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Responses of paediatric emergency departments to the first wave of the COVID-19 pandemic in Europe: a cross-sectional survey study

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ABSTRACT

Objective Understanding how paediatric emergency departments (PEDs) across Europe adapted their healthcare pathways in response to COVID-19 will help guide responses to ongoing waves of COVID-19 and potential future pandemics. This study aimed to evaluate service reconfiguration across European PEDs during the initial COVID-19 wave.

Design This cross-sectional survey included 39 PEDs in 17 countries. The online questionnaire captured (1) study site characteristics, (2) departmental changes and (3) pathways for children with acute illness pre and during the first wave of COVID-19 pandemic (January–May 2020). Number of changes to health services, as a percentage of total possible changes encompassed by the survey, was compared with peak national SARS-CoV-2 incidence rates, and for both mixed and standalone paediatric centres.

Results Overall, 97% (n=38) of centres remained open as usual during the pandemic. The capacity of 18 out of 28 (68%) short-stay units decreased; in contrast, 2 units (7%) increased their capacity. In 12 (31%) PEDs, they reported acting as receiving centres for diverted children during the pandemic.

There was minimal change to the availability of paediatric consultant telephone advice services, consultant supervision of juniors or presence of responsible specialists within the PEDs.

There was no relationship between percentage of possible change at each site and the peak national SARS-CoV-2 incidence rate. Mixed paediatric and adult hospitals made 8% of possible changes and standalone paediatric centres made 6% of possible changes (p=0.086).

Conclusion Overall, there was limited change to the organisation or delivery of services across surveyed PEDs during the first wave of the COVID-19 pandemic.

What is known about the subject?

- The burden of COVID-19 disease is now known to be lower in the paediatric population compared with the adult population.
- Levels of preparedness for a pandemic varied across European paediatric emergency departments (PEDs).
- Public health authorities globally issued advice to stream patients into high-risk and low-risk COVID-19 categories.

What this study adds?

- The majority of PEDs did not undergo major service change in response to the first wave of the COVID-19 pandemic.
- The degree of change in departments was not related to the peak incidence rates of COVID-19 in the country of origin or type of hospital.
- This information may help guide responses to ongoing waves of COVID-19 and potential future pandemics.

INTRODUCTION/BACKGROUND

Ever since the first outbreak of SARS-CoV-2 was reported in China, and subsequently the extensive outbreak in Italy in February 2020, the global COVID-19 pandemic has caused significant challenges for healthcare systems and societies at large. One of the few reassuring aspects to emerge as the pandemic progressed is the low infection rates and decreased severity of disease in children compared with adults.[1–4] The multisystem inflammatory syndrome in children has presented as a novel and severe complication but case numbers remain extremely low comparative to the adult acute and chronic disease burden.[5–8] Numbers of children attending the paediatric emergency departments (PEDs) with most other types of

acute illness have also been reported to have fallen drastically.[9–13]

Globally, public health bodies recognised the need to separate patients high risk for COVID-19 and low risk for COVID-19 presenting to healthcare services; by 15 March 2020, over 75% of surveyed centres in Europe had a pre-triage process to achieve this.[14–16] In the USA, there were country wide efforts to consolidate paediatric inpatient and community care to specialised centres.[17] In Europe, there was no formal coordinated strategy for the restructuring of paediatric patient flow.[18 19] The substantial differences in emergency department (ED) preparedness, surge capacity and management of paediatric suspected COVID-19 cases between countries were highlighted in the early stages of the pandemic.[16]

Currently, insights into the European approach to organising healthcare for children with acute illness in response to infectious pandemic and global disasters are limited. Better understanding of PED responses beyond divisions of patients by risk category will help our response to future disasters. This multinational, cross-sectional European survey aimed to understand the types of changes in paediatric emergency care delivery, which were implemented in response to the first wave of COVID-19.

METHODS

Study design

This survey was undertaken as part of the 'Epidemiology, severity and outcomes of children presenting to emergency departments across Europe during the SARS-CoV-2 pandemic' (EPISODES) study. Sites were selected directly from the Research in European Paediatric Medicine (REPEM) and European Society of Emergency Medicine (EUSEM) networks, or indirectly via national representatives of the REPEM network and following engagement with the earlier work of Bressan *et al*.[16] Unlike this earlier work, centres could only be included if they could rapidly meet these criteria: *(1) data sharing agreement in place, (2) ethics approval, (3) aggregated data available on ED presentation via electronic health records.*

Initially, 53 hospitals in 20 European countries expressed interest in participation; within these restrictions, 39 hospitals from 17 European countries were able to participate in the study. The final EPISODE cohort included an additional centre whom did not enter the study early enough to contribute to this piece of work and this cohort includes one centre whom unfortunately could not continue contributing to the wider study. Ethics approval was obtained by the ethics committee or institutional review board at each participating site (online supplemental appendix 1). The survey was distributed online via the Research Electronic Data Capture (REDCap) platform between 6 October 2020 and 6 February 2021[20] among the EPISODES study sites (online supplemental appendix 2). Each participating institution provided one response, completed by one of the local site investigators.

No patient identifiable data were used in this survey.

Survey development

The survey was developed according to best practice on survey methodology and reviewed iteratively by the study team, with input from clinical experts and the EPISODES Steering Committee, considering the reporting guidelines for Internet E-Surveys.[21] Survey domains were chosen based on expert consensus and were piloted prior to full use; questions were, in part, based on previous similar study designs.[16 22–24]

We asked site leads for the EPISODES study to complete the survey themselves or delegate to the most appropriate person within the ED. All respondents were experienced paediatric or emergency medicine trained physicians with experience of working in and/or leading their local (paediatric) ED.

The first part of the survey contained questions relating to baseline hospital demographics and working models such as triage tools, paediatric intensive care unit (PICU) support and the length of ED stay limitations. The study considered the time frame prior to February 2020 as pre-COVID-19; the second section of the survey included questions relating to changes to patient pathways and services triggered by the pandemic outbreak.

Response options included 5-point Likert scales, multiple selections, single answers or free text. Respondents were encouraged to include additional details in free text if the standardised questions did not fully encompass the local changes, or where wider regional health service organisation needed explanation. These will be highlighted in case examples where relevant. The full survey is available in online supplemental appendix 2; it includes questions pertaining to therapeutics which do not serve to inform this study. Clarification and expansion of answers was sought through email and video correspondence with the study site leads if necessary. Study site leads were either departmental clinical leads or nominated clinical deputies.

The survey covered domains that represented 37 possible points of change in provision of care for sites without a short stay unit (20 pertaining to service provision and 17 to patient pathways) and 38 possible points of change for those that did (21 service provision and 17 patient pathways). These questions are highlighted yellow in the online supplemental appendix 2.

Analyses

Descriptive results are presented as numbers and percentages for categorical variables, and means or medians with SD or IQR for continuous variables as appropriate.

We compared the percentage and number of changes in provision of care at each site to (1) the SARS-CoV-2 disease incidence as per the all age, peak national 14-day COVID-19 infection rate (per 100 000) as per European Centre for Disease Prevention and Control (ECDC) for

each country,[25] and (2) hospital type: mixed adult and paediatric hospitals versus standalone paediatric hospitals. Each point of change was assigned equal weight, with each site being assigned a site-specific percentage of change. As the variance of count of changes was higher than the mean, we used a negative binomial regression to determine associations between count of changes and peak infection rates and hospital type. We considered univariable associations, and associations adjusted for other key factors of the hospital and local community care. The variables considered were type of ED; urban or rural setting; whether the hospital is a major trauma centre; the number of beds; whether patients had access to primary care 24hours and whether the hospital had a PICU. Significance was defined as $p<0.05$.

Analyses were performed using R V.4.0.3.[26]

RESULTS

Baseline demographics

All 39 sites responded to the survey questions; 34 (87%) sites provide tertiary paediatric care with 16 PEDs (42%) in standalone paediatric hospitals. Further baseline hospital demographics are presented in table 1 and online supplemental table 1.

All departments served areas with in-hours primary care facilities, 21 departments (54%) had weekend and evening services with 17 (44%) located in areas with night time availability of primary care. Sources of referral varied with all departments accepting referrals from emergency services (e.g. ambulances) but only 5 (13%) centres accepting referrals from all sources (online supplemental table 2).

No ED had a paediatric upper age limit beyond a young person's 19th birthday (online supplemental table 3).

COVID-19 changes

Overall patterns

All but one of the surveyed departments remained open for all children. Most (23, 59%) departments reported that other regional hospitals remained open as usual; 12 (31%) departments reported acting as receiving centres for diverted children during the pandemic (table 2). A single centre reported now being the sole receiving centre for paediatric patients and five(13%) with partial redirection of children from other centres. An additional three (8%) participating centres had been the only hospital with acute paediatric services within their region since 2018; this precluded any further service consolidation.

Prior to the pandemic, 28 of the 39 (72%) PEDs had the availability of a short stay unit; during the pandemic, 18 of these 28 departments reported changes to availability, with 2 (7%) reporting increased availability, 11 (39%) reporting decreased availability and 5 (18%) closing completely (online supplemental table 3).

Most hospitals (32, 82%) had no prehospital (primary care, emergency service or front door) streaming of patients with suspected COVID-19 away from their department to another acute and emergency care provider in the region. Seven (18%) had primary care or emergency service streaming of patients with COVID-19. Four (10%) departments operated streaming pathways at the ED front door from which patients with suspected COVID-19 were directed to alternative hospitals (online supplemental table 4).

Unique centre changes

A single department in Dublin, Ireland, closed to paediatric patients during the pandemic (13 March–31 August 2020). Patients were diverted to the two other PEDs within Dublin and staff were redeployed locally or to the other departments based on skill sets and staff personal preference. Another ED in the Netherlands did not formally close to ED paediatric attendances but shifted to a model where most patients triaged to be seen directly on the paediatric ward rather than in the ED; notable exceptions were major trauma, critically unstable children and children in need of multiple specialty review. One department in Amadora, Portugal, closed for 2 weeks at the peak of the pandemic owing to COVID-19 infection levels in staff. In Szekesfehervar, Hungary, and Vienna, Austria, the departments diverted children with suspected COVID-19 to alternative hospitals. In Ljubljana, Slovenia, where children in PED are usually seen exclusively after primary care referral, a screening mechanism was introduced so that 'for every child that was referred to our ED, the primary paediatricians had to have a telephone consultation with one of our paediatricians first'. In addition, all paediatric COVID-19 suspected cases in Slovenia were diverted to their infectious disease hospital. In Rome, Italy, the ED was open to all children but once determined to be high risk for COVID-19 and stable, they were transferred to a single designated hospital (Bambino Jesu, Rome).

Changes to services

Only two PEDs increased their age limit during the pandemic, one from the 16th birthday to the 18th birthday and the other from the 17th birthday to the 19th birthday.

Prior to the pandemic, 22 (56%) departments provided a consultant advice telephone line for general practitioners; this was continued in all cases with an additional 2 departments starting this service so that 24 (62%) centres were providing this during the pandemic (figure 1). In all the departments which remained open during the pandemic, daytime direct consultant cover remained constant (97% of departments). Consultant cover out of hours (OOH) and at night underwent minimal change (online supplemental figure 1). There was little change in responsible teams in the PED (online supplemental figure 1).

Diversion of children with underlying comorbidity occurred to some extent in 16 (42%) departments prior to the pandemic and 13 (34%) during. This was

Table 1 Demographics and hospital characteristics

Summary characteristics	Frequency
What is the best description of the emergency department of your hospital?	
Tertiary-care paediatric emergency department in a hospital for adult and children	18 (46%)
Tertiary-care paediatric emergency department of a standalone children's hospital	16 (42%)
General emergency department with a paediatric section and dedicated PED docs of a general (non-academic) hospital	3 (8%)
General emergency department for both adults and children of a district general (non-academic) hospital	1 (3%)
Other	1 (3%)
What describes the geographical area of your institution best?	
Urban	29 (74%)
Rural	1 (3%)
Mixed	9 (23%)
Which option describes the paediatric services in your hospital best?	
Standalone paediatric hospital, providing tertiary care including most paediatric subspecialties	16 (41%)
Tertiary care university hospital for both adults and children, with most paediatric subspecialties	13 (33%)
Tertiary care university hospital for both adults and children, with up to five paediatric subspecialties	6 (15%)
General paediatric services within a general hospital, with up to five paediatric subspecialties	3 (8%)
General paediatric services within a general hospital, without any paediatric subspecialties	1 (3%)
How many paediatric inpatient beds are available? (median, IQR)	85 (43–127) Min: 15 Max: 514
Does your institution have a high dependency unit for children or paediatric intensive care unit?	
Yes, PICU	17 (44%)
Yes, both	14 (36%)
Yes, HDU	3 (8%)
No	5 (13%)
Number of critical care (PICU/HDU combined) beds available (median, IQR)	12 (8–20) Min: 2 Max: 62
What are the number of negative pressure cubicles available in your ED?	
0	26 (67%)
>=1 to <=5	10 (26%)
>5	3 (8%)
What type of patients are typically seen in your emergency department? *Selection of as many as apply*	
Medical—low urgency	36 (92%)
Medical—high urgency including resuscitation calls	36 (92%)
Trauma—minor trauma	33 (85%)
Trauma—major trauma	21 (54%)
Mental health	29 (74%)
Is your emergency department a designated major trauma centre?	
Yes	18 (46%)
No	16 (41%)
Not applicable	5 (13%)
What is the recommended maximum time a patient can stay in the emergency department before a decision has to be made to transfer to another location?	
<4 hours	16 (41%)
<6 hours	4 (10%)
<8 hours	1 (3%)
<24 hours	7 (18%)
>24 hours	11 (28%)

DHU, high dependency unit; PED, paediatric emergency department; PICU, paediatric intensive care unit.

Table 2 Diverted paediatric patient groups during COVID-19 time period

Unique hospital code	Hungary 001	Ireland 001	Ireland 002	Italy 004	Lithuania 001	Portugal 004	Slovenia 001	Spain 001	Turkey 002	UK 002	UK 004	UK 006
Our ED is now the only ED in the region open for paediatric patients								■				
All children, but only out of hours (OOH) (*when this would not have occurred previously*)						■			■			
Ambulances diverted to our ED		■	■			■			■		■	
Paediatric major trauma (*where previously other departments had managed*)		■	■						■			
Patients referred by primary care (*where previously primary care would have seen*)		■	■		■	■			■			
Suspected COVID-19 patients are diverted to our centre	■			■		■	■		■			
Partial Diversion from other hospitals (*in regions where some PEDs closed more than one PEDs remained open so diversion was across centres*)		■	■		■					■		■

ED, emergency department; PED, paediatric emergency department.

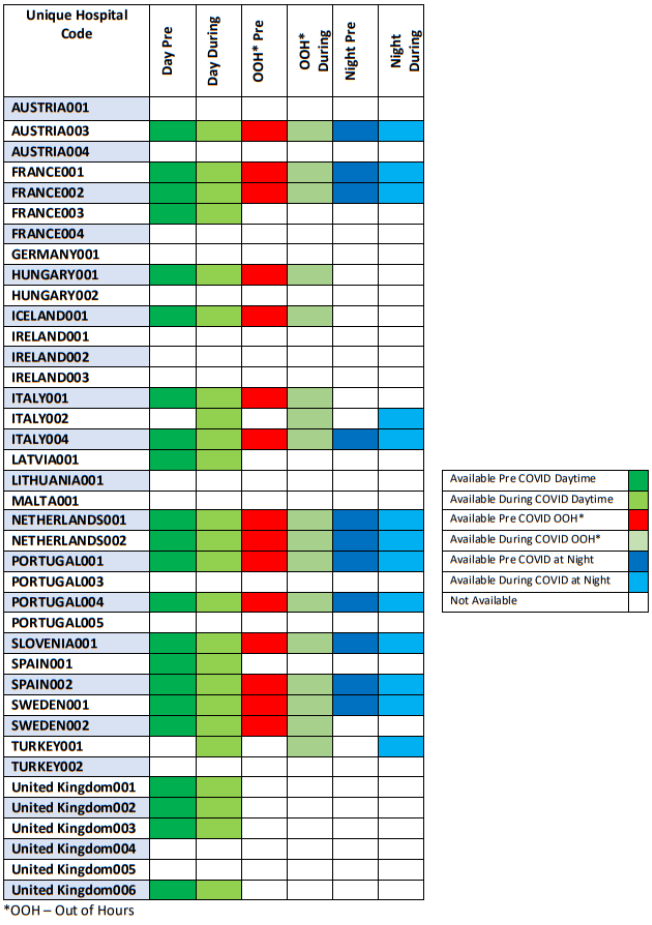

Figure 1 Consultant advice line provision.

implemented as a new pathway in two departments (5%) but five (13%) stopped such pathways (online supplemental table 3).

Changes and burden of COVID-19

Figure 2 illustrates the average percentage change across countries and figure 3 shows the relationship between percentage change and peak rate of COVID-19, these are both displayed by specific study site in online supplemental figure 2. We found that mixed hospitals (n=22)

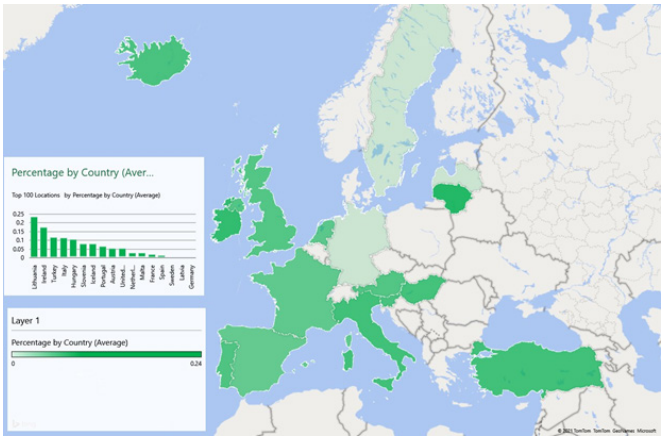

Figure 2 Average percentage of change by country.

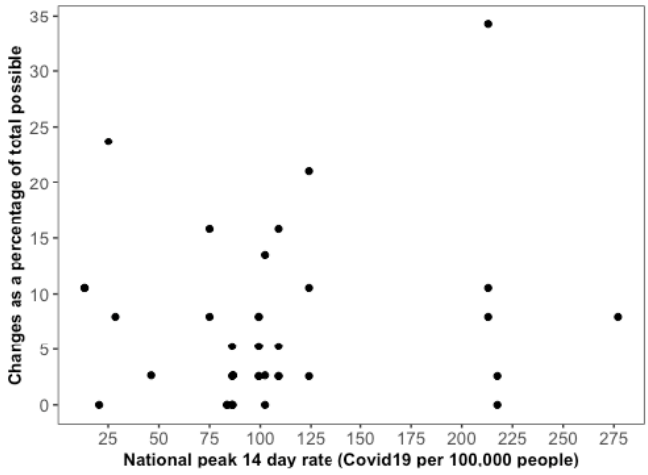

Figure 3 Percentage changes for each department compared with peak 14-day COVID-19 incidence rate. *Departments with a short stay unit had a potential for 38 changes where departments without a short stay unit had a potential for 37 changes. All potential changes were ascribed equal weights. The peak 14-day COVID-19 incidence rate is as per the European Centre for Disease Prevention and Control figures.*

made 8% of possible changes and standalone centres (n=16) made 6% of possible changes.

Univariable analysis showed no significant relationship between frequency of changes and national peak incidence rates nor type of hospital. After adjusting for hospital and primary care factors, higher number of changes was significantly associated with mixed adult and paediatric hospital with most paediatric subspecialities (n=14) when compared with paediatric standalone hospitals (n=16) (online supplemental table 5).

DISCUSSION

The results of our cross-sectional survey among 39 sites in 17 European countries show a low level of change in provision of care in these PEDs in Europe during the first wave of the COVID-19 pandemic. Some PEDs implemented large-scale changes, but these were a minority, and overall our findings showed a service delivery with a largely 'business as usual' approach. There were slightly more changes to regional healthcare pathways for mixed adult and paediatric hospitals compared with standalone paediatric hospitals. Percentage change appeared to be unaffected by the national peak SARS-CoV-2 rates.

Healthcare structure and service delivery across the included countries all have a backbone of universal access, but otherwise often differ greatly in how the health system is organised.[27–30] This study shows that across these systems, vast changes to PED were not implemented in order to manage the care of acutely unwell children during the pandemic regardless of how a healthcare system is structured more widely.

Others have highlighted changes which encompassed the necessity to separate high-risk and low-risk COVID-19 streams at the ED front door.[16 31] This was also echoed by many of our respondents; however, only a few departments redirected children to other hospitals at the point of front-door access. Earlier work suggested that hospitals achieved this separation within their pre-existing local departments through the use of physical or staff level divides.[16]

Once fully adjusted, our data support that mixed children's and adults' centres with most paediatric subspecialities underwent proportionally higher changes than standalone units. This would perhaps be expected, given increased demands from adult services in large centers coping with the high numbers, and acuity, of patients with COVID-19. However, regional consolidation of services to dedicated paediatric centres was uncommon with only 12 centres having any kind of diversion in place. This means that, although we have a selected sample, there is no immediate evidence that the regional hospitals streamed patients away to other sites. This pattern was not dissimilar to that reported in America, where despite suggestion from the Children's Hospitals Association (CHA) to consolidate services, very few hospitals reported doing so.[17 31]

In contrast to the USA experience, there was almost no change to staffing in terms of responsible clinicians or consultant cover within our centres despite the decrease in patient numbers. This is unlikely to represent fewer specialist doctors working within the US hospital system, given an arguably more established PEM training route.[32 33] It is also not explained by the proportion of standalone paediatric departments, which were similar to the US representation,[31] from which redeployment of staff may not be feasible. It is possible to hypothesise that incidence rates could affect changes; either higher incidence requiring more change or lower incidence allowing more time to make changes. However, looking at our data national SARS-CoV-2 peak incidence rates were not related to the extent of reconfiguration. Further exploration to understand the reasons behind changes, or lack of changes, across departments would be helpful to understand these patterns. Our survey used consultant cover as a proxy measure for staffing generally; if junior staffing was significantly changed, it is expected the consultant staffing would have to change to reflect this, explicit exploration of this may be useful in future work.

A consistent pattern of change was that most units with a short stay unit restricted these services in some capacity. It remains unclear if this was driven primarily by the decrease in paediatric patient numbers, or in response to the need for more adult footprint within departments, or both.

Alongside the low burden of COVID-related serious disease in children, PEDs globally also saw a steep decline in paediatric attendance overall.[9 12 34 35] In the pandemic, the quantity of 'unknowns' has been vast, and many systems have responded in semi-reactionary manners, perhaps explaining the larger changes made in mixed centres. The low patient volumes may have meant that most PEDs did not require significant changes which adult ED may have undergone in order to adequately react to the situation as it unfolded across the globe.[36–38]

The requirement to maintain a safe level of emergency paediatric care may also have seen smaller changes to the ED working than primary care, community, inpatient and outpatient paediatric services. Changes in the wider models of healthcare around children and young people may have contributed to the PED model remaining constant. Although referral pathways into the PED did not appear to change, there were extensive changes elsewhere in paediatric care which may have impacted the ED. Encouragingly, new work is continually emerging to add to understanding the full effects of the pandemic on children and young people's healthcare services.[39–41] This would be important to understanding whether, if in future pandemics, children remain minimally affected could PEDs seek to make wider changes to allow more assistance to our adult colleagues and patients?

Our results should be interpreted in the lights of study limitations. First, the survey was primarily designed to inform the response of PEDs during the first wave of the COVID-19 pandemic in the context of the EPISODES study. As discussed, wide changes in the paediatric healthcare system have not been thoroughly captured. In addition, the subset of European centres included may not be representative of all the European PEDs. The majority of participating sites were tertiary, specialised PEDs. Hence, our results might not necessarily reflect changes made in general or smaller hospitals. However, the majority of sites were not receiving diverted paediatric patients from regional hospitals, which suggests that major restructuring was not being experienced more widely.

Second, the correlation of change to all-age and national incidence rates is a reflection of an expected overall burden to entire healthcare systems and may not be representative of the paediatric specific experience.

Third, we developed an approach to quantify change which has not been validated. In this approach, all changes have been ascribed equal weights. Some may be considered to have a greater impact on direct care in the ED, some to have more system wide effects. In addition, this survey did not reflect changes over time instead asking departments to reflect on total changes made some months after the end of the first wave of COVID-19 in Europe. Refining this approach could be considered in further similar studies surrounding care delivery in future pandemic response.

Finally, this study did not consider the different funding structures behind hospitals across Europe which may have changed how services could or could not be altered. However, given that largely there was minimal change across a broad range of countries, it seems this was not likely to have been a significant factor. Given the earlier work by Bressan *et al*, and the existing length of our survey, we did not explore further how hospitals achieved

the division into high-risk and low-risk COVID-19 groups; additional learning may be possible in this area.

Similar to earlier work in America and Europe, many respondents commented on low paediatric patient volume being the most apparent change.[16 31] Further work to understand this impact, as well as disease type and severity, is ongoing as part of the EPISODE study group work; preliminary data echo significant reduction in patient volume.

CONCLUSION

Overall, there was little change to service organisation or delivery across these PEDs during the first wave of the COVID-19 pandemic. Mixed centres appeared to have made more changes but patterns to these changes are not apparent. A few centres underwent greater degrees of reorganisation mainly in consolidation of services which have the potential to be replicated by others in future pandemic responses. Although children remained largely unaffected by this pandemic, there is scope for learning from centres who made larger scale changes in thinking about future responses. It is possible that in future waves of this, or similar pandemics, PEDs could make wider changes if health systems required this.

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