

Effect of a prioritization score on the inter-hospital transfer time management of severe COVID-19 patients: a quasi-experimental intervention study

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Abstract

Background: The overburdening of the healthcare system during the coronavirus disease 19 (COVID-19) pandemic is driving the need to create new tools to improve the management of inter-hospital transport for patients with a severe COVID-19 infection.

Objective: The aim of this study was to analyse the usefulness of the application of a prioritization score (IHTCOVID-19) for inter-hospital transfer of patients with COVID-19 infection.

Methods: The study has a quasi-experimental design and was conducted on the Medical Emergency System, the pre-hospital emergency department of the public company belonging to the Autonomous Government of Catalonia that manages urgent healthcare in the region. Patients with a severe COVID-19 infection requiring inter-hospital transport were consecutively included. The pre-intervention period was from 1 to 31 March 2020, and the intervention period with the IHTCOVID-19 score was from 1 to 30 April 2020 (from 8 am to 8 pm). The prioritization score comprises four priority categories, with Priority 0 being the highest and Priority 3 being the lowest. Inter-hospital transfer (IHT) management times (alert-assignment time, resource management time and total central management time) and their variability were evaluated according to whether or not the IHTCOVID-19 score was applied.

Results: A total of 344 IHTs were included: 189 (54.9%) in the pre-intervention period and 155 (45.1%) in the post-intervention period. The majority of patients were male and the most frequent age range was between 50 and 70 years. According to the IHTCOVID-19 score, 12 (3.5%) transfers were classified as Priority 0, 66 (19.4%) as Priority 1, 247 (71.8%) as Priority 2 and 19 (5.6%) as Priority 3. Overall, with the application of the IHTCOVID-19 score, there was a significant reduction in total central management time [from 112.4 (inter-quartile range (IQR) 281.3) to 89.8 min (IQR 154.9); $P = 0.012$]. This significant reduction was observed in Priority 0 patients [286.2 (IQR 218.5) to 42.0 min (IQR 58); $P = 0.018$] and Priority 1 patients [130.3 (IQR 297.3) to 75.4 min (IQR 91.1); $P = 0.034$]. After applying the IHTCOVID-19 score, the average time of the process decreased by 22.6 min, and variability was reduced from 618.1 to 324.0 min.

Conclusion: The application of the IHTCOVID-19 score in patients with a severe COVID-19 infection reduces IHT management times and variability.

Key words: COVID-19, dispatch centre, emergency care, critical illness, triage management

Introduction

During the first wave of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) coronavirus pandemic, healthcare systems in well-resourced countries were clearly overwhelmed by the accumulation of critically ill patients

requiring admission to intensive care units (ICUs) [1]. Guidelines were established to allocate ventilatory support when it was in short supply, but these guidelines varied significantly and could lead to inequities [2]. The burden on the healthcare system is likely to be greater in areas far from main urban

centres due to the lower availability of intensive care unit (ICU) resources [3]. One of the strategies to promote fairness in ICU triage is to consider ensuring the existence of a robust inter-hospital transfer (IHT) mechanism from overwhelmed hospitals to better-resourced hospitals at the state level [4].

In our setting, pre-hospital emergency services are responsible for IHT and measures have been taken during the pandemic [5–8]. Transfer delays in IHT are associated with poor outcomes [9]. A score that made it possible to assign priority to the transfers of patients with severe COVID-19 (IHTCOVID-19) between hospital centres at one single coordination centre was designed following the ethical recommendations for decision-making in the exceptional situation resulting from the first wave of the pandemic [10–12]. There are no data on the effect of implementing this type of score on IHT management times.

The aim of the present study was to assess the improvement in IHT management times and the variability in the prioritization of severe COVID-19 patients when using the IHTCOVID-19 prioritization score created specifically for this scenario.

Materials and methods

Design, scenario and selection of patients

This quasi-experimental intervention study was designed to incorporate pre- and post-intervention analyses and was conducted on the Catalan Medical Emergency System (Sistema d'Emergències Mèdiques or SEM). The pre-hospital emergency department SEM is a public company belonging to the Autonomous Government of Catalonia. The SEM is responsible for dealing with emergencies through its basic life support and advanced life support (ALS) units. These units are responsible for assessing the situation, carrying out the triage and providing initial treatment in the first instance as well as for transporting the injured or ill patients to the most appropriate healthcare facility for secondary or tertiary treatment as transport resources allow. This is done through the pre-hospital emergency dispatch centre, which undertakes major incident management and arranges transport to the hospitals that have the capacity to treat the patients. The SEM is also responsible for coordinating and overseeing the various health structures involved in a crisis or an emergency situation. This role facilitates the optimisation of diverse operative resources and contributes synergies to other structures in the healthcare system (acute care hospitals, public health units, primary health organizations and private hospitals), thus making the service delivered better and most efficient. The goal is an urgent healthcare model based on a systemic conception of the attention of urgencies and emergencies, fully integrated into the healthcare system and system of public security.

SEM is also responsible for carrying out the IHT and coordinating the assessment of the patient's clinical situation in order to assign the most appropriate resources for the transfer with the selection of the destination hospital carried out according to the reference territory and high-tech hospital [13].

To deal with the pandemic generated by COVID-19, SEM established a number of contingency measures, of which two particularly stand out: the first, which is of a structural nature, consisted of modifying the total staffing numbers at both operational and specific units to respond to patients, especially the

most critical cases. The second, which is of an organizational nature, consisted of the creation of a specific unit at the health coordination centre to expedite the management of the IHT of critical patients diagnosed with COVID-19 and the hiring of professionals with extensive experience in the management of critical patients.

The pre-intervention period was from 1 to 31 March 2020 and the post-intervention period was from 8 am to 8 pm from 1 to 30 April 2020, which was the period when the IHT was managed by critical care staff. The intervention consisted of the application of the IHTCOVID-19 score. To carry out the study, all the IHT data were collected of patients diagnosed with severe COVID-19 infection by the referring hospital and requiring transfer to a receiving hospital by means of a ground-based ALS unit whose evolution required therapeutic escalation with the need for transfer to a high-tech hospital or whose transfer was due to a lack of ICU beds in the referring hospital. Cases of COVID-19 patients referred for procedures unrelated to the infection and those patients lacking criteria for admission to a critical care unit were excluded.

Design of the IHTCOVID-19 score, data collection method and definition of variables

The IHTCOVID-19 score was developed by a team of 15 specialists in emerging medicine and 1 statistician, who were involved in the whole process of creating the tool [14]. Content validity is in line with the good clinical practice recommendations in place at the time of its creation [15]. A principal component factor analysis was performed for testing construct validity, and reliability was assessed by calculating the score's ordinal alpha. The selected variables and scores are shown in [Figure 1](#). It was decided to give a higher score to those patients who would benefit most from admission to a critical care unit, according to their severity and likelihood of survival and the resources available at the referring hospital. In the designed score, this higher score corresponded to younger patients admitted to a hospital without an ICU, with severe hypoxemic acute respiratory failure, as defined by arterial oxygen pressure/inspired oxygen fraction (AOPF) <50, with the need for invasive mechanical ventilation (IMV), with pronation, acidosis or shock, with the presence of acute renal failure, with a good baseline status as assessed by the Clinical Frailty Scale (CFS) and no associated comorbidities. Four priority categories were defined: Priority 0: from 7 to 10 points, Priority 1: from 4 to 6 points, Priority 2: less than 4 points and Priority 3: defined by age >75 years or CFS \geq 4 points. After the elaboration of the score and prior to its implementation, six training sessions on its justification and use were held for healthcare personnel responsible for managing this type of IHT.

Demographic data were collected (sex and age), history of pathologies [hypertension, diabetes mellitus, body mass index (BMI) \geq 30, smoking, chronic obstructive pulmonary disease and Global Initiative for Chronic Obstructive Lung Disease (GOLD) category, pulmonary fibrosis, cerebral vascular accidents with residual clinical signs, heart failure and New York Heart Association functional class (NYHA), neurodegenerative diseases, active neoplasm, liver cirrhosis and Child classification], the baseline situation with CFS, data regarding the acute episode at the time of requesting IHT (AOPF, need for IMV or pronation, presence of shock or acidosis and acute renal failure), characteristics of the referring

Punctuation	-3	-2	-1	0	1	2	3	IHT-COVID-19 SCALE
Age (years)				>70	50-70	<50		Priority 0 10-7 points
Issuing hospital has ICU				yes	no			
PAFI				>100	100-75	75-50	<50	Priority 1 6-4 points
Invasive mechanical ventilation				no	yes	yes with pronation		
Shock or acidosis				no	yes			Priority 2 < 4 points
Acute kidney failure				no	yes			
Comorbidities*		>1	1	none				Priority 3 Age >75 years or CFS ≥ 4
Clinical Frailty Scale	≥ 4	3	2	1				
ICU: Intensive care unit. PAFI: arterial oxygen pressure / inspired oxygen fraction. CFS: Clinical Frailty Scale. *Comorbidities: includes GOLD C or D class chronic obstructive pulmonary disease, stroke with sequelae, heart failure with New York Heart Association III-IV functional class, neurodegenerative diseases, pulmonary fibrosis, active neoplasia, Child V-C liver cirrhosis.								Guiding result, individualize the assessment for each patient.

Figure 1 IHTCOVID-19 score.

hospital (presence of ICU at the centre of origin, location of the patient) and evolving data (length of ICU stay and mortality). The scores that would have been obtained if the IHTCOVID-19 score had been applied in the pre-intervention period and the score in the post-intervention period were both calculated. Three variables related to management times were collected: (i) alert-assignment time, defined as the time from the receipt of the request from the issuing hospital to the assignment of the type of care resource (the time at which the transfer is accepted by the receiving hospital), (ii) resource management time, defined as the time from when the type of resource that will perform the IHT is determined (assignment) until a specific care unit is finally activated and (iii) the total central management time, which is the sum of the two previous times and reflects the overall IHT transfer management process at the dispatch centre.

A sample size of 148 patients per group was calculated, considering an alpha risk of 5% and a power of 85% to detect a 20-min decrease in prioritization time. The exposure variable was the use of the IHTCOVID-19 score, and the effect variables were the different management times collected.

Statistical analysis

Qualitative variables were described as frequencies and percentages. Quantitative variables were described as mean and standard deviation (SD) if they followed a normal distribution, which was tested with the Kolmogorov-Smirnov test or as median and inter-quartile range (IQR) otherwise. Measures of association for the former were analysed using the chi-square test or Fisher’s exact test as appropriate and for the latter using Student’s *t*-test or the Mann-Whitney *U*-test for variables that did not follow a normal distribution. For the analysis of variability and process control, an individual-moving range (I-MR) chart with 3 SD was constructed. For all comparisons, differences were accepted as statistically significant if the *P*-value was <0.05, or if the 95% CI of the odds ratio (OR) excluded the value 1. The statistical analysis was

performed with SPSS version 24.0 for Windows (SPSS Inc, Chicago, IL, USA).

Ethical principles

The ethical principles of the Declaration of Helsinki on human research were followed in the development of this study. The study was approved by the Ethics and Clinical Research Committee of the Institut d’Investigació Sanitària Pere Virgili (107/2020). Under the exceptional circumstances generated by the COVID-19 pandemic and the urgent need to obtain feasible data related to this new disease, the obtainment of informed consent from patients to be included in the study was waived. The anonymity of the participants was guaranteed.

Results

During the study period, a total of 3236 IHTs were evaluated for eligibility, of which 699 (21.6%) were related to COVID-19, as is shown in Figure 2. After the application of the exclusion criteria, 344 patients were included in the final analysis. During the pre-intervention period, from 1 to 31 March 2020, 189 (54.9%) IHTs were selected, and in the following post-intervention period, from 1 to 30 April 2020, a total of 155 (45.1%) IHTs were selected.

Clinical-epidemiological characteristics and severity factors

Table 1 shows the results of the clinical-epidemiological characteristics and severity factors of the total cohort and the univariate study according to the application of the IHTCOVID-19 score. The majority of the patients were male, and the most frequent age range was between 50 and 70 years. Regarding the medical background of the research sample, 181 (52.6%) patients presented arterial hypertension and 110 (32.0%) obesity with a BMI ≥ 30 . Only eight (2.3%) patients in the sample had more than one associated comorbidity. With reference to

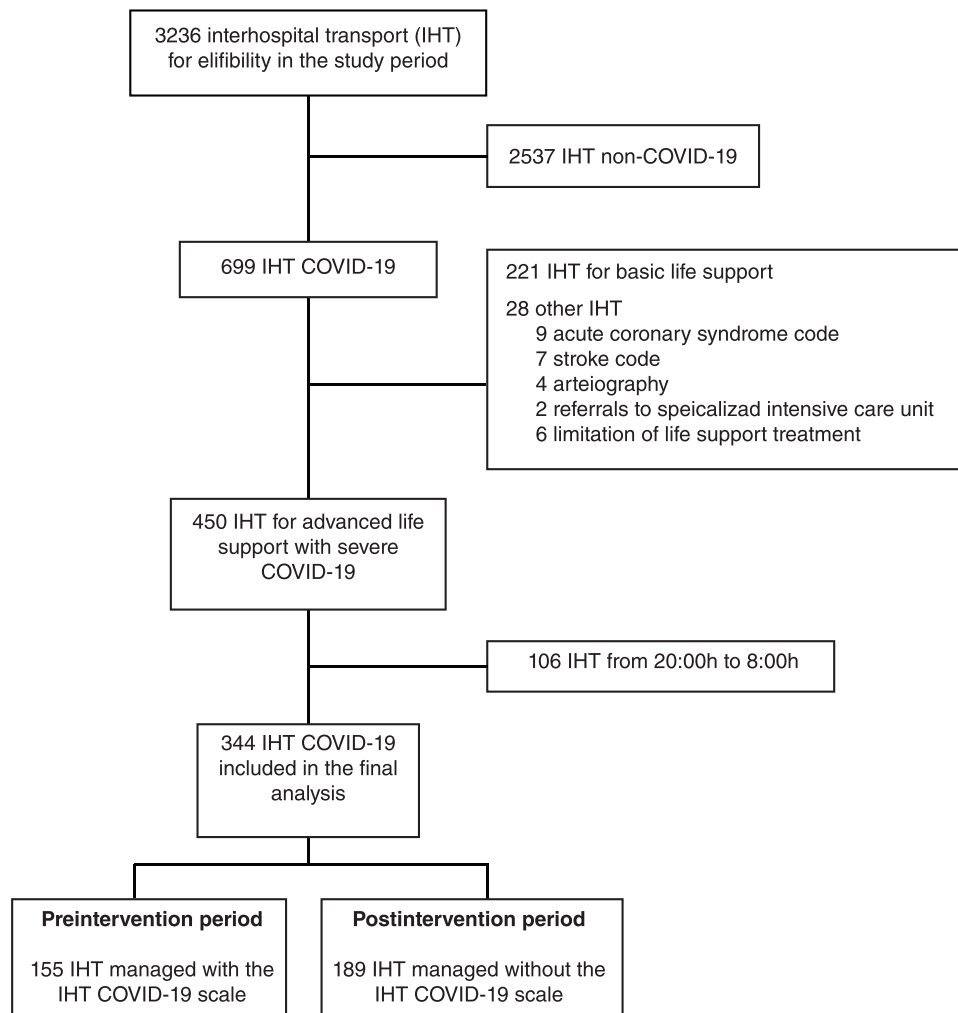


Figure 2 Flow chart.

the data regarding acute episodes, 170 (49.9%) patients presented PaO₂/FiO₂ values over 100 at the time of requesting IHT and 248 (72.1%) required IMV. Regarding the characteristics of the issuing hospitals, in 50 cases (17.1%), the hospital had an ICU but had no capacity to manage more patients, the lack of beds being the main reason in 36 (72.0%) cases, the lack of ventilators in 9 (18.0%) cases and other reasons in 5 (10%) cases. Most of the patients in the total sample, 243 (70.6%) to be exact, were located in the emergency department of the issuing hospital. Regarding the priority classes of the whole research sample, 12 cases (3.5%) were Priority 0, 66 cases (19.4%) were Priority 1, 247 cases (71.8%) were Priority 2 and 19 cases (5.6%) were classified as Priority 3.

In the bivariate analysis, the differences between the two periods compared were scarce. Significant differences were only found in the CFS score of 1, which was more frequent in the post-intervention period [12.2% vs 23.2%, OR 1.91 (1.09–3.35), $P=0.025$] and the presence of PaO₂/FiO₂ between 75 and 100, which was also more frequent in the post-intervention period [20.2% vs 35.9%, OR 1.76 (1.11–2.81), $P=0.017$]. Furthermore, no differences were found regarding the calculated IHTCOVID-19 priority of the patients and in relation to the average length of ICU stay.

However, a trend towards lower mortality can be observed in the group to which the score was applied [39.2% vs 29.7%, OR 0.75 (0.42–1.03), $P=0.006$].

Analysis of times based on the use of the IHTCOVID-19 score

Table 2 shows the global results of the time analysis. The median of the three times analysed was 46.5 min (IQR 167.3) for alert-assignment time, 23.9 min (IQR 61.8) for resource management time and 103.4 min (IQR 192.3) for total central management time. Regarding the alert-assignment time, a reduction between the pre-intervention and post-intervention period was found in Priority 0 [211.3 (IQR 338.6) vs 40.1 min (IQR 73.0); $P=0.048$]. With respect to the resource management time, a reduction between the pre-intervention and post-intervention period was also found in Priority 0 [54.1 (IQR 68.7) vs 3.0 min (IQR 15.5); $P=0.047$]. Regarding total central management time, a reduction between the pre-intervention and post-intervention periods was found in global time [112.4 (IQR 281.3) vs 89.8 min (IQR 154.9); $P=0.012$] and both Priorities 0 [286.2 (IQR 218.5) vs 42.0 min (IQR 58); $P=0.018$] and 1 [130.3 (IQR 297.3) vs 75.4 min (IQR 91.1); $P=0.034$]. In all these cases, the large

Table 1 Clinical-epidemiological characteristics and severity factors of the patients included, with and without the application of the IHTCOVID-19 score

	Total (n = 344)	Without IHTCOVID-19 scale (n = 189)	With IHTCOVID-19 scale (n = 155)	OR (95% CI)	P-value*
Demographic data [n (%)]					
Gender (male)	244 (70.9)	136 (72.0)	108 (69.7)	0.97 (0.70–1.35)	0.85
Age over 70 years	74 (21.5)	47 (24.9)	27 (17.4)	0.70 (0.42–1.18)	0.18
Age between 50 and 70 years	211 (61.3)	117 (61.9)	94 (60.7)	0.98 (0.69–1.38)	0.91
Age under 50 years	59 (27.2)	25 (13.2)	34 (21.9)	1.66 (0.95–2.90)	0.08
Medical background [n (%)]					
Hypertension	181 (52.6)	98 (51.9)	83 (53.5)	1.03 (0.73–1.47)	0.86
Diabetes mellitus	93 (27.0)	57 (30.2)	36 (23.2)	0.77 (0.48–1.23)	0.27
Obesity (BMI ≥30)	110 (32.0)	56 (29.6)	54 (34.8)	1.18 (0.76–1.80)	0.46
Active smoker	16 (4.7)	6 (3.2)	10 (6.5)	2.03 (0.72–5.71)	0.18
Comorbidities ^a					
None	276 (80.2)	153 (81.0)	123 (79.4)	0.98 (0.75–1.34)	0.91
Only one	60 (17.5)	34 (18.0)	26 (16.8)	0.93 (0.53–1.62)	0.81
More than one	8 (2.3)	2 (1.0)	6 (3.8)	3.66 (0.73–18.4)	0.12
Clinical Frailty Scale (CFS)					
1	59 (17.2)	23 (12.2)	36 (23.2)	1.91 (1.09–3.35)	0.025*
2	156 (45.3)	91 (48.2)	65 (41.9)	0.87 (0.59–1.26)	0.48
3	112 (32.6)	63 (33.3)	49 (31.7)	0.95 (0.62–1.49)	0.81
≥4	17 (4.9)	12 (6.3)	5 (3.2)	0.51 (0–18–1.47)	0.21
Data of the acute episode [n (%)]					
PAFI over 100	170 (49.9)	107 (56.9)	63 (45.2)	0.71 (0.49–1.05)	0.08
PAFI between 75 and 100	93 (27.3)	38 (20.2)	55 (35.9)	1.76 (1.11–2.81)	0.017*
PAFI between 50 and 75	67 (19.6)	34 (18.1)	33 (21.6)	1.18 (0.70–1.99)	0.53
PAFI under 50	11 (3.2)	9 (4.8)	2 (1.3)	0.27 (0.06–1.26)	0.09
Need for IMV	248 (72.1)	135 (71.4)	113 (72.9)	1.02 (0.74–1.42)	0.90
Need for pronation	56 (16.3)	32 (16.9)	24 (15.5)	0.91 (0.52–1.62)	0.76
Acidosis or shock	47 (14.5)	23 (13.8)	24 (15.5)	1.27 (0.69–2.34)	0.43
Acute renal failure	85 (24.4)	57 (29.6)	28 (18.1)	0.60 (0.36–0.99)	0.044
Characteristics of the issuing hospital [n (%)]					
ICU at issuing hospital	59 (17.1)	29 (15.3)	30 (19.4)	1.26 (0.73–2.19)	0.41
Location in semicritical department	70 (20.3)	34 (18.0)	36 (23.2)	1.29 (0.77–2.16)	0.33
Location in emergency department	243 (70.6)	135 (71.4)	108 (69.8)	0.98 (0.70–1.36)	0.88
Location in ICU department	31 (9.0)	20 (10.6)	11 (7.1)	0.67 (0.31–1.44)	0.31
Calculated IHTCOVID-19 priority					
0	12 (3.5)	7 (3.7)	5 (3.3)	0.87 (0.27–2.80)	0.82
1	66 (19.4)	36 (19.1)	30 (19.6)	1.01 (0.58–1.72)	0.95
2	247 (71.8)	134 (70.9)	113 (72.8)	1.02 (0.73–1.41)	0.92
3	19 (5.6)	12 (6.4)	7 (4.6)	0.71 (0.27–1.85)	0.48
Evolution					
Length of ICU stay [median (SD)]	19.5 (14.7)	18.9 (13.5)	20.0 (15.8)	Not applicable	0.34
Hospital mortality	120 (34.9)	74 (39.2)	46 (29.7)	0.75 (0.42–1.03)	0.06

^aComorbidities include chronic obstructive pulmonary disease GOLD class C-D, pulmonary fibrosis, cerebral vascular accident with residual symptoms, heart failure with New York Heart Association functional classes III–IV, neurodegenerative diseases, active cancer and Child–Pugh B-C score cirrhosis.

OR: odds ratio, PAFI: arterial oxygen pressure/inspired oxygen fraction, SD: standard deviation.

*P-value <0.05.

dispersion in the three process times prior to the implementation of the score is noteworthy (Supplementary Material Figure S4).

Finally, Figure 3 shows the I-MR charts before and after the implementation of the IHTCOVID-19 score. Prior to the implementation of the score, a large degree of variability in the total central management time was observed, highlighting the existence of out-of-control points on a regular basis. After applying the IHTCOVID-19 score, the average process time improved, showing an overall decrease of 22.6 min in total central management time, while the same trend can be observed with variability, which had a range in the pre-intervention period of 618.1 min, which decreased to 324.0-min post-application.

Discussion

Statement of principal findings

Our study has demonstrated that the application of the IHTCOVID-19 score is useful in reducing the IHT management times of severe COVID-19 patients, especially those considered to be Priority 0 and Priority 1, and in reducing variability in decision-making. Specifically, the degree of expected variation decreased, as did the number of out-of-control points, reflecting a trend towards the homogenization of the process and a standardization in the way of working between the different professionals at the IHT desk. These aspects are especially important in a situation such as the COVID-19 pandemic, where the management of

Table 2 Analysis of times based on the use of the IHTCOVID-19 score

	Total (n = 344)	Without IHTCOVID-19 scale (n = 189)	With IHTCOVID-19 scale (n = 155)	P-value**
Alert-assignment time (min)*				
Global	46.5 (167.3)	46.9 (270.4)	47.0 (109.1)	0.22
Priority 0	86.5 (187.2)	211.3 (338.6)	40.1 (73.0)	0.048**
Priority 1	53.2 (139.1)	55.1 (324.0)	49.3 (80.9)	0.28
Priority 2	44.7 (172.9)	41.7 (240.5)	48.1 (148.2)	0.84
Priority 3	47.9 (109.5)	54.8 (131.6)	28.7 (109.6)	0.48
Resource management time (min)*				
Global	23.9 (61.8)	29.8 (66.0)	17.7 (60.9)	0.11
Priority 0	6.7 (52.5)	54.1 (68.7)	3.0 (15.5)	0.047**
Priority 1	15.0 (61.6)	32.7 (78.3)	5.4 (48.2)	0.11
Priority 2	25.4 (61.5)	27.9 (62.2)	22.0 (61.3)	0.71
Priority 3	33.6 (62.9)	40.5 (64.2)	33.5 (70.9)	0.90
Total central management time (min)*				
Global	103.4 (192.3)	112.4 (281.3)	89.8 (154.9)	0.012**
Priority 0	99.5 (267.7)	286.2 (218.5)	42.0 (58.0)	0.018**
Priority 1	87.1 (149.6)	130.3 (297.3)	75.4 (91.1)	0.034**
Priority 2	108.5 (213.9)	109.1 (258.3)	106.3 (193.1)	0.39
Priority 3	94.1 (160.7)	108.9 (120.2)	43.8 (195.2)	0.30

*Median (inter-quartile range). Alert-assignment time from receipt of the request from the issuing hospital (alert time) to the time until the type of care resource is determined (assignment time). Resource management time: time elapsed from the assignment time until the time at which the specific care unit is finally activated to carry out the inter-hospital transport (unit activation time). Total central management time: time elapsed from the alert of the issuing hospital until the specific care unit is finally activated, the sum of the two previous times and reflects the overall management process of IHT.

** P-value <0.05.

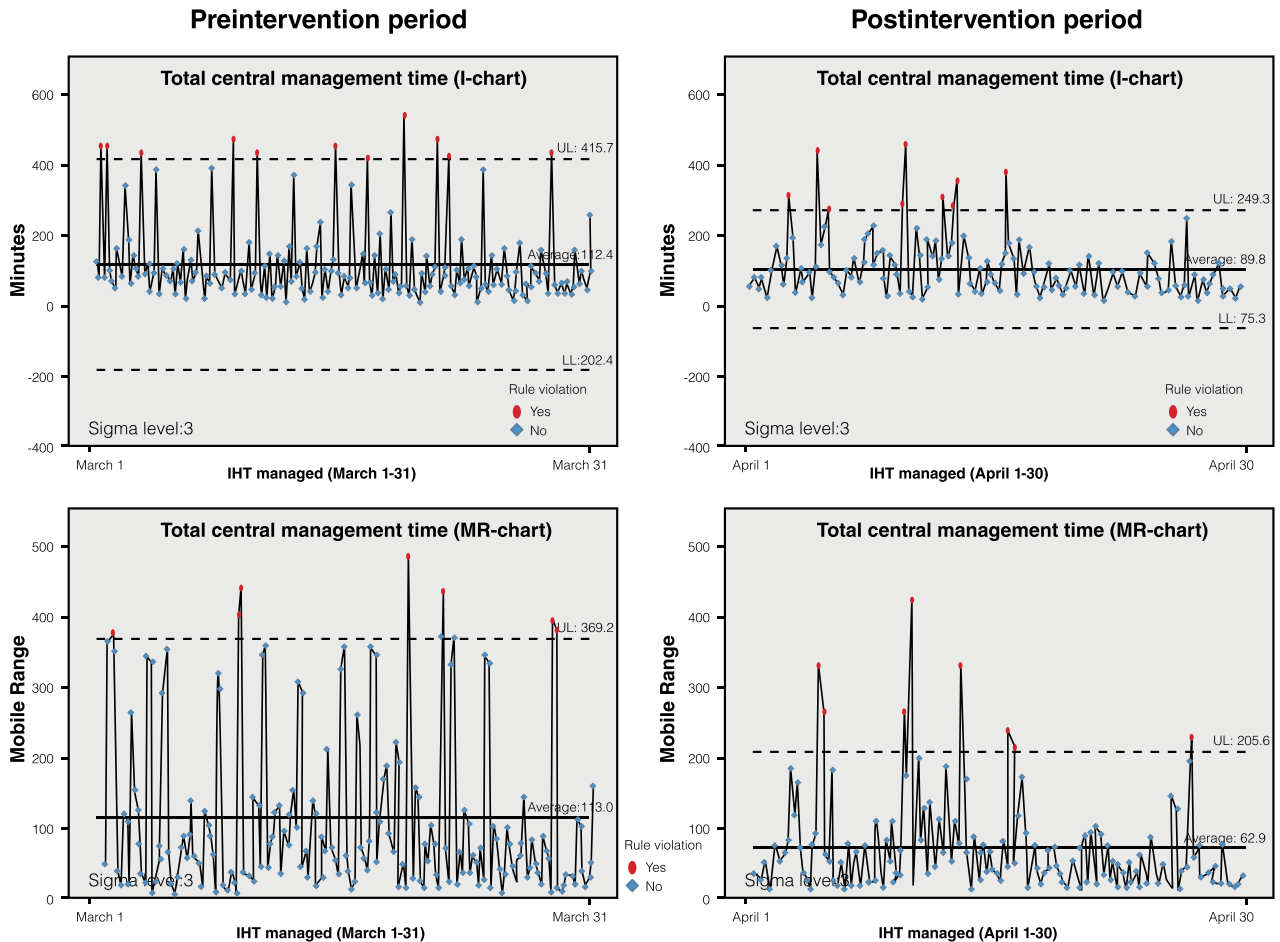


Figure 3 I-MR control charts before and after intervention. The introduction of the IHTCOVID-19 scale reduces the average of total central management time as well as its variability.

limited health resources is fundamental to ensure a high-quality, equitable process.

Strengths and limitations

The quasi-experimental design of the study, with a pre-intervention period and a post-intervention period, strengthens our results, as the score was implemented in a routine clinical practice situation.

Although there were concerns regarding the clinical variables selected for the creation of the score during the process of developing IHTCOVID-19, subsequent studies have demonstrated the consistency and prognostic importance of each of these variables in the evolution and prognosis of the disease [16–21]. A variable related to a structural resource was included, namely whether or not the referring hospital had an ICU. This variable carries little weight in the score, scoring only 1 point if the issuing hospital does not have an ICU. It was decided not to give a higher score to this variable since it only reflects the hospital's lack of resources to provide definitive care to a critical patient and does not prevent the possibility of the patient receiving certain treatments, such as IMV, in the first hours of evolution until transfer is possible.

Our study has several limitations. The intervention was not applied between 8 pm and 8 am. However, IHTs in this time slot did not show large differences when compared to the intervention (Supplementary Material Table S3), which minimizes the possible bias that could be caused by this circumstance.

Another aspect to bear in mind in relation to time is that the greater or lesser speed in performing the IHT was not exclusively affected by its prioritization but could also be affected by other variables such as the availability of adequate resources for its performance or the geographical proximity between the sending and receiving centres, as well as the proximity of the ambulances with respect to the sending centre. These variables may also have influenced some of the times analysed, especially the resource management times and the total central management time.

Interpretation within the context of the wider literature

IHT for critically ill patients is needed when the structural capacity of a hospital is exceeded or when the patient requires highly complex resources that can prove beneficial and improve health outcomes [22]. In a situation such as the COVID-19 pandemic, the large number of patients in need of IHT can lead to excessive delays or shift resources to other needs [23]. While there exist consensus documents on the IHT of patients in pandemic and disaster situations, they have not been able to provide additional mechanisms for dealing with a situation such as COVID-19, and published experiences with IHT are scarce and more focused on the type of resource used [15, 24].

In the field of emergency medicine, especially at the pre-hospital level, there is a common need to incorporate different prioritization models that adapt to evolving clinical scenarios and the emergence of new resources [25, 26]. However, in the current situation, it has been difficult to find strategies that can improve the care of patients with COVID-19, and this is further complicated by the ethical and economic dilemmas that are imposed by the pandemic [10, 12, 27].

In the light of that, the creation of the IHTCOVID-19 score not only improves IHT management times and standardizes prioritization but also adds value by enhancing equity in the decision-making process.

Implications for policy, practice and research

One ramification of the creation of this tool is that it has standardized the way IHT is prioritized, providing a score that is easy to use and does not require specialized medical knowledge. This may make it possible for the management of IHTs to be carried out by non-medical healthcare staff and thus free up medical staff for care tasks that cannot be performed by other healthcare professionals, thereby distributing human resources in a more efficient way.

With regard to the priority categories, the IHTCOVID-19 score was intended only as a prioritization system to manage transfers in a standardized way and does not define which patients are candidates for a more limited therapeutic effort. Therefore, the Priority 3 category, which is defined as over 75 years of age or a CFS score ≥ 4 , only defines a priority for IHT. We would also like to highlight that the Priority categories 0 and 1 are the ones that registered the largest and most significant decreases in time. This is important because patients in these categories are in the most unfavourable clinical situation and therefore at the highest risk of death. In other clinical scenarios, the transfer of critically ill patients to centres with more resources and experience has been associated with better final outcomes [28–30], so it is to be expected that this may also occur in patients with a severe COVID-19 infection. In fact, our results show a trend, although not significant, towards lower mortality in the period in which the score was applied.

Conclusions

In situations where there exists a disproportion between demand and existing resources, as in the COVID-19 pandemic, it is necessary to create new tools to help manage resources according to the specific characteristics of the situation. In this sense, the use of the IHTCOVID-19 prioritization score made it possible to improve IHT management times and standardize prioritization, reducing variability between the decisions taken by different professionals.

Supplementary material

Supplementary material is available at *International Journal for Quality in Health Care* online.

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S.S.-M., Y.A. and X.J.F. conceived and designed the study. S.S.-M., J.T., R.B., J.M., X.G., B.S., X.J.F. and J.J. designed the IHTCOVID-19 scale. A.L., X.G., B.S. and C.C. contributed to data collection. S.S.-M. and J.F. were responsible for the statistical analysis. S.S. wrote the first manuscript. S.S.-M., Y.A., J.T., X.J.F., R.B., A.L., J.M.A., X.G., B.S., J.F., C.C. and J.J. contributed to writing and reviewed the manuscript. Y.A. was responsible for the ethical issues and wrote and reviewed the final manuscript.

Data sharing statement

Available upon request.

Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

We make our data available to researchers who may consider them of interest upon request to the main author of this article.

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