



## ■ SPINE

# The management of emergency spinal surgery during the COVID-19 pandemic in Italy

A PRELIMINARY REPORT

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### Aims

The current pandemic caused by COVID-19 is the biggest challenge for national health systems for a century. While most medical resources are allocated to treat COVID-19 patients, several non-COVID-19 medical emergencies still need to be treated, including vertebral fractures and spinal cord compression. The aim of this paper is to report the early experience and an organizational protocol for emergency spinal surgery currently being used in a large metropolitan area by an integrated team of orthopaedic surgeons and neurosurgeons.

### Methods

An organizational model is presented based on case centralization in hub hospitals and early management of surgical cases to reduce hospital stay. Data from all the patients admitted for emergency spinal surgery from the beginning of the outbreak were prospectively collected and compared to data from patients admitted for the same reason in the same time span in the previous year, and treated by the same integrated team.

### Results

A total of 19 patients (11 males and eight females, with a mean age of 49.9 years (14 to 83)) were admitted either for vertebral fracture or spinal cord compression in a 19-day period, compared to the ten admitted in the previous year. No COVID-19 patients were treated. The mean time between admission and surgery was 1.7 days, significantly lower than 6.8 days the previous year ( $p < 0.001$ ).

### Conclusion

The structural organization and the management protocol we describe allowed us to reduce the time to surgery and ultimately hospital stay, thereby maximizing the already stretched medical resources available. We hope that our early experience can be of value to the medical communities that will soon be in the same emergency situation.

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### Introduction

The current COVID-19 pandemic is the biggest challenge faced by national health systems in a century. The outbreak started in December 2019 in Wuhan, China, where the first cases of pneumonia of unknown origin were reported. Shortly afterwards, the pathogen was identified as a coronavirus and named COVID-19.<sup>1</sup> Since then, the infection has spread to most of the world, with cases reported on every continent except Antarctica.<sup>2-7</sup>

On 20 February 2020, a young male in the Lombardy region of Italy was admitted with an atypical pneumonia, which later proved to be

COVID-19. This was the start of the epidemic in our country. By 28 March 2020, Italy had the second highest number of confirmed cases (92,472) after the USA, according to the Istituto Superiore di Sanità, and the highest number of reported deaths, with a mortality approaching 8%.<sup>8</sup> Nonetheless, in most other European countries, including the UK, Spain, Germany, and France, as well as in several metropolitan areas of the USA, the pattern of infection is closely following that of the Italian experience and is likely to develop in the same way over the next few weeks.

The Italian national health system is currently overwhelmed by the number of patients requiring

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intensive care beds to treat patients with COVID-19. In an attempt to limit the spread of the infection, the Italian government implemented several emergency measures on 10 March 2020, including travel restrictions and a ban on public gatherings, sporting events, and funerals. Initially, measures were applied only in the region of Lombardy, which is the most affected from the disease; the restrictions were then extended to the whole country.

Concurrently, the regional health system was reorganized to maximize the number of ICU beds needed for COVID-19 patients and to rationalize the care of patients with unrelated conditions. Under this new system, several hub hospitals were chosen to treat patients with non-deferrable conditions that might require ICU beds, such as cardiac disease, stroke, tumours, and trauma. Our hospital (A.S.S.T. Grande Ospedale Metropolitano Niguarda, Milano) was selected as one of the three hubs for emergency spinal surgery, specifically vertebral fractures and spinal cord compression. Even before the COVID-19 pandemic, spinal trauma and cord compression were managed in our hospital by an integrated multidisciplinary spinal surgery team, including both orthopaedic and neurosurgeons, with a prescribed care pathway for diagnosis and treatment. This was maintained and used during the pandemic, with the aid of other orthopaedic and neurosurgeons seconded from other hospitals, to provide prompt and effective intervention and to limit the patient's stay in the hospital as far as possible.

Given the current pandemic status of the COVID-19 infection, and the consequent pressure on national health systems, a coordinated response to ensure the safety of patients with non-COVID-19 conditions is essential. Countries that are unfortunate enough to have been exposed early to this disease can offer very valuable experience to countries that are preparing to face the emergency.

In this paper, we describe an organizational model for emergency spinal surgery during the pandemic, and report our early experience.

## Methods

**Study population.** A prospective cohort study with a retrospective control group was undertaken. Data on each patient admitted to our hospital with an admission diagnosis of vertebral fracture or spinal cord compression between 9 and 27 March 2020 were collected prospectively. These included demographics, diagnosis, type of surgery, and time interval between admission and surgery. This cohort was compared to a retrospective cohort of patients admitted for the same reasons in the same period the previous year (9 to 27 March 2019). Patients' data were retrieved from a search of specific diagnostic codes in the institutional database. Clinical information was then retrieved from each patient's medical record.

**Organizational flow chart.** Since 2018, an integrated spinal team of three neurosurgeons and three orthopaedic surgeons has been working at our hospital. It offers a comprehensive approach to all spinal injuries. Each operation is carried out by an orthopaedic surgeon and a neurosurgeon. In two years, this team has undertaken over 100 operations on the spine.

In January 2020, a care pathway for the management of vertebral fractures and spinal cord compression was written by

the spine surgeons in collaboration with all the other medical professionals involved in the management of spinal injuries (emergency doctors, trauma surgeons, neuroradiologists, ICU, and rehabilitation medical staff). It was then approved by our institutional review board

Since the government's decision to create hub hospitals on 10 March 2020, the care pathway was slightly modified in order to deal with COVID-19 patients (Figure 1), and applied as the standard of care for each patient admitted for emergency spinal surgery. A spinal team with at least two surgeons was made available around the clock, with an operating theatre dedicated to emergency spinal surgery, and two nurses and an anaesthetist always available.

The path of treatment is as follows: a patient with a potential spinal injury attends our hub hospital for emergency spinal surgery. Admission can be directly from the territorial emergency network or as a transfer from another non-hub hospital. The patient is then tested for COVID-19. A patient admitted from another hospital with a negative test for COVID-19 carried out more than seven days previously is retested.

If the patient has multiple injuries, they are evaluated by our trauma team; neurological status is assessed using the American Spinal Injury Association (ASIA) impairment scale (AIS). If the patient is haemodynamically stable, then follows a CT scan of C0-T4 and plain radiographs of the thoracic and lumbosacral spines. If the patient is haemodynamically unstable, a whole body CT is performed. CT angiography is carried out if indicated by the modified Denver criteria for cerebrovascular injury.<sup>9</sup>

If the patient has no major trauma, they are evaluated by the emergency doctors and undergo radiological assessment as described above.

In the case of vertebral fracture and/or neurological deficit, the patient is evaluated by the spinal surgery team and an anaesthetist, and their AIS reassessed.

An urgent MRI is required in the presence of progressive neurological deficit, suspected ligamentous lesions, or a non-evaluable patient. When surgery is indicated, the available team is activated in order to treat the patient within the following timescales:

- Cervical displacement, any AIS: Urgent Early < 12 hours
- Any worsening of AIS: Urgent Early < 12 hours
- Any level, AIS B, C, D: Urgent < 24 to 36 hours
- Spinal cord injury with previous cervical spondylosis: Middle Urgent < 36 to 48 hours
- Any level, AIS A/E stable: Planned < 72 to 96 hours

Rehabilitation is started as soon as possible so as to be able to discharge the patient a few days after their surgical procedure.

## Results

Between 9 and 28 March 2020, 19 patients (11 males and eight females with a mean age of 49.9 years (14 to 83)) underwent emergency spinal surgery in our hospital. Of those, six were transferred from non-hub hospitals and 13 were admitted directly. According to our protocol, 16 patients were tested for COVID-19, while three had a recent negative test. There were no positive results. A total of 16 patients were admitted with a spinal injury. The trauma mechanism was a fall from

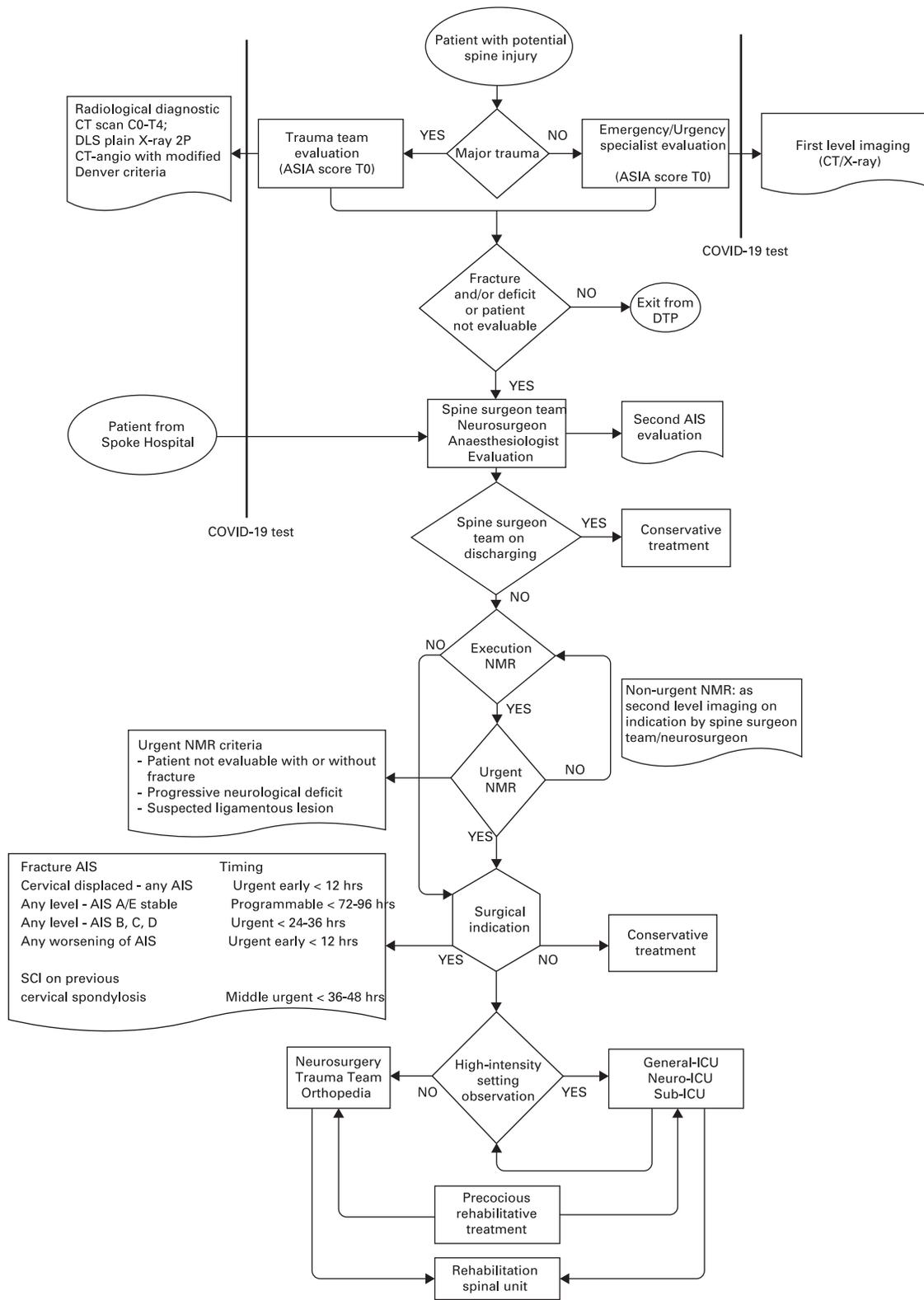


Fig. 1

Care pathway flow chart. Angio, angiogram; AIS, American Spinal Injury Association Impairment Scale; ASIA, American Spinal Injury Association; DLS, dorsal and lumbar spine; ICU, intensive care unit; Neuro, neurology; NMR, nuclear magnetic resonance; SCI, spinal cord injury; Sub-ICU, subintensive care unit.

**Table I.** Diagnosis, scheduled surgical timing according to the protocol, type of surgery, and time interval from admission to surgery for patients treated since the beginning of the emergency.

Patient number	Diagnosis*	AIS score	Scheduled timing	Surgery	Time interval (hrs)
1	B3 type fracture of T4-5	E	Programmable	PF T2-6	8
2	T12 discitis	D	Urgent	PF T10-L2	16
3	A4 type L1 fracture	E	Programmable	PF T12-L2	48
4	C type T12 fracture	B (worsening)	Urgent early	PF T10-L2	8
5	C3 sacral fracture	E	Programmable	Spinopelvic triangular fusion (L4-pelvis)	56
6	A4 type L1 fracture	E	Programmable	PF T12-L2	48
7	Tubercular discitis C7-T1	B (worsening)	Urgent early	ACCF C6-T1 + PF C5-T3	8
8	A4 type L1 fracture	E	Programmable	L1 corpectomy and T12-L2 anterior fusion	48
9	C type fracture C5-6 + B type fracture of the odontoid	A	Urgent early	PF C1-T2	9
10	B2 type fracture T5-6	A	Programmable	PF T3-7	36
11	B2 type L1 fracture	E	Programmable	PF T11-L3 + L1 corpectomy and T12-L2 anterior fusion	36
12	B3 type fracture C5-6	E	Programmable	ACCF C5-7	30
13	B2 type T3 fracture	E	Programmable	PF C6-T6	52
14	B type C2 fracture	E	Programmable	PF C1-2	36
15	C5-6 dislocation	E	Programmable	ACCF C5-C7 + PF C5-T1	36
16	B2 type L1 fracture	Nx	Urgent	Deceased for trauma complications	-
17	LDH L5-S1 with cauda syndrome	C	Urgent	Microdiscectomy	12
18	T3 metastatic cord compression	D	Urgent	Decompression + T2-T4 PF	20
19	B3 type T12 fracture	E	Programmable	PF T9-L3	78

\*Fracture classification was done according to the AO Spine upper cervical, subaxial cervical, thoracolumbar, and sacral fracture classification systems.

ACCF, anterior cervical corpectomy and fusion; AIS, American Spinal Injury Association (ASIA) impairment scale; Nx, neurology non-valuable; PF, posterior fusion.

a height in ten patients, a motor vehicle incident in four, and work-related trauma in two cases. Three patients needed urgent spinal surgery for cord compression (one spondylodiscitis, one pathological fracture in metastasis, one lumbar disc herniation with cauda syndrome). One multiply injured patient with an AO Spine B2 fracture of L1 died before undergoing spinal surgery. Specific diagnosis, type of surgery, and urgency classification according to our protocol were recorded and are reported in Table I. According to our protocol, seven cases were classified as urgent or urgent early, while 12 patients were classified as planned and underwent surgery at a mean time of 1.7 days.

In the same period of the previous year, we had ten admissions for spinal injury (seven males and three females with a mean age of 47.3 years (27 to 80)). Two patients had injuries that were deemed urgent early from admission (cervical subaxial type C injuries), which were operated at four and eight hours. Eight of these patients had injuries that were considered programmable and were operated on after a mean of 6.8 days (SD 4.7). This was significantly slower than the mean of 1.7 days (SD 0.8) in the current series ( $p < 0.001$ , independent samples *t*-test).

## Discussion

The spread of COVID-19 has satisfied the epidemiological criteria to be defined as a pandemic according to the journal Nature and the World Health Organization (WHO), having infected more than 100,000 people across more than 100 countries.<sup>10,11</sup> The novelty of this situation for modern national health systems is highlighted by the fact that in the last 60 years only

two other infectious diseases have reached pandemic status: HIV/AIDS in the late 1980s and early 1990s, and the 2009 H1N1 influenza virus. However, neither of these challenged the capacity of health systems to the extent of COVID-19. Indeed, medical resources, in particular ICUs, have been stretched to breaking point in all the affected countries while trying to care for diseased patients. In this dreadful situation, regular medical activity needs to be limited with the dual aim of allocating most of the medical resources to treating patients with the virus and limiting the spread of the infection within hospitals. However, time-dependent medical emergencies such as cardiac disease, stroke and other neurological diseases, tumours, and trauma still need to be addressed. One such emergency is spinal fracture and cord compression.

The care pathway proposed in this study is applicable to other countries preparing to counter the emergency that Italy is facing right now. However, several aspects of the pathway need to be addressed. First, the admission of each patient to the hub hospital is managed by the regional emergency network. Therefore, in case of multiple injuries the patient is directly referred from the scene of the accident to our emergency room (ER). Otherwise, if the patient is admitted or injured in a non-hub hospital, a transfer is set up as soon as possible. In order to ensure the safety of medical and nursing staff as well as that of other patients, we implemented a rule for COVID-19 testing. Patients admitted directly to our hospital ER are all tested for COVID-19, unless they have had a recent (less than seven days) negative test. Until the results of the test are available, they are seen in a 'grey' area, which includes the resuscitation room as

well as a CT scan and MRI. Patients who need urgent early surgery are treated as COVID-19 positive until the definitive test results are obtained. Once the diagnostic tests have been completed, patients who need surgery are scheduled. In order to maintain a high standard of care for the patients, each operation is carried out by both a neurosurgeon and an orthopaedic surgeon, in order to benefit from the microsurgical abilities of the former and the biomechanical knowledge of the latter.

In the protocol, the timing of surgery was based on the most recent guidelines and literature.<sup>13,14</sup> Given the prevailing situation, our goal was to reduce the time to surgery with the ultimate aim of reducing the overall length of hospital stay for the patients. In particular, planned operations were always performed sooner than the proposed 72 to 96 hours. In order to reach these goals, a multidisciplinary team of spinal surgeons and a dedicated theatre and staff always have to be available. In the event, a statistically significant reduction in the time from admission to surgery was seen for planned cases when compared to the previous year.

While most of the literature about COVID-19 understandably concentrates on the disease itself, there have been few papers about the management of urgent non-COVID-19 conditions during the pandemic. In the orthopaedic field, Chang Liang et al<sup>15</sup> recently reported the organizational experience in Singapore. Patients who needed urgent care of their injuries were still admitted to hospital and treated in the same way as usual. Moreover, and more interestingly, they reported that day cases were also managed as usual, since the required hospital stay was less than 23 hours. The rationale was that the short hospital stay does not pose a major drain on healthcare resources and does not carry a high risk of nosocomial COVID-19 infection. In our approach, we tried to achieve the shortest hospital stay by two means: first, by operating on each surgical patient as soon as possible, and second, by lowering the threshold for surgical management. As such, when the condition warranted either a 'watch and wait' strategy or a surgical intervention that allowed early mobilization, the latter strategy was preferred.

This is a preliminary study with a limited number of patients. Our aim, however, is to provide information for those who have still not experienced the pandemic in its full force; therefore delaying the publication to gather more data would not be helpful. Moreover, it is the authors' opinion that all the data gathered during this emergency will provide the scientific foundation for healthcare organization in future circumstances similar to the current one. It will be of utmost importance that, at the end of this pandemic, several more complete papers will be published to fill the gaps of the present one.

Italy is currently ahead of the curve in facing the COVID-19 outbreak, with other countries all over the world preparing for the same situation. While most of the medical resources are allocated to fighting the pandemic, national health systems should also be prepared to deal with medical emergencies unrelated to COVID-19. Here we propose an organizational model and associated care pathway which can be applied to the management of spinal emergencies, such as vertebral fracture and spinal cord compression. The structural organization and management protocol described here allowed us to reduce the time to surgery and ultimately hospital stay, thereby maximizing the already

stretched medical resources available. We hope that our preliminary experience will be of value to the medical communities that will soon be in the same emergency situation.



### Take home message

- The COVID-19 pandemic is stretching medical resources all over the world, but medical emergencies unrelated to COVID-19 still need to be dealt with.
- In Italy, to optimize resource allocation, hub hospitals dedicated to the emergency care of non-COVID-19 conditions were defined.
- In our hospital, we applied a strict protocol to manage emergency spinal surgery during the pandemic.
- Under this protocol, we reduced the time interval between admission and surgery with the ultimate goal of reducing hospital stay, thereby reducing the risk of nosocomial infection for the patients and maximizing the use of the already thinned medical resources available.

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