a pediatric burn center during the covid-19 pandemic

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**Abstract:**

The aim of this study was to evaluate the results of an algorithm that was created to prevent coronavirus disease-2019 (COVID-19) transmission during the management of children with burns in a tertiary pediatric burn center. Children admitted to the burn center between May 2020 and November 2020 were prospectively evaluated for cause, burn depth, total body surface area (TBSA), length of stay, symptoms suggesting COVID-19, suspicious contact history, history of travel abroad, and COVID-19 polymerase chain reaction (PCR) test results. Patients were divided into two groups: unsuspected (Group 1) and suspected (Group 2), depending on any history of suspicious contact, travel abroad, and/or presence of symptoms. A total of 101 patients were enrolled in the study, which included 59 boys (58.4%) and 42 girls (41.6%). Group 1 included 79 (78.2%) patients, and Group 2 consisted of 22 (21.8%) patients. The most common cause of the burns was scald injuries (74.2%). The mean age, TBSA, and length of stay were 4.5 years, 12.0%, and 13.2 days, respectively. Four patients (3.9%) had a positive PCR test (two patients in each group). Comparing groups, males were more commonly found in Group 2 ( $p=0.042$ ), but no differences were found for the other variables. No patients or burn center staff members developed COVID-19 during the course of hospitalization. In conclusion, every child should be tested for COVID-19 upon admission to a burn unit, and a modified algorithm should be constructed for the handling and management of pediatric burn patients.

 **Key words:** COVID-19, burn, children, pediatric burn center

## **Introduction**

The global coronavirus disease-2019 (COVID-19) pandemic is having a devastating impact all around the world and is overwhelming health systems in many countries. The disease originated in China in December 2019 and rapidly developed into a global pandemic. It is causing a significant death toll and is still not under control. The mortality rate has been reported to be around 2% of all cases.<sup>1</sup> As there are still no effective medical treatments, prevention of transmission is currently the most effective way of dealing with this outbreak. Most nations have developed their own individual nationwide protocols to combat the pandemic.<sup>2,3</sup>

Burns are common in children globally and constitute a significant cause of accidental childhood deaths in underdeveloped and developing countries.<sup>4</sup> American Burn Association (ABA) guidelines suggest that children with moderate burns can be managed in peripheral burn units, but children with major burns should be transferred to tertiary burn centers.<sup>5</sup> Our hospital is the biggest hospital complex in Turkey, with over 3,700 beds in total and 600 beds for children. It serves as a pandemic hospital for both adults and children. The Pediatric Burn Center (PBC) of our hospital is a tertiary referral center that serves children with major burns in our country as well as from neighboring countries. During the pandemic, our PBC remained operational and continued to serve all children with major burns regardless of the pandemic and the patient's infectious condition.

In children, the disease process of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection is usually mild or asymptomatic.<sup>6</sup> As cellular and humoral immunity are

compromised in children with burns, various infections may be more lethal than they would be in unaffected children.<sup>7</sup> In addition to the other infections that arise secondary to burns, additional infection with COVID-19 may increase the morbidity and even mortality in these patients.<sup>8</sup> Due to these concerns, prevention of COVID-19 transmission becomes more critical in children with burns, and identification and isolation of burn patients infected with COVID-19 may improve outcomes and reduce mortality.

Driven by the above-mentioned concerns, we created an algorithm to help prevent COVID-19 transmission and to improve the management of pediatric burn patients during the pandemic. The aim of this study was to evaluate the results of our approach and clinical outcomes.

## **Methods**

All patients under 18 years of age who were admitted to the PBC between May 2020 and November 2020 were enrolled in the study. The study was designed as a prospective study, and local ethical committee approval was obtained (Nu:E1-20-956). The study was carried out by adhering to the principles of the Helsinki Declaration. An informed consent was obtained from the parents or legal guardian of each patients. A detailed history was obtained at the time of admission regarding the presence of symptoms of COVID-19 infection (including fever, cough, and diarrhea), suspicious contagious contact history, and travel abroad before the burn. Additionally, epidemiological data, cause of burn, depth of burn, TBSA, total hospitalization days, polymerase chain reaction (PCR) test results (at admission and during the treatment process), and presence of lung involvement in patients with positive PCR test results were extracted from patient records.

A nationwide action plan was organized by the Ministry of Health in 2012, and a systematic algorithm was created to organize a homogenous distribution of sufficient number and quality

of burn units and centers to provide effective transport and management of burn patients.<sup>9</sup>

Thanks to the algorithm, a burn patient who is admitted to any health facility can be transported to a burn unit/center in an average of two hours after initial resuscitation and management is performed. In this context, 55 burn units and 16 burn centers with a total of about 1100 patient rooms are available nationwide. Our hospital and PBU are located in the capital city of Turkey, and the PBU a referral center for pediatric burn cases.

A WhatsApp group was formed by the physicians who are in charge of the burn units/centers all around Turkey. When a burn case is admitted to a health facility, medical data and images of the burned areas are delivered to the staff of the burn unit/center. After a quick evaluation (around two hours) of the patient using telemedicine, a decision is made for the most convenient burn unit/center for the patient to be transported to. Also, the means of transport (by land or air) is decided on depending on the clinical condition of the patient and the distance to the referral center. This algorithm is also useful during natural or manmade disasters to coordinate convenient transport of patients with multiple trauma. With the emergence of the pandemic, information about the patient's COVID-19 test results, suspicious contact history, presence of symptoms, and travel history abroad are also included in the algorithm to ensure that all necessary precautions are taken before the patient arrives at the burn center. The algorithm we employed during admittance and management of pediatric burn cases in our center is presented in Figure 1.

Admitted patients were divided into two groups according to COVID-19 status. Group 1 included patients without a positive COVID-19 test result and with no suspicious contact history, history of travel abroad, or COVID-19 symptoms. Group 2 included patients with confirmed COVID-19 infection or with a suspicious contact history, history of travel abroad, or symptoms of COVID-19.

During the initial evaluation and management of the patients in Group 1, a surgical mask, apron, and gloves were used in the standard fashion during wound care and medical treatments. N95 masks, protection glasses, face shields, surgical suits, surgical gloves, and boots were used in the standard fashion during the care of patients in Group 2 (Figure 2).

There are 12 patient rooms in our center, and all are designed as intensive care unit rooms. All rooms are single, and two have negative pressure systems. This arrangement enabled the isolation of patients and their companions. One asymptomatic parent without a suspicious contact history was allowed to accompany the child, and meals were served in patients' rooms.

All interventions were suspended if possible and if deemed "not urgent" until PCR results were obtained. PCR results were usually available within four to six hours. Urgent interventions (initial wound care, urgent escharotomy/fasciotomy) were performed as a bedside procedure in the patient's room under necessary precautions depending on the patient's risk group, and sedoanalgesia/anesthesia was performed when necessary. All further surgical procedures (fascial excision, grafting) were suspended until the PCR results were obtained.

If early surgery was not anticipated, wound care products that do not require frequent replacement, such as Therabond™ (Silverlon, Argentum Medical LLC, Geneva, IL, USA ), Aquacel™ (ConvaTec Inc., Flintshire, UK) and Acticoat™ (Smith & Nephew Co. Ltd., UK), were preferred for initial wound care. If the patient's PCR test result was negative, then surgical interventions and consecutive wound care were performed in the operation room reserved for burn patients, which is located in the burn center. If the PCR test result was positive, routine wound care was performed as a bedside procedure under sedoanalgesia/anesthesia in the patient's room. Other surgical interventions were performed

in another operating room that was reserved for COVID-19 positive patients in the general hospital block with all the recommended precautions for COVID-19. All staff without symptoms underwent routine tests weekly, and staff with symptoms tested immediately.

### **Statistical Analyses**

The Statistical Package for the Social Sciences (SPSS) software version 21 (SPSS Inc., Chicago, IL) was used for the statistical analyses. Numerical variables (including age, length of hospital stay, and the other parameters) are given as mean (minimum-maximum; range). Categorical variables are given as percentages. Initially, the normality of the numerical variables was evaluated with a visual histogram and the Shapiro-Wilk test or Kolmogorov-Smirnov test. Numerical variables with normal distribution were evaluated with Student's t-test, and variables that were not distributed normally were evaluated with the Mann-Whitney U test. Categorical variables were evaluated with the chi-square test. A p-value of <0.05 was considered statistically significant.

### **Results**

During the study period, 101 patients were hospitalized in our burn center; 59 (58.4%) were boys and 42 (41.6%) were girls. During the same time period of the previous year (May-September 2019), 98 patients were hospitalized in our center. The mean age of the patients was 4.5 (0.6–17.6; range 17.0) years. The most common cause was scalding (boiling water burn) (74.2%), while the remainder were flame, electricity, and chemical burn injuries (14.9%, 8.9%, and 2.0%, respectively). The mean TBSA of the patients was 12.0% (1.0–55.0%; range 54.0%). The burn depth was second degree in 86.1% of the patients and third degree in 2.0%, while the remaining 11.9% had second and third degree burns at the same time. The mean length of hospital stay was 13.2 (1.0–92.0; range 91.0) days (Table 1).

Among the whole study group (n=101), 79 (78.2%) who had no history of travel abroad or

suspicious contact and without symptoms are enrolled in group 1, while the rest 22 patients (21.8%) who has one of these findings are enrolled in group 2. Four of the patients in Group 2 had a history of travel abroad, nine had a history of a suspicious contact, four had fever, three had diarrhea, and two had coughing. Among the whole cohort, the PCR test at the time of admittance was positive in four patients (4.0%, n=101). Two were in Group 1, and the other two were in Group 2. Both of the patients in Group 2 who had a positive PCR test also had a history of suspicious contact.

Boys were significantly more common in Group 2 ( $p=0.042$ ). No significant difference was observed between the groups in terms of age, length of stay, TBSA, number of tests performed, rate of PCR positivity upon admission, and cause of the burn injury ( $p=0.494$ ,  $p=0.351$ ,  $p=0.204$ ,  $p=0.240$ ,  $p=0.206$ , and  $p=0.921$ , respectively).

Although statistical analyses for burn depth, history of travel abroad, presence of symptoms, and suspicious contact history could not be performed as there were insufficient cases, the depth of burn appeared to be deeper in Group 1. Detailed statistical analyses are presented in Table 2.

Among the four patients with a positive PCR test, only one patient in Group 1 (admitted with a 50% TBSA flame burn) demonstrated signs of severe infection. This patient was isolated due to a positive PCR test. A lung x-ray obtained for respiratory distress during follow-up revealed pulmonary involvement, and treatment for COVID-19 was initiated. The PCR test became negative on follow-up, and his/her isolation was terminated. Details about the other three patients are presented in Table 3.

None of the patients in either group became COVID-19 positive during their hospitalization period, and none of the staff of the burn center had a positive COVID-19 PCR test.



## Discussion

Although the overall rate of hospital admittance decreased during the COVID-19 pandemic, the rate of admittance to burn units and centers did not reduce significantly.<sup>10-12</sup> No significant change in the number of hospitalized patients (98 patients vs 101 patients) were observed in our center, too. Maintaining the health service provided to patients with burn injuries during the pandemic presented additional risks for patients and health care professionals. During the COVID-19 pandemic, it has commonly been observed that more rapid spread and even outbreaks can emerge when proper precautions are not taken during patient admittance because transmission from asymptomatic patients to other patients and healthcare staff can occur.<sup>13</sup> Because of this concern, various precautions are recommended<sup>2,14</sup>. Therefore, in accordance with the recommendations of the Infection Control Committee of our hospital, each admitted patient is regarded as a “possible case” and isolated until the PCR test result is obtained.

Asymptomatic COVID-19 infections are much more common in children than adults and have been reported to be between 4.4% and 53%.<sup>15-20</sup> Accordingly, asymptomatic children are regarded as potential “super-spreaders” because the high rate of asymptomatic disease in children can cause the disease to spread more rapidly. The course of COVID-19 infection is more severe in patients with coexisting diseases, in immunosuppressed individuals, and in the elderly. Patients with burn injuries are also included in this high-risk group as they have a co-existing burn injury.<sup>21</sup> The rate of asymptomatic infection at admission was 4.0% in our cohort of patients. Although this rate may appear low, it is significant because patients treated in burn units/centers are in a high-risk group. During the study period, no patient-to-staff transmission of COVID-19 was demonstrated.

Due to the rapid rate of spread of COVID-19, rigorous precautions should be taken in order to prevent transmission between patients and staff.<sup>13</sup> Azzena et al. reported successful prevention of spread by performing COVID-19 tests at the time of admission for all patients, which is consistent with our study.<sup>21</sup> Others have also reported successful prevention of transmission by performing similar precautions.<sup>2,22</sup> Nevertheless, these precautions are not sufficient alone when not accompanied by other additional measures. Physical distancing, mask use, and hygiene principles should be strictly followed to prevent COVID-19 and other infections because the most common cause of death in burn patients is still infections.<sup>23,24</sup>

Prevention of transmission is still the best way to confront the COVID-19 pandemic since there are no effective drug treatments, and the success of vaccination programs, which have been initiated more recently, is unclear.<sup>25</sup> This is more pronounced for intensive care units and burn centers where nosocomial transmission may be faster and more lethal.<sup>26</sup> Due to the high rate of asymptomatic infection in children, clinical and laboratory findings in children should be interpreted more cautiously.<sup>27</sup> Complicated symptoms secondary to the involvement of multiple organ systems due to burn injuries make the evaluation of burn patients more complicated. Fever, which is commonly encountered during the clinical course of patients with burn injuries, is also a common finding of COVID-19 infection. All these additional concerns have significantly complicated the management process of patients with burn injuries in burn centers during the COVID-19 pandemic. Accordingly, we lowered the suspicion threshold for COVID-19 infection in our center and ran the necessary tests repeatedly (depending on the clinical course) during follow-up to prevent the spread of COVID-19 in the burn center.

## **Conclusion**

Asymptomatic COVID-19 positive patients (especially children) who carry a high risk of transmission of COVID-19 are significant threats to vulnerable patients, such as patients in burn centers. Therefore, an appropriate algorithm during the pandemic should be devised that describes and organizes urgent interventions, elective interventions, regular wound care, choice of wound care products, and appropriate environment to perform each of these interventions. All admitted patients should be screened for COVID-19, and the patient should be isolated until the results are obtained, without performing any interventions other than urgent interventions and wound care. Urgent interventions should be performed under Group 2 preventive precautions. Thanks to our algorithm, we believe that we have prevented the transmission of COVID-19 infection from asymptomatic patients to other patients and staff. The absence of an outbreak during this pandemic period in our center that has a high patient burden may confirm the successful management of burn patients during the pandemic.

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## Tables

Table 1. Demographic data of patients

Variables		
Gender, n (%)	Male	59 (58.4)
	Female	42 (41.6)
Age , Mean (Min-Max;Range)		4.5 (0.6-17.6;17.0)
Length of stay at burn center (days) Mean (Min-Max;Range)		13.2(1.0-92;91)
Total Burned Body Surface Area (%)		12.0(1.0-55.0;54.0)
Number of test, Median (IQR 25,50,75)		1.0 (1.0;1.0;3.0)
PCR positivity on admission to hospital		4 (4%)
Burn cause	Scald	75 (74.2%)
	Electricity	9 (8.9%)
	Chemical	2 (2.0%)
	Flame	15 (14.9%)
Burn depth	Second degree	87 (86.1%)
	Third degree	2 (2.0%)
	Second and third degree	12 (11.9%)
Travel history abroad		4 (3.9%)
The presence of symptoms		9 (8.9%)
Family history		9 (8.9%)

Table 2. Statistical analysis of patients according to their gender

Variables		Group 1 (n=79)	Group 2 (n=22)	p
Gender, n(%)	Male	42(53.2)	17(77.3)	0.042*
	Female	37(46.8)	5(22.7)	
Age , Mean (Min-Max;Range)		4.7(0.6-17.6;17)	4.0(0.9-16.9;16)	0.494* *
Length of stay at burn center (day) Mean (Min-Max;Range)		12.2(1-92;91)	16.5(1-75;74)	0.351* *
Total Burned Body Surface Area (%) , Mean(Min-Max;Range)		11.6(1-55;54)	13.7(1-32;31)	0.204* *
Number of test, Median(IQR 25,50,75)		1.0(1.0,1.0, 2.0)	2.0(1.0,2.0, 3.25)	0.240* *
PCR positivity on admission to hospital	Negative	77(97.5)	20(90.9)	0.206* **
	Positive	2(2.5)	2(9.1)	
Burn cause, n(%)****	Scald	59(74.7)	16(72.7)	0.921* **
	Electricity	7(8.9)	2(9.1)	
	Chemical	2(2.5)	0	
	Flame	11(13.9)	4(18.2)	
Burn depth	Second degree	65(82.3)	22(100.0)	N/A
	Third degree	2(2.5)	0	
	Second and third degree	12(15.2)	0	
Travel history abroad		0	4(18.2)	N/A
The presence of symptoms		0	9(40.9)	N/A
Suspicious contact		0	9(40.9)	N/A

\* Pearson Chi-Square test used.

\*\* Mann-Whitney U test used.

\*\*\* Fisher's exact test used

\*\*\*\* Those with zero among the variables were combined with the closest group and compared.

### **Figure legends**

Figure 1. The algorithm of admittance and management of pediatric burn cases in our center.

Figure 2. Precautions during intervention to the patients at Group 2.

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**Figure 1:** The algorithm of admittance and management of pediatric burn cases in our center

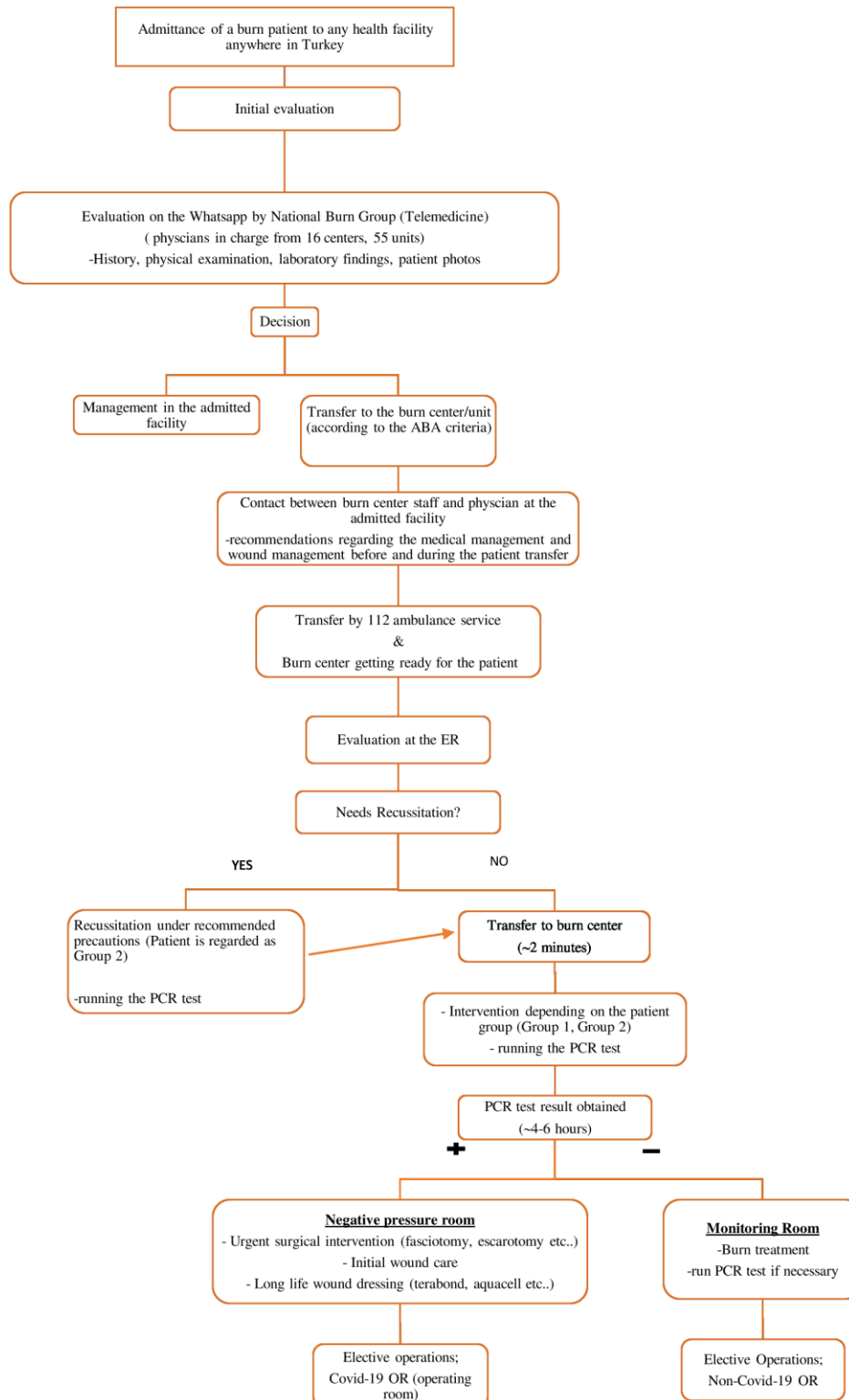


Figure 2



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