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# Burn Unit admission and management protocol during COVID-19 pandemic

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ABSTRACT

*Background:* The actual epidemic outbreak is the third time in the last two decades in which a coronavirus results in a major global spread with serious consequences in terms of vastity of affected patients, life losses, health system organization efforts and socio-economic implications. Lacking effective therapies and vaccinations, during viral outbreak the major and most incisive mean for viral spread control is spread prevention, especially for the fragile burn-injured patients we are called to care for in Burn Units.

*Methods:* We developed an admission and inpatient management protocol to preserve burn patients from SARS-CoV-2 contagion, in order to avoid additional morbidity and mortality in patients with already compromised health conditions.

Data from burn-injured patients admitted to our Unit following this new protocol were retrospectively analyzed in order to verify its effectiveness in prevention of viral spread.

*Results:* From the 8th of March to the 8th of June, we admitted 18 patients in the Burn Unit ICU and semi-ICU and 17 patients in the Burn Ward. Two of them resulted positive to COVID-19 nasopharyngeal swab and bronchoalveolar lavage collected immediately on admission, for both the extension of burns and their general clinical conditions implied ICU admission. Moreover, a caregiver of an admitted child resulted positive to the nasopharyngeal swab. No other cases of SARS-CoV-2 positivity have been reported neither between hospitalized patients nor between healthcare workers.

*Conclusion:* The evidence of high ICU admission rate and high mortality in patients affected by SARS-CoV-2 combined with the fragile clinical conditions of burn patients required the development of an admission and hospitalization management protocol.



*Abbreviations:* COVID19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; ARDS, acute respiratory distress syndrome; ICU, intensive care unit; BU, Burn Unit; CT, computer tomography; BAL, broncho-alveolar lavage; RT-PCR, real time polymerase chain reaction; SD, standard deviation; TBSA, total body surface area; ER, emergency room; PPE, personal protection equipment.

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## 1. Introduction

At the beginning of December 2019 was reported for the first time, in the city of Wuhan, Central China, a pneumonia of unknown origin, named "coronavirus disease 2019" (COVID-19), caused by an agent initially known as 2019 novel coronavirus (2019-nCOV) and later referred as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1].

Since the end of January 2020, the SARS-CoV-2 started spreading worldwide until it was declared a pandemic disease by the World Health Organization on March 11th 2020. By the end of May, the disease reached 188 countries causing nearly 370 thousands of deaths with the greatest number of cases in the United States and Brazil. In Italy, clusters of cases were detected on 21th and 22th of February only in the regions of Lombardy and Veneto. At the beginning of March, the virus was present in all regions of Italy leading the government to quarantine the whole population from March 8th till May 4th. For several weeks Italy counted the greatest number of cases and deaths worldwide with a steep increase in the number of hospitalizations and ICU admissions leading to consequent hard stress for the National Health System. Meanwhile, scientists from all over the world started to work intensively in basic clinical research in order to unravel virus features and to develop new therapeutic approaches.

Since COVID-19 epidemic onset, SARS-CoV-2 demonstrated a major contagious capability, with an R0 higher than SARS-CoV [2]. The mechanism of infection among humans is based on inhaled respiratory droplets. However, the inhalation is probably not the only way of contagion, in fact it is reported that close contact could represent a spreading source through mucosal surfaces of nose, mouth and eyes [3,4]. Besides, there is also the chance of aerosol transmission in a relatively closed environment with continuous exposure to high concentrations of aerosol. Moreover, an additional transmission modality could be represented by body fluids during gastrointestinal disease presentations such as diarrhea and vomiting [5].

The most common symptoms of COVID-19 at onset of disease are fever, cough and myalgia or fatigue. Less common presentations are sputum production, sore throat, nasal congestion, anosmia, headache, hemoptysis and diarrhea [6]. The severe pattern of evolution is characterized by worsening dyspnoea with hypoxemia and lymphopenia after which septic shock, ARDS, metabolic acidosis, and coagulation dysfunction develop rapidly [7]. More than half of patients progress to dyspnoea within 8 days from the onset and may develop ARDS within 9 days with the need of mechanical ventilation by day 10 [6].

Due to the lack of effective therapies and prevention measures such as vaccination, during virus outbreak the major and most effective ways for spreading control were isolation of affected patients, tracing of infected, hands hygiene, respiratory airways protection and surfaces sterilization [8].

During the Italian COVID-19 emergency, the intense effort of the hospitals to secure ICU bed availability and personnel adequate in numbers and expertise, forced the delay of all possible activities.

In Plastic Surgery, only major oncological and trauma cases were scheduled [9]. Our Burn Unit reduced its elective activity related to the correction of burn sequelae. However, urgent and emergent activities greatly increased since burn patients could not be accepted by all other centers in Italy. Thus the continuous incoming of patients from different cities and regions within the pandemic epicenter, represented an increased risk both for patients in the BU and for healthcare workers, due to COVID19 rapid spreading inside and outside the University Hospital of Padua.

For this reason, since the beginning of the emergency period, in our Burn Unit we developed a protocol for the acceptance of all the new patients and the surveillance of the hospitalized ones, distinct for the pediatric and adult population. These measures were later followed by the general prevention and management indications established by the Medical Direction of the University Hospital of Padua, which in turn were in accordance with the most updated Italian Government and International literature guidelines [10,11].

## 2. Materials and methods

From the 8th of March to the 8th of June we referred to a specific acceptance and management protocol, immediately developed in our Burn Unit after the first cases of SARS-CoV-2 spread in Northern Italy (Table 1). The protocol was validated by the Medical Direction and a specific multidisciplinary group of experts at the University Hospital of Padua.

Furthermore, we retrospectively analyzed all clinical data and procedures performed in burn-related injured patients admitted to our Burn Unit following this new predisposed admission protocol.

For each of these patients, resorting to the Electronic Medical Record of our Hospital, we examined age, sex, diagnosis (extension and etiology of burn), date of admission and discharge, the necessity of endotracheal intubation or tracheostomy with ICU admission, blood tests and imaging studies (Chest X-rays, lungs CT). We reviewed in detail the personal and family history of patients, with a particular focus on infective symptoms or contacts with symptomatic subjects before the hospital admission. We also retrieved all the tests for SARS-CoV-2 detection performed in each patient, at the admission and during hospitalization: nasopharyngeal swab, BAL, micro-BAL, rectal or ocular swab, all of which underwent qualitative reverse transcription-polymerase chain reaction analysis. In a limited number of patients tested positive at one of the previously mentioned tests, we also assessed the specific serology for SARS-CoV-2 (IgM and IgG).

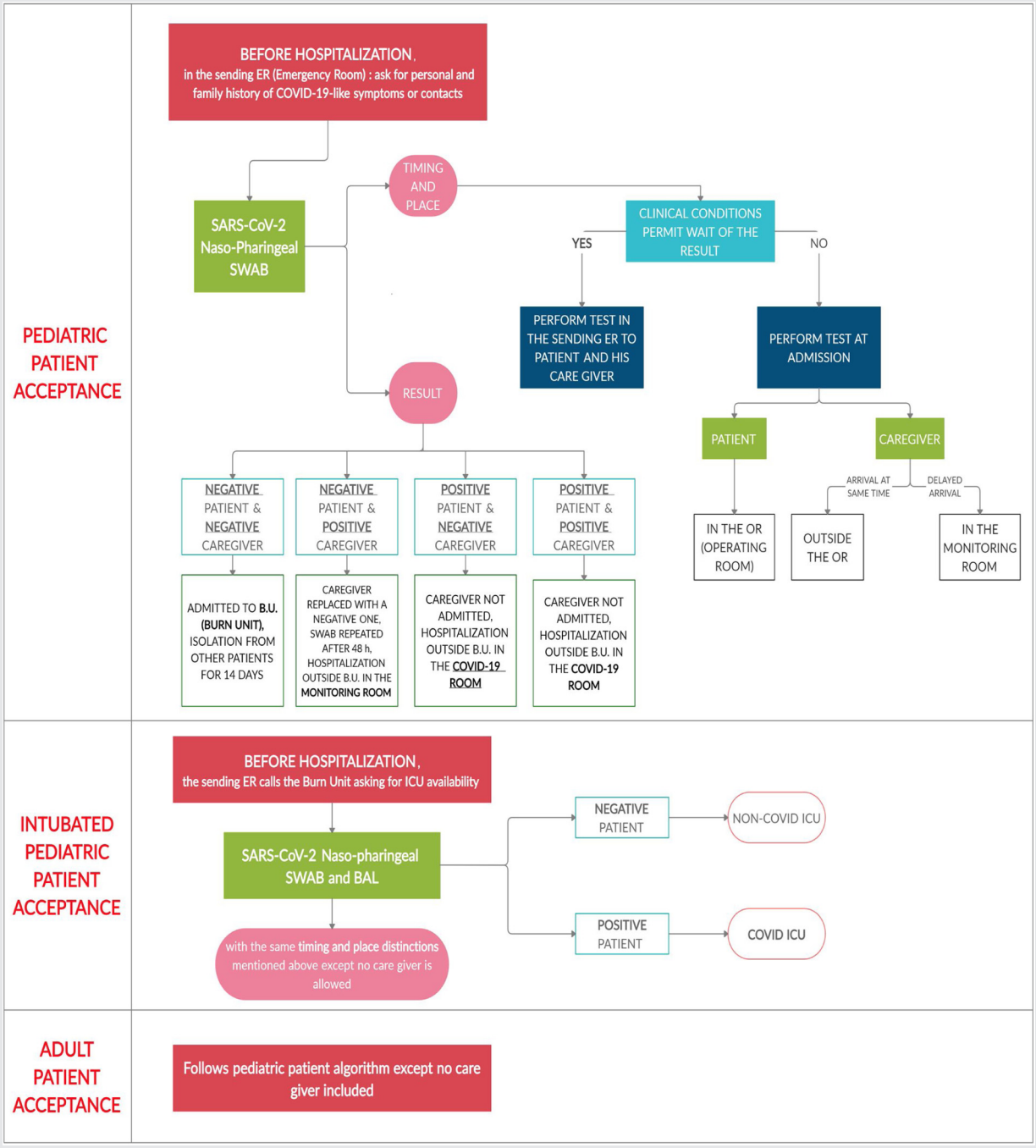
### 2.1. *Statistical analysis*

Qualitative variables are expressed as frequencies while quantitative variables are presented as mean ± SD.

## 3. Results

From the 8th of March, immediately after COVID-19 spread in our region and development of our protocol, to the 8th of June, we admitted in the Burn Unit (ICU and semi-ICU) 18 patients: 12 males (66.7%), 6 females (33.3%), included 4 children, with a

**Table 1 – Acceptance protocol for pediatric and adult patients admitted to Padua University Hospital Burn Unit.**




median age of 56 years (min value: 1 year, max value: 81 years). 13 patients (72.2%) were from the Hospital region Veneto, 5 (27.8%) were from other Italian regions.

12 patients (66.7%) were admitted for flame, 3 (16.6%) for scald, 1 (5.5%) for chemical accidents and 2 (11.1%) for Lyell syndrome. The TBSA affected by the burn was <10% TBSA in 2 patients (11.1%), 10–20% in 10 patients (55.5%), 20–50% in 3 patients (16.6%), 50–75% in 2 patients (11.1%) and 75–100% in 1 patient (5.5%). The predominant grade of the burn was second-degree in 13 patients (72.2%) and third-degree in the remaining 5 (27.8%). An average of 4.8 procedures was performed on each patient (SD: 7.3). Intubation and ICU admission was necessary for 11 patients (61.1%).

The nasopharyngeal swab was performed in the sending ER in 9 patients (50%), in our operating room at the moment of immediate arrival in the remaining 9 (50%).

Moreover, in the same period we admitted in the burn ward for minor burns 17 patients: 10 males (58.8%), 7 females (41.2%),

included 2 children, with a median age of 57 years (min value: 1 year, max value: 82 years). All 17 patients (100%) were from the Hospital region.

10 patients (58.8%) were admitted for flame, 7 for scald (41.2%). The TBSA affected by the burn was <10% TBSA in 6 patients (35.3%), 10–20% TBSA in 8 patients (47.1%), 20–50% TBSA in 3 patients (17.6%). The predominant grade of the burn was second-degree in 16 patients (94.1%) and third-degree in the remaining 1 (5.9%). An average of 2.1 surgical procedures (SD: 1.4) was performed for each patient with 16 patients undergoing at least one surgical procedure (94.1%).

The nasopharyngeal swab was collected in the ER for 8 patients (47.1%), in our operating room in the remaining 9 (52.9%).

Among these admitted patients, two were ventilated adult cases of large burns affected by COVID-19. They were immediately identified, thanks to the identification with a nasopharyngeal swab and BAL, and directed in the COVID19 dedicated ICU. The serology after a first period characterized by high IgM antibodies titers, actually shows a prevalence of IgG. Because of the extension and grade of the burn injury, they are both still hospitalized in the ICU.

The 5 nasopharyngeal swabs of the caregivers collected in our Center tested all negative. Besides, the swab collected in the sending ER of the mother of a pediatric patient admitted in the Burn ward tested positive: she was immediately replaced by a negative caregiver with no previous contacts with the mother, who was then allowed to be in contact with the child. The little patient and the caregiver were isolated in the monitoring room outside of the Burn Unit during all of the hospitalization, with observance of the appropriate measures of protection. The swab was repeated to both of them after 48 h and 5 days (in conjunction of the discharge) with a negative result.

No other cases of SARS-CoV-2 positivity have been reported neither between admitted patients nor between healthcare workers.

The accesses to the clinic were dramatically reduced: at a distance video-call consultations nearly completely replaced post-operative follow-up.

## 4. Discussion

Burn-injured patients are deeply affected in nearly all their vital functions with pathophysiologic changes that can range from hemodynamic instability to altered metabolism, hypothermia and, more importantly, airway and pulmonary impaired functions.

SARS-CoV-2 has represented in Italy an impressive public health threat, rapidly spreading among regions with Lombardy and Veneto as epidemic centers. Because of the high viral infectious rate and its capability to damage several organs, especially the lung with a particular severe pneumonia, effective prevention and treatment are essential [12].

Various treatment options are being tested, with a variety of studies investigating the utility of some off-label drugs. Currently, the major way to avoid virus spreading is the epidemiologic control through preventive measures such as isolation of infected patients and identification of the source of infection. All categories of people are susceptible to SARS-CoV-2 but most severe cases are recognized in the elderly patients and those with underlying diseases or immune dysfunctions [6,13]. Burn injuries must be considered similar to the above-mentioned conditions for their intrinsic immune and multiple organ dysregulation, in the context of a general severe illness affecting all vital functions [14].

The fast COVID-19 spread from China to European countries such as Italy, and particularly the region in which our center is located, therefore imperatively required the implementation of every procedure and admission protocol in our Burn Unit [15].

Our Burn Center, located in the North-East of Italy, is a third level facility responsible for the acceptance and treatment of all major burns in an area with a population of approximately 5 million people. The burn-injured patient is firstly transferred from the place of injury to the closest hospital with an emergency facility. Here, the first treatment, if needed, is provided to the patient. Meanwhile, our Unit is activated and we give our first telephone consultation, predisposing the transfer to our facility, if necessary. Our Burn Unit consists of three separate units: an ICU, a semi-ICU and a Burn and Plastic Surgery Ward. There is also an outpatient clinic for post-discharge follow-up and small interventional procedures.

During the epidemic, we decided to stop any kind of visitor to inpatient rooms, considering that patients usually are from different cities or regions, implying an elevated risk of infection for themselves and their relatives. We provided our patients with the possibility of phone or video calls, improving communication with their relatives about clinical conditions and therapeutic management.

To enforce our admission model, we referred to the guidelines and the suggestions reported by the first Burn Centers involved in COVID19 infection management [16,17]. Starting from the literature review we created an admission protocol, distinct in some aspects for pediatric and adult patients, based on three fundamental principles: patients' history, rapid testing and isolation in a dedicated room until the test response and further isolation with frequent reevaluations during following 14 days after admission in the BU. A history of fever, cough, respiratory distress or other COVID-19 presentation symptoms [6] and contact with suspected or confirmed COVID-19 cases are the first level of control which indicates the necessity of isolation of a patient even if the test performed is negative. Besides, rapid and accurate detection of SARS-CoV-2 is essential to control the outbreak of the infection inside the hospital. Nucleic acid detection is a major method of laboratory diagnosis performed in nasal and pharyngeal swab then submitted to reverse transcription qualitative PCR test [18]. Patient admission in our center is performed exclusively in the operating room, using the appropriate PPE when necessary [19]. All patients referred to our Burn Unit, before admission to the Ward, semi-ICU and ICU, must be tested in the sending hospital when the response timing do not interfere with treatment or in our Hospital when the case is defined as urgent and no treatment has to be delayed during wait for swab result [17].

For emergency cases instead, with major burns, we designed a specific diagnostic path with our microbiological lab: at the admission the patient is immediately tested with

nasopharyngeal swab. In addition, only for pediatric cases, also the caregiver is tested outside the operatory room if the arrival of the patient and the caregiver is simultaneous, in the monitoring room if it is delayed.

Immediately after collection, samples are sent for examination at the Microbiology lab and the result is available in about 90 min.

During the wait for the result, the patient is treated as a suspect case in a dedicated room or in the operating room, if intubated.

Moreover, hospital personnel employs all the appropriate protections according to the specific-setting contagion risk [20,21], which, in particular, is higher during aerosol-generating procedures as collection of diagnostic respiratory specimens for COVID-19, intubation, extubation, manual ventilation, suctioning of the respiratory tract, tracheostomy, bronchoscopy and surgery [22,23].

In the case of a ventilated patient we also performed a BAL which can allow the detection of a positive case even with a negative swab result. At the end of the admission procedure, the patient is managed according to the test result (Table 1). If the patient is intubated, during the test waiting period he is not moved from operating room with no more emergencies treated in the same operatory block in order to avoid contamination risk to other health workers and patients. In some cases, when the number of required tests was substantial, particularly in the acute emergency period, and the waiting time for the result was prolonged, the non-intubated patient could be temporarily moved to a dedicated and isolated room equipped as a burn unit room.

In the case of a pediatric positive patient and a negative caregiver, only the patient is hospitalized in "COVID-19 room", a room designed for positive patients outside Burn Centre, supplied with the same equipment of Burn Centre rooms and assistance guaranteed by Burn Centre personnel.

Instead, if the pediatric patient is negative and the caregiver positive, the patient is hospitalized in the monitoring room for up to 48 h and a new caregiver is designated. The former caregiver is invited to return home and adopt isolation measures keeping in contact with the local authorities. The Burn Centre physician has to inform the Epidemiology service of the caregiver positivity. The new caregiver and the patient have to be tested with the nasopharyngeal swab and if the result is negative they are both admitted outside the Burn Unit and placed in the isolation room for 14 days.

If the pediatric patient is intubated, no caregiver is included because in the ICU access is denied to anyone who does not belong to healthcare personnel.

Negative patients are finally moved to the Burn Unit and quarantined for the following 14 days. During this period, they are tested daily for fever and COVID-19 symptoms. These measures are also effective for the caregiver of the pediatric patient. Moreover, a second nasopharyngeal swab is performed after 48 h in suspect cases and every 7 days after admittance in the other cases, according to the fact that incubation period of SARS-CoV-2 is estimated to be 3–7 days with a range period from 2 to 14 days [24]. Our protocol takes in consideration the report about the capability of COVID-19 transmission during incubation period by asymptomatic or mildly symptomatic patients [25] and the existence of the so-called 'superspreaders': mild symptomatic and high infective [26]. Furthermore, SARS-CoV-2 demonstrates a higher reproductive rate than other SARS coronavirus [27]. Because of all these considerations, we decided to strictly monitor our patients using a period of 14 days as recommended by the World Health Organization (WHO) [24]. At the same time, all healthcare workers of the Burn Unit were weekly tested with the nasopharyngeal swab.

The development of this admission and hospitalization management protocol was essential to avoid the viral spreading: no episodes of contagion were detected neither between patients nor healthcare professionals. In addition, we also managed to individuate two COVID-19 positive cases in extensively burned adult patients and a suspect case of a child with strict contact with his mother, who tested positive for the virus. Consequent isolation and specific treatment were thus immediately predisposed.

Effectiveness of the adopted measures during the COVID-19 epidemic outburst allowed our Burn Unit to preserve its clinical and surgical activity simultaneously safeguarding patients and hospital personnel from contagion risk, despite a high rate of admitted critical patients and the geographical position in the center of an epidemic area.

## 5. Conclusion

Burn-injured patients are deeply affected in nearly all their vital functions with pathophysiologic changes that can range from hemodynamic instability to altered metabolism, hypothermia and, more importantly, airway and pulmonary impaired functions.

The evidence of high ICU admission rate and high mortality in patients affected by SARS-CoV-2 combined with the fragile clinical conditions of burn-injured patients that we are called to care, required us the development of an admission and hospitalization management protocol.

We hope this protocol will be a starting point for healthcare practitioners and hospital management personnel in order to introduce or implement already existing containment measures to face actual COVID-19 and possible future microbiological threats with field tested management protocols.

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## Disclosures/conflict of interest

The authors declare no competing interests.

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