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.

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loads, not for the sharp increases seen in recent years, and even less for an epidemic. 3 Many emergency services are outdated and need to be at least renovated if not completely redesigned. 4

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.
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 (i.e., 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
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,
waves arrive.

easier but will not necessarily be reproducible if new COVID-19


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.

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.

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

**Table 2** Implementation of the guidelines in the different centres

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

*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.

**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

<table>
<thead>
<tr>
<th>Guidelines</th>
<th>Total</th>
<th>Centres able to increase the surface area</th>
<th>Centres unable to increase the surface area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=57</td>
<td>n=42 (%)</td>
<td>n=15 (%)</td>
</tr>
<tr>
<td>1. Flow separation</td>
<td>28</td>
<td>49.1</td>
<td>20</td>
</tr>
<tr>
<td>2. Mask wearing</td>
<td>48</td>
<td>84.2</td>
<td>37</td>
</tr>
<tr>
<td>3. Specific triage area</td>
<td>30</td>
<td>52.6</td>
<td>23</td>
</tr>
<tr>
<td>4. Signage of high viral density areas</td>
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<td>5. Specific sector</td>
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<td>39</td>
<td>68.4</td>
<td>27</td>
</tr>
<tr>
<td>7. Isolated route‡</td>
<td>29</td>
<td>50.9</td>
<td>22</td>
</tr>
</tbody>
</table>

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REFERENCES


