Adaptation of ED design layout during the COVID-19 pandemic: a national cross-sectional survey

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ABSTRACT

Background The aim was to describe the organisational changes in French EDs in response to the COVID-19 pandemic with regard to architectural constraints and compare with the recommendations of the various bodies concerning the structural adjustments to be made in this context.

Methods As part of this cross-sectional study, all heads of emergency services or their deputies were contacted to complete an electronic survey. This was a standardised online questionnaire consisting of four parts: characteristics of the responding centre, creation of the COVID-19 zone and activation of the hospital's emergency operations plan, flow and circulation of patients and, finally, staff management. Each centre was classified according to its workload related to COVID-19 and its size (university hospital centre, high-capacity hospital centre and low-capacity hospital centre). The main endpoint was the frequency of implementation of international guidelines for ED organisation.

Results Between 11 May and 20 June 2020, 57 French EDs completed the online questionnaire and were included in the analysis. Twenty-eight EDs were able to separate patient flows into two zones: high and low viral density (n=28/57, 49.1%). Of the centres included, 52.6% set up a specific triage area for patients with suspected COVID-19 (n=30/57). Whereas, in 15 of the EDs (26.3%), the architecture made it impossible to increase the surface area of the ED.

Conclusion All EDs have adapted, but many of the changes recommended for the organisation of ED could not be implemented. ED architecture constrains adaptive capacities in the context of COVID-19.

Key messages

What is already known on this subject

- Given the incidence of nosocomial transmission of COVID-19 in hospitals reported to be up to 44%, EDs may need to review their organisational structure or design and layout.
- Many countries have issued guidelines for the architectural design of emergency services in the event of an exceptional health situation or specifically for COVID-19.

What this study adds

- This survey of 57 EDs in France found that less than half were able to implement the main recommendation (ie, to separate patient flows into two zones: high and low viral density).
- This study shows that despite the edited recommendations, many EDs are not in a position to follow them due to their structural aspects constraints.
- This article calls for a rethinking of EDs' design based on the experience of COVID-19 allowing for more flexibility.

INTRODUCTION

The emergence and rapid spread of the SARS-CoV-2 virus has forced EDs to adapt in different ways.[1] Of the many necessary adjustments, structural adaptation and spatial organisation were among the most important to implement. Prior to the pandemic, the design for EDs focused more on sorting patients according to their acuity and on managing the flow of patients, rather than on ensuring they are isolated in each sector and protected from each other.[2] Furthermore, hospital systems were designed for average patient loads, not for the sharp increases seen in recent years, and even less for an epidemic.[3] Many emergency services are outdated and need to be at least renovated if not completely redesigned.[4]

There are about 650 EDs in France. They are all designed on the same model globally. First, arriving patients are placed in a triage room with triage nurses and a supervising physician. Then, depending on their acuity, patients are directed to the resuscitation room, the severe care department or the ambulatory care department.

As the pandemic progressed, in France and elsewhere, measures had to be put in place to avoid nosocomial contamination due to existing issues with poor infection control, poor flow design, physical congestion of patients, inadequate protection of staff and care in the corridors.[5] Emergency medicine societies in the USA, UK, France and Australia issued guidelines for the physical adjustments of emergency services in the event of an exceptional health situation or specifically for COVID-19 (figure 1).[6–9]

These adjustments had to be made within the constraints imposed by the existing ED architecture and often required modifying or increasing the surface area of services. We hypothesised that many EDs were not in a position to implement the guidelines of the different academic bodies due to their existing design. Our objective was to assess the capacity to implement the recommendations and measure the current response in French EDs to cope with COVID-19.

1. Flow separation: separate areas for high and low viral density, from the patients' arrival at the ED up to their departure.
2. Mask wearing: all patients and caregivers must wear a mask upon arrival in the emergency department.
3. Triage area: define a triage area for suspect patients and wear surgical masks.
4. Signage: create signage for areas of high viral density.
5. Specific sectors: individualize and isolate the trauma sector of the emergency structure and have surgeons take charge of this sector (French and English recommendations).
6. Rapid transfers: encourage rapid transfers from the emergency department to a buffer zone with a single room before hospitalization, in order to maintain reception capacities.
7. Isolated route: set up a transfer procedure, with a secure and isolated route, between the emergency room and the downstream intensive care units.

Figure 1 Seven common aspects of the guidelines.

METHODS

Design

This study was a cross-sectional survey conducted between 11 May and 20 June 2020.

Settings and participants

An electronic survey was sent to the heads of EDs or their deputies by email (n=435). The hospitals were selected using real-time national open data based on their total caseload. We divided all French regions into terciles based on the caseload of their EDs, and the hospitals were assessed according to their type (ie, university hospital centre, high-capacity hospital centre >40 000 patients per year and low-capacity hospital centre <40 000 patients per year). For each of the three caseload levels, a minimum threshold was set a priori in order to obtain a large representative panel.

The survey was constructed in reference to the guidelines that were derived from the seven common recommendations of French Society of Emergency Medicine, American College of Emergency Physicians, Royal College of Emergency Medicine and Australian College for Emergency Medicine. The questionnaire had three main sections: the characteristics of the centre including number of patient admissions per month from February to May 2020 (12 questions), the creation of the COVID-19 zone and the activation of the hospital emergency operations plan (20 questions) and the flow and circulation of patients (22 questions) (see online supplemental appendix 1). The questionnaire was pretested on a sample of emergency physicians before rolling out. The email sent to the heads or deputy heads of the EDs contained a link to the self-administered online questionnaire. A reminder was sent after 15 days. This was an open survey, and in order to avoid multiple entries, a comparison of the participants' EDs was made, and only one answer per centre was accepted. In cases of discrepancy, a new questionnaire was requested from the centre.

Patient and public involvement

No patient involved.

Statistical analyses

Continuous variables were summarised as means and SD, or median values with IQRs, while categorical variables were reported as numbers and percentages. The percentage of each guideline's implementation was analysed separately for each of the seven directives. Categorical variables were compared using the Fisher's exact test. All data were analysed using R software (R Core Team, 2014, R: a language and environment for statistics computing, R Foundation for Statistical Computing, Vienna, Austria).

Ethical considerations

The ED Clinical Research Team of the CHU Angers coordinated the survey, in accordance with the principles of the Declaration of Helsinki and the Good Clinical Practice guidelines. Consent for participation was not applicable. The Checklist for Reporting Results of internet E-Surveys was followed.

RESULTS

Of 435 EDS invited, 57 French EDs completed the online questionnaire and were included in the analysis (for a participation rate of 13.1%.). Those that responded included 14 EDs in university hospital centres (n=14/57, 24.6%), 15 EDs in high-capacity hospital centres (n=15/57, 26.3%) and 28 EDs in low-capacity hospital centres (28/57, 49.1%) distributed throughout metropolitan and overseas France (figure 2). The characteristics of the different hospital centres are summarised in table 1.

Evolution of organisation over time

The average number of monthly admissions to EDs during 2019 for all French services was around 3250 (±1905) patients per month. The trend was similar at the beginning of 2020 before a significant decline (around 30%) in ED visits began in February and reached a nadir in March and April. At the same time, the number of ED visits for suspected COVID-19 infection rapidly increased, reaching a plateau from March 2020 onwards, then declined from May 2020 onwards at the end of the lockdown. Hospital and government decisions were taken simultaneously (creation of high viral density zone, activation of the hospital emergency's plan and obligation for everyone to wear the

Table 1 Description of the organisation of the responding centres

	Total of centres n=57 (%)
Kind of ED	
Adults only	23 (41.1)
Adults and children	34 (59.6)
Number of admissions to the ED in 2019, median (IQR)	39 000 (25 223–57 675)
University hospital centre	60 233 (51 039–88 500)
High-capacity hospital centre	47 919 (43 000–57 115)
Low-capacity hospital centre	25 541 (20 031–31 690)
High caseload level*	21 (36.8)
University hospital centre	5 (8.8)
High-capacity hospital centre	6 (10.5)
Low-capacity hospital centre	10 (17.5)
Moderate caseload level*	18 (31.6)
University hospital centre	5 (8.8)
High-capacity hospital centre	5 (8.8)
Low-capacity hospital centre	8 (14.0)
Low caseload level*	18 (31.6)
University hospital centre	5 (8.8)
High-capacity hospital centre	4 (7.0)
Low-capacity hospital centre	9 (15.8)
Existence of resuscitation rooms/acute care rooms	54 (94.7)
Existence of resuscitation rooms dedicated to patients with COVID-19	46 (80.7)

*According to the occupancy rate in intensive care units.

masks). More than 90% (n=51/57) of hospitals implemented the National Disaster Medicine Response Plan, with multifactorial triggers for activation of different steps of this plan. For the majority, the trigger was the evolution of the number of cases in France (n=40/57, 70.2%). For more than 35.1% of the centres, the presence of clusters in the area was also taken into account (n=20/57).

Implementation of international guidelines

Twenty-eight EDs implemented a separation of patient flows into two zones: high viral density and low viral density (n=28/57, 49.1%). Mask wearing for patients with suspected COVID-19 (84.2%) and signage of areas of high epidemic density within the EDs (93.0%) were the most respected measures. A specific triage area for patients with suspected COVID-19 was set up in 52.6%. The individualisation of specific healthcare sectors, such as traumatology, under the responsibility of other specialties, was established in 27 hospitals (47%). The specialities concerned were mainly surgery, cardiology and psychiatry. Low-capacity hospital centres had the lowest rate of compliance with guidelines (56.1%) (table 2).

Architectural adjustments

The architecture of 15 of the EDs surveyed (26.3%) prevented any increase in their space to accommodate additional patients. Of those that were able to increase their space, 16.7% (n=7/42) used an existing, non-clinical part of the ED (waiting room, transfer area, etc), 16.7% (n=7/42) used an extension in the building that had already been anticipated for use by the ED, 78.6% (n=33/42) used a space not initially allocated to the ED and 52.4% (n=22/42) set up a tent outside the ED and, for the most part, upstream and at the entrance. Several services combined these different types of resources to increase the space for emergencies. The services that did not increase the size of their patient care areas increased the number of rapid transfers to other services (table 3). In 45.6% of EDs (n=26/57), an auxiliary circuit was planned for in case of overcrowding of the emergency services. Among these, 73% placed this auxiliary circuit in the ED. Out of the 57 centres, 22 set up subsidiary COVID-19 medical centres outside the EDs, with general practitioners for consultations during the day (38.6%) to see patients with symptoms of COVID-19 but without severe signs. For patient arrival, 52.6% of the EDs set up two separate areas for patients suspected of having COVID-19 or not (n=30/57). The triage area differed depending on the centre. Only 26% of the services kept the pre-existing area with a separation (n=15/57). For the rest of the centres, triage was set up upstream of the EDs before referral to the different zones: in outdoor tents, direct assessments in the ambulance or rarely outdoors.

In 84% of cases, the patient waiting area comprised two separate locations (n=48/57). Five centres made arrangements involving the creation of a hermetic barrier (tarpaulin, wall and partition), and one centre used the same room with a removable barrier as the only protection. For the majority of centres (82%, n=47/57), patients were then directed to different areas depending on their severity. For seriously afflicted patients, 95% of the centres were equipped with a resuscitation room, and among them 81% had one or more resuscitation rooms dedicated to patients with suspected COVID-19.

For patient requiring continuous vital sign monitoring, 79% of the centres (n=45/57) created a monitoring area in each zone (ie, low and high viral density). Nine centres (15.8%) could not physically separate their monitoring zone within the ED. Seventy per cent of the EDs maintained (n=40/57) short-term hospitalisation areas in the ED. Radiography and CT scan rooms dedicated to patients with COVID-19 were set up in 49.1% (n=28/57) and 52.6% (n=30/57) of the EDs, respectively.

DISCUSSION

Because of their 'pivotal' positions between the community and the hospital, emergency services play a central role in any health crisis, with the need to organise flow, preserve hospital structures and avoid unnecessary hospitalisation while maintaining capacity for life-threatening emergencies. The strength and the originality of this study was its assessment of ED adaptation. While many EDs in France have adapted their organisation,

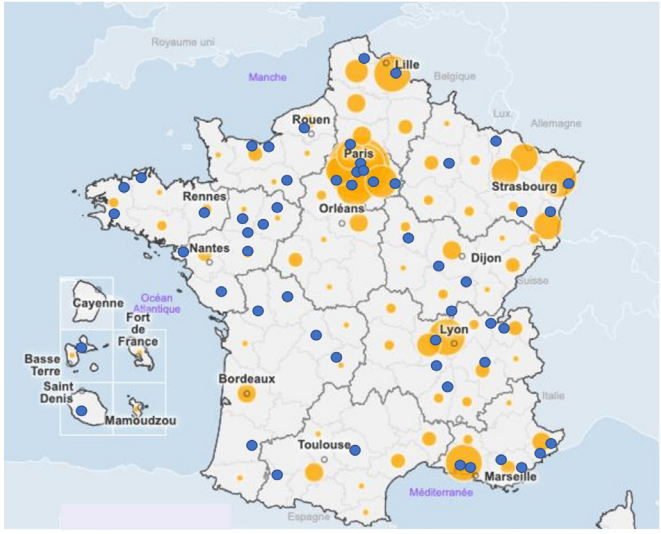

Figure 2 Distribution of responding centres.

Table 2 Implementation of the guidelines in the different centres

Guidelines*	Total centres, n=57 (%)	University hospital centre, n=14 (%)	High-capacity hospital centre, n=15 (%)	Low-capacity hospital centre, n=28 (%)
1. Flow separation	28 (49.1)	7 (50.0)	9 (60.0)	12 (42.9)
2. Face covering mask	48 (84.2)	12 (85.7)	13 (86.7)	23 (82.1)
3. Specific triage area	30 (52.6)	8 (57.1)	11 (73.3)	11 (39.3)
4. Signage of high viral density areas	53 (93.0)	13 (92.9)	15 (100)	25 (89.3)
5. Specific sectors	27 (47.4)	9 (64.3)	8 (53.3)	10 (35.7)
6. Rapid transfers	39 (68.4)	10 (71.4)	13 (86.7)	16 (57.1)
7. Isolated route‡	29 (53.7)	9 (64.3)	7 (46.7)	13 (46.4)

*Definitions for each guideline can be found in the Introduction.
†Difference between university hospital centre and low-capacity hospital centre.
‡EDs do not have an intensive care unit.

49% of the French EDs were not able to implement the main recommendation of introducing separate flows with regard to viral density levels, and almost a third of the EDs possess an unsuitable architecture limiting their ability to increase patient care space. These limitations in the ability to adapt were seen in both low-capacity hospitals and university hospitals.

The main explanation for not implementing these guidelines is likely to be a too strong architectural constraint. In a previous study of the preparedness among French EDs, more than a third declared their treatment space and numbers of rooms were inadequate and said that their structures would not allow them to create separate circuits for patients with COVID-19.[10] In this study, the two recommendations most frequently followed were signage and the wearing of masks. This did not require any structural adjustments.

Despite the presence of architectural constraints in many departments, this study reveals the great diversity of the solutions put in place for dealing with existing constraints and a high infectious disease. Approximately one-quarter of EDs were not able to increase their care space. However, they addressed this by promoting rapid transfers to buffer areas outside the ED or to inpatient units. Among those who were able to increase their space, three-quarters used a space that had not been intended to be used as an ED and half set up a tent outside the ED. This study shows the creativity and resilience of caregivers in the face of architectural constraints. These adaptations took place in the context of an overall decrease in ED visits worldwide, estimated at around 30% in this study.[11] This has undoubtedly made things easier but will not necessarily be reproducible if new COVID-19 waves arrive.

Table 3 Comparison between the group that was able to increase the area and the group that did not in terms of implementing the guidelines

	Total		Centres able to increase the surface area		Centres unable to increase the surface area	
Guidelines	n=57	%	n=42	%	n=15	%
1. Flow separation	28	49.1	20	35.1	8	53.3
2. Mask wearing	48	84.2	37	64.9	11	73.3
3. Specific triage area	30	52.6	23	40.4	7	46.7
4. Signage of high viral density areas	53	93.0	39	68.4	14	93.3
5. Specific sector	27	47.4	20	35.1	7	46.7
6. Rapid transfers	39	68.4	27	47.4	12	80.0
7. Isolated route	29	50.9	22	38.6	7	46.7

Implementation of guidelines is a complex process that is influenced by different factors, related to both the evidence and feasibility of the guidelines themselves and to the social, organisational, economic and political context.[12] However, the guidelines could only be completed followed half of the EDs. These types of difficulties were also reported in Singapore.[13] A Swiss narrative review emphasises the importance of early identification of possible upstream outreach spaces to expand critical care and emergency services.[14] Our EDs are no longer suited to the contemporary constraints of increasing patient flows and the predominant risk of infection. Future innovations in the layout of emergency rooms must be made with due thought for these major issues.

So how should future EDs be designed? In the aftermath of the outbreak of this pandemic of COVID-19, bringing together architects, administrators, health caregivers and patients in order to take into account all the new constraints will make it possible to build the future of ED design.[15 16]

Limitations

This study has some limitations. First, this survey provides a snapshot of the changes in France and may not reflect permanent adaptations of the EDs. Second, the questionnaire included many questions, which may have limited participation. Third, we have not invested whether the change made has impacted on the flow for non-COVID-19 patients.

To conclude, all the hospitals introduced changes, but only half were able to institute the recommended flow measures requiring design changes. The architecture of tomorrow's EDs will have to take these difficulties into account to prepare for the next pandemic.

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