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Rethinking Trauma Hospital Services in one of Spain's Largest University Hospitals during the COVID-19 pandemic. How can we organize and help? Our experience

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ABSTRACT

Introduction: The severe disruptions caused by the SARS-CoV-2 coronavirus have necessitated a redistribution of resources to meet hospitals' current service needs during this pandemic. The aim is to share our experiences and outcomes during the first month of the Covid-19 pandemic, based on the strategies recommended and strategies we have implemented.

Methods: Our experience comes from our work at a referral hospital within the Spanish National Health System. Changes to clinical practice have largely been guided by the current evidence and four main principles: (1) patient and health-care worker protection, (2) uninterrupted necessary care, (3) conservation of health-care resources, (4) uninterrupted formation for residents. Based on these principles, changes in the service organization, elective clinical visits, emergency visits, surgical procedures, and inpatient and outpatient care were made.

Results: Using the guidance of experts, we were able to help the hospital address the demands of the Covid-19 outbreak. We reduced to a third of our orthopaedics and trauma hospital beds, provided coverage for general emergency services, and five ICUs, all continuing to provide care for our patients, in the form of 102 trauma surgeries, 6413 phone interviews and 520 emergency clinic visits. Also in the third week, we were able to restart morning meetings via telematics, and teaching sessions for our residents. On the other hand, eight of the healthcare personnel on our service (10.8%) became infected with Covid-19.

Conclusions: As priorities and resources increasingly shift towards the COVID-19 pandemic, it is possible to maintain the high standard and quality of care necessary for trauma and orthopaedics patients while the pandemic persists. We must be prepared to organize our healthcare workers in such a way that the needs of both inpatients and outpatients are met. It is still possible to operate on those patients who need it. Unfortunately, some healthcare workers will become infected. It is essential that we protect those most susceptible to severer consequences of Covid-19. Also crucial are optimized protective measures.

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Introduction

On March 11th, 2020, the World Health Organization (WHO) declared coronavirus disease-19 (COVID-19) a pandemic. Currently, more than 2,314,621 people across all the world have been infected by this virus, and more than 157,847 people have died [1].

The rapid increase in this contagion have forced all area hospitals to transform rapidly from general or specialized care facilities to dedicated "COVID structures". All elective procedures have been postponed and only emergency care has continued. Emergency rooms are filled with patients coming in for respiratory distress and fever, and the number of contagions increases daily [2]. On March 14th, 2020, a State of Emergency (implementation of stringent lockdown measures for the population) was declared in Spain, and this has persisted to this date [3]. Regular hospital wards are now called COVID 1, COVID 2, and so on. Every single

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medical professional is involved. There were and are no longer any subdivisions in our work [4].

Hospitals' work regimes have been re-prioritized. However, even though coronavirus infection must be a priority, this pandemic does not cause other health emergencies, including orthopaedic and other trauma, to disappear [5]. Orthopaedic surgery and trauma staff is the largest surgical department in most hospitals around the world. Although most traumatologists are not fighting on the front line against Covid-19, we must guarantee treatment for orthopaedic and trauma patients and, in the meantime, protect healthcare workers and patients from Covid-19 infection [6]. Many different strategies have been proposed and implemented worldwide in an attempt to contain this pandemic, some more successful than others [7]. Each decision requires an individualized risk/benefit assessment, with the aims of protecting healthcare personal and patients, helping hospitals deal with Covid-19 lines, and not compromising the assessment and outcomes of our patients. We cannot provide specific guidance, because resources and coronavirus infection curves are different between countries, cities, and hospitals. Nonetheless, we can share our experiences and outcomes during the first month of the Covid-19 pandemic, based on the strategies recommended and the strategies we have implemented. We think this is important because, despite guidance via expert opinions [6–10], no published outcome experiences are based on the strategies applied. Furthermore, that guides do not explain how orthopaedic and trauma staff can help and be part of the solution of this outbreak.

Methods and Materials

Our experience comes from our work at a referral hospital within the Spanish National Health System. Specific records have been kept since March 14th, 2020, when a State of Emergency (implementation of stringent lockdown measures for the population) was declared in Spain. Our hospital is one of the orthopaedic and trauma referral centers in Spain. We perform all kinds of elective and emergency surgery in trauma and orthopaedics, 8000 surgeries per year. Since the emergence of the COVID-19 outbreak, local orthopaedics and trauma practices have been markedly affected.

Changes to clinical practice have largely been guided by the current evidence and four main principles: (1) patient and health-care worker protection, (2) uninterrupted necessary care, (3) conservation of health-care resources, (4) uninterrupted formation for residents. Based on these principles, changes in the service organization, elective clinical visits, emergency visits, surgical procedures, and inpatient and outpatient care have been tailored, as will be described later.

Minimizing Risk

Daily information on the status of Covid-19 positive patients at our institution was presented via telematics. On April 02nd, 707 Covid-19 patients were admitted, among whom 165 were considered critical and requiring intensive care unit (ICU). A policy of avoiding all wearing of street clothes and street shoes in the hospital was implemented, as was the mandatory use of surgical masks and gloves throughout the hospital. In the emergency room and in surgery rooms, wearing a N95 mask, FFP 2 mask, or FFP 3 mask was mandated.

Organization

Separate Teams (A&B) work in separate weeks. Only people essential to the delivery of healthcare services are encouraged to go to the hospital. In our service, there are 10 units, which include a hip unit, knee unit, ankle and foot unit, shoulder and elbow unit,

hand and microsurgery unit, spine unit, tumor unit, septic pathology and bone reconstruction unit, trauma unit, and orthopaedics and childhood trauma unit. The teams were constructed so that one person from each unit is always present or on call. Likewise, an attempt was made to exclude elderly healthcare providers (over 60 years old) from the service, as well as those with newly-born children, so that such individuals may avoid going to the hospital unless absolutely essential.

Daily telematics reunions between the chief of the service and chiefs of the individual units occur. Personnel have been organized to support the Covid-19 units, to cover trauma care (emergency clinical visits and emergent surgeries), operating rooms (delayed fracture emergencies) and clinical consultations (general and specialized consultations via telemedicine). On the third week, we were able to restart the services' morning meetings, via telematics. Morning meetings have included information on the number of patients admitted the previous day for emergency care and a morning teaching session for the residents.

Help to COVID areas and hospital beds

In our hospitals, we have 120 beds for trauma and orthopaedics patients, divided between three floors. Two floors are currently being used for COVID patients, while one floor is used for non-COVID patients. During the pandemic, inpatient visits are performed by different teams that include two faculty and two residents each day. Also, a new ICU was constructed on one floor of the orthopaedics building, consisting of 80 intensive care unit beds, and this unit is partially covered by orthopaedics and trauma faculty and residents.

Elective Clinical Visits

The adoption of telemedicine was improved. We started to conduct phone interviews with outpatients to determine if their health issues might be resolved without a hospital visit or their visit postponed. At our intuition, we have 70 weekly clinics, each with between 20 and 30 patients. Fifty of these clinics are for orthopaedics and trauma specialties and 20 for general trauma and orthopaedic consultations. Each doctor was responsible for their own patients' telephone visits. General clinic schedules were distributed among the older specialists and those with newborn children. Only one daily consultation clinic remains, with a maximum of 10 patients, with an attending physician available to see patients whose visit could not be postponed. Also, two weekly general clinics for fracture patients who require follow-up were left open (maximum of 15 patients).

Emergency Clinical Visits

For the implementation of stringent lockdown measures for the population, emergency clinical visits were reduced. Consequently, the trauma emergency team was reduced to a minimum, consisting only of two traumatologists and orthopaedic surgeons and three traumatologists and orthopaedic residents.

In the beginning, a real-time reverse transcription-polymerase chain reaction (RT-PCR) for Covid-19 was only requested if the patients had symptoms or had pathological chest x-ray evaluated by a radiologist, our biggest mistake. Due to the increase of the pandemic outbreak and for the protection of health workers, we improved the protocol. Currently, all patients that need visit wear gloves and mask, also all patients who need hospital admission undergo a RT-PCR test for Covid-19 and have a chest x-ray (Fig. 1).

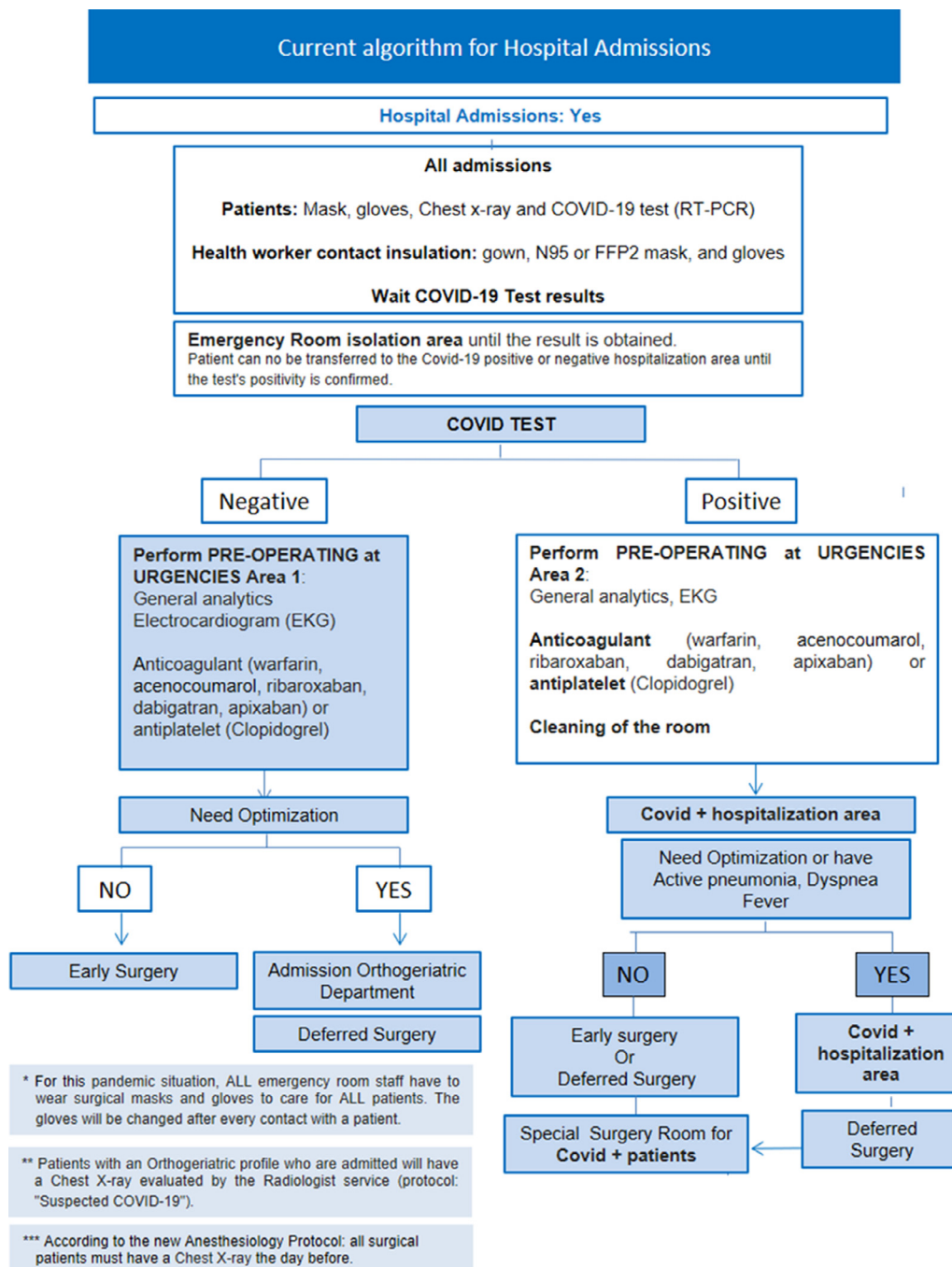


Fig. 1. Current algorithm for the patients that need hospital admission at trauma emergencies

Orthopaedics and Trauma Surgery

Elective surgical cases have been postponed to permit hospitals to free up beds for the treatment of patients with either confirmed or suspected Covid-19. For emergent and urgent surgical cases, two different surgical areas have been created, each on a different floor: one a COVID-positive surgical area and the other a COVID-negative surgical area. RT-PCR tests for Covid-19 and chest x-rays are performed the night before or the same day that patients undergo surgery.

The description of personal protective equipment (PPE) in surgery rooms was performed in Table 1, and is shown on Fig. 2. The results, the mortality and the nosocomial infection of Covid-19 were recorded, to know if it was pertinent to operate patients

during this pandemic outbreak. Covid-19 nosocomial infection was defined as the Covid-19 infection that was acquired in the hospital.

Results

Minimizing Risk and Organization

Even though we adopted a split team policy and encouraged complete team segregation, out of 46 orthopaedics and trauma faculty and 28 orthopaedics and trauma residents, five faculty and three residents ultimately were discovered to have been infected with Covid-19. Of these eight, seven have already recovered, while the other remains in isolation at home.

Table 1
Description of personal protective equipment (PPE).

Description of personal protective equipment (PPE)
1. Waterproof gown
2. Mask. The conventional surgical mask does not offer protection if aerosols exist. The type of mask that is required includes the N95 and FFP2/FFP3 masks (which filter 96 and 99% of organisms, respectively). It is preferable to use masks without valves, since masks with valves do not protect patients from our microorganisms. We recommend wearing a surgical mask over a N95 or FFP2/FFP3 mask.
3. Glasses. Because of the power tools, aerosols are produced during procedures, so that complete ocular screen coverage is essential.
4. Full face coverage screen. This does not protect from aerosols, but is necessary when there is a risk of splashing (blood, vomiting or other biological fluids).
5. Sterile gloves (2 pairs)
6. Cap. It is a good idea for all staff with long hair to have it fully tied up in a low bun and properly restrained.
7. Exclusive footwear for the area of activity, without perforations. We recommend long boots for arthroscopy.
Once the PPE is in place, surgical scrubbing with an alcohol gel will be performed on the surgical gloves, and sterile equipment necessary for the surgical intervention (gown and sterile gloves) will be placed on the PPE.

#: Percentage, PPE: Personal protective equipment



Fig. 2. Photographs of our personal protective equipment (PPE)

Help to COVID areas and hospital beds

On March 14th, 108 orthopaedic and trauma patients were admitted to the hospital. By the end of the first week, the number of patients admitted had been reduced to a third (42 patients). From that day forward, the mean number of hospital admissions for this cohort of patients has been 32 (range, 25 – 42), all admitted to trauma emergency services. It was essential, the help of the faculty surgeons to make a faster discharge of the patients.

Eight faculty and eight residents help the COVID teams every day. This helps to cover the general emergency department and five ICUs. A description of the duties that were performed in the ICUs is in [Table 2](#).

Organization of clinical visits

Phone interviews were conducted with 6,413 outpatients. More than 95.6% of patients had their issue resolved as outpatients, while under 4.4% (287) needed a prompt clinical visit. The most clinical specialist visits that were required were for consultations

for postoperative patients. The mean number of patients per daily clinic was 8, range 3 – 10. The two weekly general clinics left open, the most common visit were nonoperative fracture, mean number of patients was 12, range 8 – 15.

Emergency Clinical Visits

Five hundred twenty emergency clinical visits occurred. Mean patient visits per day were 28 (range 4-36). A decrease of more than 25%, relative to the normal number of visits performed, was observed during this first month after stringent lock-down measures were implemented across the country. There also was a decrease in the number of poly-trauma patients, traffic accidents and work-related accidents. A comparison with the previous month, before lockdown measurements were done in [Table 3](#).

Orthopaedics and Trauma Surgeries

We performed 102 trauma surgeries. Because of the implementation of stringent lock-down measures for the general population, polytrauma surgeries decreased, such that only three such surgeries were performed. The remaining 97.3% of surgeries were deferred emergencies. Brief descriptions and percentages for the surgeries performed are provided in [Table 4](#). Forty-six surgeries (41.1%) were for osteoporotic hip fractures, the most common indication for admission for surgery during this period.

Among the 102 patients admitted for surgery, 10 Covid-19 positive patients were identified at admission. We also identified 11 nosocomial COVID-19 infections, 9 cases in elderly patients who underwent surgery for an osteoporotic hip fracture. The nosocomial COVID-19 infection rate was 10.7%. Among the 81 COVID-19 free patients, 91% were discharged home, while six patients remain in the hospital with good outcomes and no intrahospital mortality. Among the 21 COVID-19 patients, only three died after surgery, while 6 are still in-hospital and 12 were discharged to home or some other residence. The intrahospital mortality rate among operated-upon patients over this time was 1.7%.

Among the eight healthcare personal who became infected with COVID-19, no infection was related to surgeries, since none of these physicians performed any surgery at our hospital prior to their infection. For the surgeries, a maximum of three surgeons was allowed (2 faculty and one resident), although most of the surgeries were performed by only two surgeons (2 faculty or 1 faculty and 1 resident).

Discussion

Using the guidance of experts, we were able to help the hospital address the demands of the Covid-19 outbreak. We reduced to a third our orthopaedics and trauma hospital beds, provided

Table 2

Description of the duties that were performed in the intensive critic units (ICUs).

Description of the duties that were performed in the intensive critic units (ICUs)
Verification of medical treatment (computerized system) of admitted patients:
- Review ALLERGIES of the patients. If they have allergies, activate the computer alert
- Review standard basic treatment:
1. Thromboprophylaxis regimen (enoxaparin 40 mg every 24 hours / SC)
2. Digestive bleeding prophylaxis regimen (Pantoprazole 40mg every 24 hours / EV)
- Review possible interactions of the COVID treatment with other treatments prescribed in the patient. If risk of interactions is detected, COMMUNICATE to the doctor responsible for the patient.
- Check that all patients have an EKG in the computer system.
- Check that medical orders are printed and signed on top of the patient's folder.
* Calls to some patients' relatives
<u>Verification of Covid-19 treatment</u>
Complementary income tests
- Analytical tests: Troponin, NT-proBNP, IL-6, LDH, D-Dimer, Ferritin. Hemocultives. Legionella antigens and pneumococcus antigens.
- EKG
Treatment
- Hydroxychloroquine 400mg every 12 hours for the first day, followed by 200mg every 12 hours for 5 days
- Ceftriaxone 1 gram every 24h (7 days) + Azithromycin 500mg every 24 hours (5 days) - (In case of penicillin allergy: Levofloxacin 750 mg every 24 hours + Azithromycin)
* In case of institutionalized patient: Coverage for pseudomonas (piperacillin-tazobactam) + MARSA cleavage.
Tocilizumab (under discussion) Will be evaluated individually in those patients with refractory progressive impairment.

COVID: coronavirus disease-19, EKG: Electrocardiogram, NT-proBNP: pro b-type natriuretic peptide, IL-6: Interleukin 6, LDH: Lactate dehydrogenase

Table 3

Comparison of emergency clinical visits with the previous month before implementation of stringent lock-down measures for the population. To establish the relationship between the two different periods, a Chi-squared test analysis were made in the statistical package of IBM SPSS ver.25.0 (IBM Corp., Armonk, New York, USA).

	PERIODS ANALYZED DURING OUR STUDY			
	Period 1	Period 2	TOTAL	P value
Age. Median (SD)	54.6 (22.5)	57.5 (22.5)	55.1 (22.1)	0.08
Sex				
Men (%)	998 (47.9)	252 (46.9)	1250 (48.1)	0.14
Women (%)	1085 (52.1)	268 (53.1)	1353 (51.9)	
Destination to Discharge				
Home discharge (%)	1812 (86.9)	427 (82.1)	2239 (86.1)	0.001
Hospital admission (%)	212 (10.2)	90 (17.3)	302 (11.6)	
Flight or abandonment (%)	54 (2.6)	3 (0.6)	57 (2.2)	
Voluntary discharge (%)	5 (0.3)	0 (0.0)	5 (0.1)	
Insurance Type				
Catalan health service (%)	1903 (91.4)	489 (93.8)	2392 (91.9)	0.2
Polytraumatics patient	49 (2.4)	3 (0.6)	52 (2.0)	
Workplace accident (%)	45 (2.2)	11 (2.1)	56 (2.2)	
Traffic accident (%)	84 (4.0)	19 (3.5)	103 (3.9)	

SD: Standard deviation; %: percentage; period 1: From February 12 to March 13, 2020, previous month before the state of Emergency, period 2: From March 14 to April 13, 2020, first month of the Spain State of Emergency.

coverage for general emergency services and five ICUs, all the while continuing to provide care for our patients, in the form of 102 trauma surgeries, 6413 phone interviews and 520 emergency clinic visits. Also in the third week, we were able to restart morning meetings via telematics, and teaching sessions for our residents. On the other hand, eight of the healthcare personnel on our service (10.8%) became infected with COVID-19. Our biggest mistake was not performing a RT-PCR in all the patients that need hospital admission since the first day.

That we had 10.8% of our attending and resident physicians become infected with COVID-19 is a problem. In fact, this is one of the most important problems that has arisen facing the coronavirus outbreak. It is known, for example, that COVID-19 has forced thousands of healthcare workers out of action in Europe [11]. On April 11th, 2020, more than 25,000 healthcare workers were infected in Spain [12]. Of our own healthcare workers' infections, six were in the first week, and the other two in the second week. We think that the reduced infection rate among healthcare workers was because we had implemented more stringent hospital policies.

At the beginning of the first week, healthcare personnel only used surgical masks in the hospital, and we only tested emergency room patients who reported symptoms. Presently, all healthcare workers wear gloves and a surgical mask – either a N95 or FFP 2 mask – throughout their time in the hospital. All patients who come to the hospital also must wear at least a surgical mask and gloves. We perform chest x-rays and RT-PCR testing for COVID-19 on all patients who need hospital admission. Furthermore, among patients admitted through the emergency room or a clinic and those who undergo surgery and test positive for COVID-19, appropriate PPE has been implemented.

Supporting COVID-19 teams is important at this time. The first thing we can do is minimize patients' exposure to COVID-19 by postponing all elective surgical procedures and hastening the discharge of patients who are admitted. We postponed all elective surgeries and were able to reduce our hospital bed use to a third of its baseline. The purpose of this recommendation is also to limit the use of hospital beds, increasing the hospital beds available for COVID-19 patients [7]. Discharging patients as early as possible

Table 4

Descriptions and percentages for the surgeries performed. The absolute frequencies and percentage were used to report the categorical variables. the statistical package of IBM SPSS ver.25.0 (IBM Corp., Armonk, New York, USA).

Surgery	Number	Percentage (%)
Polytrauma External Fixation	3	2.9
Osteoporotic Hip Fractures	46	45.3
Femur Shaft Fracture	2	1.9
Distal Femur Fracture	2	1.9
Periprosthetic Hip Fractures	3	2.9
Periprosthetic Knee Fractures	2	1.9
Tibial Plateau Fractures	3	2.9
Tibia Shaft Fractures	2	1.9
Ankle Fractures	5	4.9
Proximal Humerus Fractures	5	4.9
Humerus Shaft Fractures	1	0.9
Distal Radius Fracture	3	2.9
Spine Fractures	6	5.9
Foot Fractures	2	1.9
Musculoskeletal infection	5	4.9
Periprosthetic joint infection	3	2.9
Hand Injuries	4	3.9
Quadriceps Tendon Rupture	1	0.9
Other surgeries	4	3.9

%. Percentage

also is important because it reduces the likelihood of nosocomial COVID-19 infection via spread back and forth between patients and healthcare workers. Another vital point during this pandemic is the assistance of all healthcare workers [4,13]. Even though many of us are relatively unprepared to handle the use of mechanical ventilators, and many of us have not worked in an ER or ICU in years, we can help. We must recognize that, just like we understand that most physicians cannot apply an external fixator device, they also know that we cannot intubate patients and operate mechanical ventilators. Depending on the will, knowledge and skills of each member, our teams were divided in such a way that all necessary aspects of care could be addressed, including handling patients' medications, making calls to patients' relatives, providing emergency care prior to the initial triage of COVID-19 and non-COVID-19 patients, and helping to transport patients. In our institution, none have regretted having helped.

Also, apart from helping, we must not forget our service, our patients and the formation of our residents. Over 100 trauma surgeries were performed. To our knowledge, no healthcare personnel has become infected with COVID-19 during any of these surgical procedures. We cannot say the same about inpatient visits. First, we recommend only operating when it is essential, and remember that we put both ourselves and our team, which includes anesthesiologists and nurses, at risk too. Even most trauma surgery could be performed with regional anesthesia, as we must remember that intubation is considered one of the highest-risk procedures when dealing with COVID-19 patients [14]. Surgical indications also depend on the severity of the epidemic and the availability of resources. In locations with widespread infections and limited resources, the risk of surgical procedures, both for the patient and community, may outweigh the benefit [15]. In the current literature, Lei et al, in their retrospective review, analyzed 34 surgical patients who underwent elective surgeries during the incubation of COVID-19 in Wuhan, and found that all patients developed COVID-19, 44% required admission to an ICU, and seven died after ICU admission [15]. Even though the intrahospital mortality rate was low (1.7%), nosocomial COVID-19 infections developed in 10.7%. This percentage correlates with that of our healthcare workers, so that we believe that these new COVID-19 infections occurred during inpatient visits. One potential explanation is that hospital inpatient floors are more fluid sites, where doctors, nurses, security,

and housekeeping personnel change every 8 or 12 hours. For this reason, minimizing the number of healthcare workers and increasing protective measures (e.g., PPE, cleaning supplies, etc.) is vital on hospital floors. Another important factor has been pre-operative mortality. During the first week, two patients admitted to the hospital for an osteoporotic hip fracture were discovered to be COVID-19 positive, so we decided to delay their surgery; both ultimately died. Based on this, if resources and equipment are available, we recommend trying to operate on such patients promptly. Among our 46 elderly patients, 28 were discharged home COVID-19 free, while 9 patients developed a COVID-19 infection. Among these 9, 4 are still in the hospital, three have died, and two have been discharged. Surgical contraindication would be a patient with active pneumonia, dyspnea or fever. But for the mere fact of being COVID, the surgery of any patient should not be postponed.

Every doctor can help to keep as many patients as possible at home [1]. As in the USA, trauma and orthopaedic consultations comprise almost 70% of all clinical consultations [6]. For that reason, we organized and made 6413 phone interviews with outpatients to try to resolve their health issues, so they could avoid going to an emergency room. Because losing a friend or a coworker can be fatal for a service, despite their willingness to help, elderly physicians and those with newborn children were asked to contribute from home, especially providing clinical consultations by phone. As such, infection of our center's healthcare personnel generally affected our younger physicians, ranging in age from 28-50.

Finally, another important objective is the training of residents. It is obvious that their time in surgery has decreased, but their development should not [16]. During the second week of the pandemic, we were able to resume morning rounds and a morning teaching session for the residents. The use of videoconferencing is strongly recommended to facilitate continued learning and counteract the stress of social isolation. With respect to assisting in surgical procedures, all residents took turns so they continued to develop their skills, stressing the importance of there currently being as few people in the operating room as possible.

Conclusions

As priorities and resources increasingly shift towards the COVID-19 pandemic, will it be possible to maintain the high standard and quality of care necessary for trauma and orthopaedics patients while the pandemic persists? In our opinion, it is possible. We must be prepared to organize our healthcare workers in such a way that the needs of both inpatients and outpatients are met. Daily telematics-obtained information on the status of COVID-19 positive patients is vital. This information is crucial because it helps healthcare personnel to appreciate exactly what are they facing. It is still possible to operate on those patients who need it, being careful both in the operating room and, even more importantly, on hospital floors. Unfortunately, some healthcare workers will become infected. It is essential that we protect those most susceptible to severer consequences of COVID-19, like those who are elderly and those with young children. Also crucial are optimized protective measures.

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Declaration of Competing Interest

Jorge H. Nuñez, Juan Antonio Porcel, Joan Pijoan, Lledó Batalla, Jordi Teixidor, Ernesto Guerra-Farfan and Joan Minguell declared no

potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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