

Emergency department waiting-time in the post pandemic era: new organizational models, a challenge for the future

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Abstract. *Background and aim:* Covid-19 has profoundly changed the Emergency Department system in Lombardy, especially for the type of accesses and the number of diagnoses. Accordingly, the pre-hospital rescue system has undergone heavy changes, in particular regarding the times of rescue. Despite this, studies concerning the post-pandemic phase are lacking to understand whether the conditions of the emergency systems has resumed to the pre-pandemic period. The aim of the study is to evaluate the length of stay (LOS) phenomenon in the emergency departments (EDs) in the post-pandemic era. *Methods:* A retrospective observational study was conducted, which analyzed the first six months of the years 2019, 2021 and 2022. The pandemic peak phase, corresponding to the first months of 2020, wasn't included. The investigated area included the provinces of Milan and Monza, a metropolitan area with 4 million inhabitants. *Results:* The average time spent by patients in the ED increased by +3.8 hours in 2022 and by +1.3 hours in 2021 compared to 2019. The average time from ED access to hospitalization also increased by +4.8 hours in 2022 and +5.0 hours in 2021 compared to 2019. The percentage of time in ED recorded in a National Emergency Department Overcrowding Study (NEDOCS) in black code in 2022 reached 5.4% against 1.7% in 2021 and 0.5 % in 2019. *Conclusions:* Data show an increase in the time spent in the EDs and an increase in the overcrowding, according to the NEDOCS index. New management models and a reorganization of EDs are needed as the workload has increased significantly. (www.actabiomedica.it)

Key words: Length of Stay, Emergency Departments, Health system organization, Post pandemic era

Background

Lombardy is the Italian region that was most impacted by the Covid-19 pandemic in 2020 and it was the first European region in which the virus began to circulate as early as in January 2020, therefore the EMS was profoundly changed by the outbreak (1-4).

The emergency healthcare system had to deal with numerous problems. Indeed, the emergency medical service (EMS) was under deep pressure as a consequence of the high number of first aid calls due

to Covid-19. Hospital emergency departments (EDs) and Agenzia Regionale Emergenza Urgenza (AREU) faced a substantial reorganization to manage critical patients during this pandemic (1-2).

Among the multitude of problems that already plagued the national healthcare system in the pre-pandemic period, a deterioration in the management of patient flows in hospitals and within EDs was observed. In particular, the effect of the pandemic on phenomena such as ED overcrowding and boarding within hospital systems (5-7) has been analysed.

ED overcrowding causes delay in the diagnostic process and in the start of treatment, prevents access to triage and increase its duration and increases the length of stay (LOS) and finally increases the mortality rate (5-9). At the same time, the boarding phenomenon, defined as the practice of holding patients in the ED after they have been admitted to the hospital because no inpatient beds are available, can be considered as one of the root causes of the ED overcrowding (10). Boarding dissipates resources such as space, beds, diagnostic imaging techniques, but also human resources, leading to an increase in LOS and a negative effect on the output factors of overcrowding. Boarding may cause the deterioration of the clinical outcome delivered by an ED and may potentially represent a substantial resource waste and a significantly increased ED cost (11,12).

The evaluation of overcrowding became an important aspect for EDs (13-15) and different indicators, such as the National Emergency Department Overcrowding Scale (NEDOCS) evaluation system, were developed (16-17). The NEDOCS score is a scoring system ideated by Weiss et al, in 2004 and it measures the ED overcrowding objectively, demonstrating good discriminatory power for clinical perception of crowding (18,19). Nevertheless, it is also argued that health staff do not perceive a risk caused by ED overcrowding when the NEDOCS corresponds to overcrowding situations equal to or higher than 5 (severely crowded and dangerously crowded), which put at risk patient safety (19).

After the Covid-19 pandemic new organizational models are needed and desirable in the short term. These decisions and new models will be discussed with all health professionals and policy makers of the national health system, since the pandemic forced policy makers to work in a single team with technical figures (20), in order to prevent future subversions in the SSN (Sistema Sanitario Nazionale – National Health System) and to also prevent future system changes, as happened during the Covid-19 era, according with the preparedness aspect (21,22).

In order to implement a new organizational model, specific training for laypeople and health professionals should be implemented to share future proposals; indeed, the positive impact of training was proved in previous research (23,24).

The healthcare system has also profoundly changed for chronic patients; in fact, marked changes

have also been recorded in this population, with regard to access to facilities (25) and to mental pathologies (26). The implementation of new organizational models is central, for both the changes introduced by the pandemic and for a view to preparedness for future pandemics, especially in the light of new technologies and new clinical protocols (27-30).

An important aspect, not to be overlooked, in the development and implementation of new organizational models is the evaluation of their impact on healthcare workers' mental health (31,32), already markedly stressed during the pandemic phase (33,34). For this reason, they should not be further stressed in case of management testing or experimentation.

However, in the development of new hospital systems it is also necessary to evaluate the pre-hospital EMS system, especially the pre-hospital protocols, since the emergency transport system is important for patient outcomes (35-38). Furthermore, in diverse clinical conditions, research has shown that the EMS system is the patient's gateway to hospitals and it is one of the first points of reference for patients experiencing a medical emergency (39-42).

For these reasons, any models to be implemented to improve ED problems must take into consideration the entire process of the patient, starting from the EMS system leading to the chronic patient and discharges to low-intensity care facilities. No model should be implemented forgetting the impact that Covid has had on operators and their health and without focusing on the new technologies developed during the Covid-19 pandemic (43). To this end, it is necessary to define a context investigation to understand the problems recorded in the post-pandemic phase. In order to fill this knowledge gap, the aim of this study is to evaluate the LOS phenomenon in the post-pandemic era. The analysis has been conducted by observing the differences depicted by Lombardy EDs collected in different periods from 2019 to 2022.

Methods

We performed an observational retrospective study. The study was conducted in accordance with the principles of the Helsinki declaration and was

approved by the AREU Data Protection Officer in December 2022 code 1.23.

The data recorded in the online regional portal called EUOL (Emergenza e Urgenza OnLine) was analysed according with the aim of study. A comparison of admitted patient to the EDs in SOREU Metropolitana (all Hospitals in the provinces of Milan and Monza) in first semester of three years of comparison, 2019, 2021 and 2022 was performed.

SOREU Metropolitana is composed by 34 EDs and serves a total of 4 million citizen.

The categorical variables are presented as number and percentage, the continuous variables are presented as mean. Continuous variables were tested for normality and Z test for means was performed. Anova test one way was performed for categorical variables. Differences were considered significant (S) when $p < 0.05$; otherwise, they were considered non-significant (NS).

Results

In the period under analysis, we highlight a difference in total accesses in 2019 compared to 2021 and 2022 (635,736 vs 481,768 vs 624,016). In the three periods under analysis, the percentage of patients' arrival in ED by a EMS vehicle has changed in a relevant way in 2021 but it then returned in line with 2019, in terms of absolute number (163,000 vs 142,000 vs 156,000) and percentage (25.6% vs 29.5% vs 25.0%).

An important point, regarding the evaluation of the demographic context of the subjects accessing the ED, is the percentage of patients who are hospitalized. This value has changed significantly in the years of observation, involving 72,900 (11.5%) subjects in 2019, with a slight increase in 2021 with a total of 68,200 (14.2%), but with a return to the starting values in 2022, with a total of 73,800 (11.8%). In fact, in 2021 the probability of being hospitalized in the ED increased significantly compared to 2019 (OR 1.27, 95% CI 1.25-1.29, $p < 0.001$), but decreased in 2022 (OR 1.03, 95% CI 1.02-1.04, $p < 0.001$).

The demographic characteristics of the population accessing EDs have remained similar, with regard to the percentage of female subjects, 51.4% in 2019, 51.7% in 2021 and 50.5% in 2022.

Instead, we register a marked change in terms of age, with an increase in the probability of access in the age group of 15-64 years old in 2021 (OR 1.11, 95% CI 1.09-1.12, $p < 0.001$) and in 2022 (OR 1.06, 95% CI 1.05-1.07, $p < 0.001$) compared to 2019.

Another significant finding, considered as index of appropriateness of access, is the number of subjects who abandon the ED. About this value, a change was recorded only in 2021. In fact, in 2021 the number of patients who abandoned the ED was significantly higher than in 2019 (OR 1.35, 95% CI 1.32-1.37, $p < 0.001$). Indeed, the value returns to the pre-pandemic value in 2022 (OR 0.99, 95% CI 0.98-1.01; $p = 0.55$).

The average time spent by patients in the ED increased by +3.8 hours in 2022 and by +1.3 hours in 2021 compared to 2019. The average time from ED access to hospitalization also increased by +4.8 hours in 2022 and +5.0 hours in 2021 compared to 2019.

The calculation of NEDOCS during the three periods under consideration is shown in Table 1. In 2019 there was a percentage of Green codes equal to 53.2%, decreasing in 2021 (50.7%) and sharply decreasing in 2022 (36.7%). This phenomenon juxtaposes with the increase in Black codes from 0.5% in 2019 to 5.4% in 2022.

Table 2 shows an increase in missed triage in the three years of observation. However, the missing data rate is low. the highest percentage of accesses occur with green triage color. The triage color percentage did not change substantially in the three years of observation.

Table 1. NEDOCS evaluation.

Nedocs code	2019	2021	2022
Green	53.2%	50.7%	36.7%
Yellow	32.4%	27.2%	27.3%
Orange	8.8%	9.8%	13.0%
Red	2.0%	4.1%	6.6%
Black	0.5%	1.7%	5.4%
No register	3.1%	6.5%	11.5%

Discussion

The analysis of context that we conducted shows that in the post-pandemic phase, considered as in 2022, the number of accesses to EDs returned to the levels of the pre-pandemic phase, despite a decline in 2021. The demographic characteristics of the population accessing show a non significant difference regarding the percentage of female subjects. However, it is important to point out the increase in the probability of access for subjects aged between 15 and 64 years. These data appear to be relevant for the system, above all because deaths caused by Covid-19 have greatly affected the elderly population, and for this reason a marked increase in accesses in lower age groups can be hypothesized; this because elderly subjects make up for the “frequent users” of emergency services, and, with a high death rate among them, we can suppose that a portion of them did not access the ED during

Table 2. Analysis of low gravity codes.

Triage Code	2019	2021	2022
White (%)	91,395 (14.38)	50,180 (10.42)	66,657 (10.68)
Green (%)	440,482 (69.29)	339,431 (70.46)	443,153 (71.02)
Yellow (%)	93,649 (14.73)	80,371 (16.68)	100,227 (16.06)
Red (%)	10,110 (1.59)	10,010 (2.08)	11,240 (1.80)
Black (%)	99 (0.02)	103 (0.02)	98 (0.02)
Missing data (%)	1 (0.0)	1,673 (0.35)	2,641 (0.42)

Anova test one way: p value = 0.95.

Table 3. The LOS (length of stay) of patients in EDs.

	2019	2021	2022
Average time of all patients (SD)	4.9 (9.2)	6.2 (12.9)*	8.7 (4.9)*
Average time of discharged patients (SD)	4.0 (7.9)	4.6 (10.3)*	8.0 (5.2)*
Average time of hospitalized patients (SD)	10.6 (13.9)	15.6 (20.0)*	15.4 (13.6)*

*Z test for means < 0.05.

that period. Nonetheless, this finding deserves a proper discussion with specific insights.

The method of access of patients, either self-presented or by EMS vehicles, has not changed in the post-pandemic phase; instead, during the pandemic phase there was an increase in the percentage of accesses via EMS vehicles, reaching 29.4% of all accesses in 2021. This phenomenon has already been highlighted in literature (41).

During 2021, the percentage of subjects who abandoned the ED decreased significantly. This finding may be linked to the pandemic, because during this period people were afraid to turn to the ED for fear of contagion. For this reason, patients presented to the ED only in case of significant clinical problems and did not abandon the ED, finding that it is also confirmed by the increase in the probability of hospitalization after access to the ED.

According with the aim of study, in these analyses it is possible to observe the main trends characterising ED accesses and the phenomenon of boarding in the geographical area under consideration.

Table 3 shows the impact of the pandemic on ED length of stay. The trend from 2019 to 2022 sharply increased for all patients accesses, especially for hospitalised patients.

In fact, time in hours increased from 2019 to 2022 (4.9 vs 8.7; $p < 0.05$) for all patients who had access to the ED. The average time doubled in the study period. In addition, waiting times for hospitalisation after access has increased markedly from 2019 to 2022 (10.6 vs 15.4; $p < 0.05$).

Focusing on the issue of ED overcrowding, the NEDOCS index has some limitations in terms of coding. In fact, in 2022, the percentage of unavailable data is significantly higher than in the pre-pandemic era, reaching 11.5 %. In terms of registered data, between 2019 and 2022, there has been a marked increase in the black code (from 0.5 % to 5.4%), opposing the overall green code decrease (from 53.2% to 36.7%).

In table 3, the most significant number of patients who accessed the EDs have a colour code of white or green. These patients present with a less relevant clinical disease, and in the same case, they could be taken care of in other care settings, such as general practitioner ambulatories.

Considering all the elements presented above, new organisational models need to be developed to overcome the issue affecting the regional healthcare system. The AREU launched the Centrale Medica Integrata (CMI) as a new telemedicine model. CMI, being developed by and launched in Lombardy, might be a model for mitigation of overcrowding and boarding effects on the ED system.

The idea of this project was developed by AREU during the pandemic era. In fact, a telephonic triage service to ensure the territorial intake and follow-up of patients with suspected or ascertained Covid-19 symptoms was developed. Throughout the pandemic, the CMI activities reduced the proportion of ambulances that would have been deployed. To this end, AREU has launched a program to extend the activity of this “virtual ED” to other non-urgent circumstances, no longer related only to Covid-19.

The great pressure in the ED, highlighted in our study, forces all health professionals to hypothesise new models. The great challenge of the future of healthcare is the reorganisation of the Emergency Department.

Our study has some limitations. Firstly, we analysed the metropolitan area, and we didn't analyse the rural area, where the overcrowding might be not as relevant. Secondly, in our database, the NEDOCS code wasn't assigned in a discrete percentage of the time. Thirdly, the NEDOCS index in the EUOL system lacks a critical element, which is patient boarding. Only the LOS permanent time, which is, in any case, a proxy of the boarding time, is calculated. Boarding, the time that the patient remains in the ED from the decision on hospitalisation to the actual hospitalisation, is not clearly reported on the EUOL portal. This data is essential in calculating the NEDOCS, but is not entered by doctors working in the ED. Therefore, it is not possible to evaluate the phenomenon thoroughly.

A possible explanation for the significant increase in LOS may be linked to a greater spacing of the beds within the hospital structures. In fact, this leads to a clear reduction of the beds in the medical area departments. A return to pre-Covid indications might help and perhaps be necessary to reduce the problem of LOS and boarding. Furthermore, in the

post-pandemic phase, the second element that explains this phenomenon could be a reduction in hospital staff. Finally, many intermediate hospitalisation facilities, in which patients undergo rehabilitation after hospitalisation, have rigid protocols and very slow access times. For all these reasons and for the data shown in our analysis, a re-evaluation of the patient flow within the ED and the hospital is necessary in order to prevent any delay in hospitalisations or transfers, which are evident in the increase in boarding and LOS.

Conclusion

ED in the post-pandemic phase presents an increase in the volume of occupancy, as a result, new models need to be devised to satisfy the health needs of citizens. The challenge for the future will be to implement projects that modify the organizational and process frameworks of the health system.

Strengthen the receptivity of the hospital systems, reorganizing the workforce and defining a new patient flow model from access to the pre-hospital system up to discharge to the territorial structures is of paramount priority for the entire healthcare system.

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