Regional variations in short stay urgent paediatric hospital admissions: a sequential mixed-methods approach exploring differences through data linkage and qualitative interviews


ABSTRACT

Objectives  The aim of this sequential mixed-methods study was to describe and understand how paediatric short stay admission (SSA) rates vary across Health Board regions of Scotland.

Design  Exploratory sequential mixed-methods study. Routinely acquired data for the annual (per capita) SSA to hospital were compared across the 11 regions. Five diverse regions with different SSA per capita formed cases for qualitative interviews with health professionals and parents to explore how care pathways, service features and geography may influence decisions to admit.

Setting  Scotland.

Participants  All children admitted to hospital 2015–2017. Healthcare staff (n=48) and parents (n=15) were interviewed.

Results  Of 171 039 urgent hospital admissions, 92 229 were SSAs, with a fivefold variation between 14 and 69/1000 children/year across regions. SSAs were higher for children in the most deprived compared with the least deprived communities. When expressed as a ratio of highest to lowest SSA/1000 children/year for diagnosed conditions between regions, the ratio was highest (10.1) for upper respiratory tract infection and lowest (2.8) for convulsions. Readmissions varied between 0.80 and 2.52/1000/year, with regions reporting higher SSA rates more likely to report higher readmission rates (r=0.70, p=0.016, n=11). Proximity and ease of access to services, local differences in service structure and configuration, national policy directives and disparities in how an SSA is defined were recognised by interviewees as explaining the observed regional variations in SSAs. Socioeconomic deprivation was seldom spontaneously raised by professionals when reflecting on reasons to refer or admit a child. Instead, greater emphasis was placed on the wider social circumstances and parents’ capacity to cope with and manage their child’s illness at home.

Conclusion  SSA rates for children vary quantitatively by region, condition and area deprivation and our interviews identify reasons for this. These findings can usefully inform future care pathway interventions.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ One strength of the study is the exploratory sequential mixed-methods approach taken.
⇒ A second strength is that quantitative and qualitative data were obtained from across a whole nation.
⇒ A limitation is that SARS-Cov-19 meant that our intended recruitment strategy for interviews had to be changed to remote recruitment.
⇒ A further limitation is that since there are only 11 health board regions, the comparison of characteristics across regions was underpowered.

INTRODUCTION

There has been a recent rise in paediatric urgent admission rates in the UK, which is mostly explained by rising short stay admissions (SSAs). Reasons for the rise are complex and include changes in parents’ health seeking behaviours, reduced capacity or time to see children in community or emergency department (ED) clinical areas and shorter length of stay in hospital with an associated rise in readmissions. There is a well-described need to develop solutions which safely reduce the number of urgent paediatric admissions, and perhaps 25% or 50% of urgent paediatric admissions could be managed outside of hospital. However, there is a paucity of evidence of what interventions might be effective.

Admissions vary fivefold across English local authorities for acute bronchiolitis, which is a common reason for an SSA. Developing an ‘as atlas of variation’ of SSA comparing regions could give insights into the context and causal mechanisms and inform the design of interventions to improve care pathways.

The FLAMINGO study (FLow of Admissions in children and youNG peOple) used...
a mixed-methods approach with public and patient involvement (PPI) throughout to improve understanding of SSAs in Scotland and our methods are described in full elsewhere. Qualitative interviews with parents and health professionals were used to explore contextual factors relating to SSAs that could not be gained from the quantitative data, including the experiences of parents and health professionals, the referral pathways that led to an SSA, and preferences for future interventions. The aims of this paper were to use the FLAMINGO dataset to (1) identify how SSAs varied across regions of Scotland and then (2) report relevant perspectives from interviews with parents and NHS staff from regions selected as cases representing both higher and lower rates of SSAs with the purpose of informing future care pathway interventions.

**METHODS**

**Study design**

An exploratory sequential mixed-methods approach was undertaken consisting of a quantitative data linkage component, followed by qualitative exploratory interviews; this allowed integration of the quantitative and qualitative components. The quantitative data analysis was completed prior to qualitative data collection. A priori propositions (or hypotheses) to be explored by mixed methods agreed by the team were:

1. SSA would vary across Scotland according to the care pathway, structure and processes of acute urgent care (before, during and after an SSA).
2. SSA would vary according to deprivation/inequalities/underserved populations.
3. Readmissions after an SSA would vary across Scotland according to the care pathway, structure and processes of acute urgent care (before, during and after an SSA).

In order to integrate quantitative and qualitative data, and per the Mixed Methods Appraisal Tool (mixed-methods studies), findings including similarities and discrepancies were presented immediately after each theme in the results section.

Our study included patient and public involvement throughout.

**Setting and participants**

The National Health Service (NHS) for Scotland has 14 geographically distinct Health Boards (regions), each of which is responsible for healthcare provision to their region’s population. Three Island Health Boards have no inpatient facility and are not included in this study. Characteristics of the 11 regions included are presented in Table 1. Quantitative analysis used anonymised details of paediatric admissions to hospitals in mainland Scotland throughout 2015–2017 and were provided by the Information Services Division of the Scottish Government, as described previously. The number of all urgent admissions and SSAs (standardised per capita) was identified for each region. Attendance at the ED where the child was not admitted to medical paediatric services was not considered an admission. A child admitted under paediatric services to a short stay paediatric assessment unit was considered as having been admitted. For quantitative purposes, an SSA was defined as one where a child was admitted and discharged on the same date. Non-urgent admissions to medical specialties and admissions to surgical specialties were excluded from the analysis. SSA and composite diagnoses (ie, groups of conditions that are similar but coded differently) documented as the reason for admission were determined (see online supplemental table 1, also described previously). The number of admissions was calculated by adding all admissions between 2015 and 2017, dividing by the average population of <16 years 2015–2017 and then dividing by three to yield admissions/1000/year. Atlases of variation were created using R studio (R Core Team, R Foundation for Statistical Computing, Vienna, Austria) to compare admissions/1000/year in each board region for all urgent admissions and all SSA visually on maps of Scotland.

Following a review of the data linkage results by the FLAMINGO team, 5 of the 11 Health Board regions were purposively identified to act as ‘cases’ that varied in characteristics including: (1) high or low SSA rates (relative to the median), (2) very high or very low population density and (3) presence of either a paediatric-specific ED or ED for children and adults. This identification facilitated a more in-depth study through qualitative interviews to enhance understanding of both the a priori propositions and the quantitative data. Parents of children with a recent SSA and health professionals working in primary or secondary care within all eleven regions, but with a focus on the five case regions, were recruited to take part in interviews designed to explore their experiences and contexts relating to the care pathways between home and hospital leading to SSAs. PPI, through engagement with parents attending community groups and parent-toddler groups (n=10), was undertaken to invite parents to share their experiences and inform the project’s interview topic guide and recruitment materials. PPI discussions revealed that many families were unsure at what time point in their hospital visit their child was officially classified as ‘admitted’. Therefore, the definition of SSA used for interviews was an admission where a child is/was admitted and discharged within 24 hours. Box 1 describes definitions used. Participants were purposively sampled to ensure a range of job roles across primary and secondary care and a range of family experiences. As the recruitment period for FLAMINO took place during COVID-19 pandemic restrictions, alternative convenience sampling methods were also required, including online platforms and social media, press releases and newspaper advertisements. Separate semistructured topic guides for parents and health professionals (see online supplemental file 1) were developed with PPI contributions. During interview discussions, participants were asked to focus on
their experiences pre SARS-CoV-19 before discussing any changes experienced during or resulting from the pandemic. All interviews were carried out over the telephone between December 2019 and March 2021 by experienced qualitative researchers (EK and CM) with backgrounds in health services research (EK and CM) and clinical paediatric nursing (CM). Interviews were audio recorded, anonymised, transcribed verbatim and lasted between 18 and 55 min.

Data analysis
For quantitative data, mean number of admissions/1000/year were presented with stratification by region and Scottish Index of Multiple Deprivation (SIMD). For the 10 most common diagnoses, known by region and SIMD, the coefficient of variation for each diagnosis across regions was calculated by dividing the SD of number of admission/1000 by the mean and expressed as a percentage. These data informed the qualitative methods.

For qualitative data, our conceptual approach to analysis was informed by critical realism, which is critical of the notion of ‘factual truth’ while maintaining that a reality exists in recognition of the fact that interviews are at the same time ‘factual’ and reconstructions of events.19 20 A thematic framework approach to analysis was adopted.21 22 Our approach to analysing the complete FLAMINGO interview dataset is reported in detail elsewhere.15 In this paper, we focus on additional analysis and interpretation of the data to address the specific aims of this paper, that is, to better understand variations in SSAs. The main relevant themes from the FLAMINGO project coding framework (service -structure of buildings and place; non-medical/clinical factors influencing decisions; readmission and aftercare) were analysed in depth.

<table>
<thead>
<tr>
<th>NHS Health Board</th>
<th>No of resident &lt;16 year olds (average 2015–2017)</th>
<th>Area covered by NHS Health Board, square miles (children/square mile)</th>
<th>Median deprivation quintile* (IQR, most deprived)†</th>
<th>No of whole time equivalent GPs per 10 000 patients‡§</th>
<th>Median age of children* (quartiles 1, 3)</th>
<th>Health Board details. The average no of staffed beds for 2016/2017 is provided (the no in brackets corresponds to beds/10 000 children¶)</th>
<th>Mean weighted distance (km) from each data zone to hospital**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayrshire and Arran</td>
<td>62 038</td>
<td>1310 (47)</td>
<td>2 (1–4)</td>
<td>6.3</td>
<td>2.4 (0.8, 6.3)</td>
<td>One medical paediatric inpatient facility. 34 beds (5.5).</td>
<td>15</td>
</tr>
<tr>
<td>Borders</td>
<td>18 999</td>
<td>1831 (10)</td>
<td>3 (2–4)</td>
<td>8.3</td>
<td>3.1 (1.0, 8.1)</td>
<td>One medical paediatric inpatient facility. 16 beds (8.4).</td>
<td>20</td>
</tr>
<tr>
<td>Dumfries and Galloway</td>
<td>23 592</td>
<td>2400 (10)</td>
<td>3 (2–4)</td>
<td>6.4</td>
<td>2.3 (0.7, 6.7)</td>
<td>One medical paediatric inpatient facility. 31 beds (13.1).</td>
<td>32</td>
</tr>
<tr>
<td>Fife</td>
<td>64 262</td>
<td>512 (125)</td>
<td>2 (1–4)</td>
<td>5.9</td>
<td>2.5 (0.8, 7.0)</td>
<td>One medical paediatric inpatient facility. 52 beds (8.1).</td>
<td>15</td>
</tr>
<tr>
<td>Forth Valley</td>
<td>52 836</td>
<td>1020 (51)</td>
<td>3 (2–4)</td>
<td>5.7</td>
<td>3.0 (1.0, 7.8)</td>
<td>One medical paediatric inpatient facility. 44 beds (8.3).</td>
<td>11</td>
</tr>
<tr>
<td>Grampian</td>
<td>99 483</td>
<td>3360 (30)</td>
<td>3 (2–4)</td>
<td>6.0</td>
<td>2.0 (0.6, 5.7)</td>
<td>Two hospitals (65 miles apart) each with medical paediatric inpatient facility. 73 beds in total (7.3).</td>
<td>18</td>
</tr>
<tr>
<td>Greater Glasgow and Clyde</td>
<td>194 416</td>
<td>453 (429)</td>
<td>2 (1–4)</td>
<td>5.9</td>
<td>1.9 (0.6, 5.3)</td>
<td>Two paediatric inpatient facilities (11 miles apart, 154 beds (7.9). Also paediatric ED.††</td>
<td>9</td>
</tr>
<tr>
<td>Highland</td>
<td>53 059</td>
<td>12 507 (4)</td>
<td>3 (2–4)</td>
<td>9.0</td>
<td>2.2 (0.6, 6.0)</td>
<td>One medical paediatric inpatient facility. 45 beds (8.5).</td>
<td>148</td>
</tr>
<tr>
<td>Lanarkshire</td>
<td>118 165</td>
<td>883 (134)</td>
<td>2 (1–4)</td>
<td>4.9</td>
<td>2.4 (0.8, 6.5)</td>
<td>One medical paediatric inpatient facility. 68 beds (5.6).</td>
<td>12</td>
</tr>
<tr>
<td>Lothian</td>
<td>148 356</td>
<td>700 (211)</td>
<td>3 (2–4)</td>
<td>6.6</td>
<td>1.8 (0.5, 4.5)</td>
<td>Two hospitals (17 miles apart) each with a medical paediatric inpatient facility, 96 beds in total (6.5). The larger unit has a paediatric emergency department (ED),‡‡</td>
<td>7</td>
</tr>
<tr>
<td>Tayside</td>
<td>67 872</td>
<td>2986 (23)</td>
<td>3 (2–4)</td>
<td>6.9</td>
<td>2.6 (0.9, 6.7)</td>
<td>One medical paediatric inpatient facility. 70 beds (10.3).</td>
<td>21</td>
</tr>
</tbody>
</table>

Details of the three Island boards are not included as they have no formal paediatric inpatient facility.

*With reference to children who were admitted.
§Children seen and sent home in the ED are not considered an admission.
††Where there were two hospitals in a region the larger of the two hospitals was used.
with further line by line coding conducted by three members of the FLAMINGO team (EK, CM and EF). Differences were discussed and debated at weekly project team meetings and final themes confirmed once consensus was reached. The qualitative interview reporting adhered to the Consolidated Criteria for Reporting Qualitative Studies guidelines.23

**RESULTS**

**Data linkage: SSA variation across Scotland**

There were 171,039 urgent hospital admissions, including 92,229 SSAs. The number of SSAs varied across the 11 regions between 14 and 69/1000/year, and for all urgent admissions between 37 and 105/1000/year (figure 1, table 2). Across regions, SSAs and all urgent admissions were higher for children in the most deprived (SIMD1) compared with least deprived communities (SIMD5), online supplemental figure 1. The coefficient of variation for SSA between regions was 41%, and the ratio of highest to lowest SSA admissions was 4.9:1 (online supplemental table 2). When diagnostic condition for the SSA was considered, the coefficient of variation was lowest (31%) for convulsions and highest (64%) for upper respiratory tract infection (figure 2 and online supplemental table 2). The ratio of highest to lowest number of SSA/1000/year for condition between regions was lowest (2.8:1) for convulsions and highest (10.1) for upper respiratory tract infections (online supplemental table 2). The number of readmissions varied between 0.80 and 2.52/1000/year (table 2); there was a positive correlation between SSAs and readmissions (r=0.70, p=0.016, n=11), online supplemental figure 2. Median distance from home to the nearest hospital with paediatric services, available for a subset of 18,941 admissions, was 6 (3, 16) miles for 10,502 SSA and 5 (3, 12) miles for 8,439 non-SSA admissions, Mann-Whitney U test p<0.001. Online supplemental figure 3 presents scatter plots comparing SSA/1000/year and the following characteristics of the 11 regions: number of children/square mile; number of general practitioners (GPs)/1000; mean distance from hospital and number of paediatric hospital beds/1000.

**Perspectives of professionals and parents**

Forty-eight health professionals and 15 parents were interviewed. Online supplemental table 3 summarises characteristics of the five case regions. Online

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**Box 1 Definitions used for this study**

**Urgent admission:** An unplanned (or emergency) admission to a medical paediatric inpatient facility. This does not include cases seen in emergency department (ED) and discharged.

**Readmission:** Where two urgent admissions occur within 30 days for the same diagnosis.

**Scottish Index of Multiple Deprivations (SIMD, see footnote table one):** A small-area-based index where the population is evenly distributed across quintiles and where 1 is the most deprived. The 2016 version was used.

**Short stay admission (SSA):** For quantitative analysis, this was an urgent admission where a child is admitted and discharged on the same calendar day. For qualitative analysis, the definition of SSA used for interviews was an admission where a child is/was admitted and discharged within 24 hours; this was because many families were unsure at what time point in their hospital visit their child was officially classified as ‘admitted’.

**Health Board:** Territorial Health Boards are geographical areas in Scotland where healthcare is administered for the population in this area by a single organisation. There are 11 mainland Health Boards in Scotland and 3 Island Health Boards where there are no inpatient facilities for children. Two of the 11 mainland Health Boards have 2 inpatient facilities for children (NHS Grampian and NHS Lothian). Two hospitals with inpatient facilities for children have EDs staffed by paediatricians (NHS Greater Glasgow and Clyde and NHS Lothian).

**NHS24:** A telephone decision service which can be the first point of contact for patients who are acutely unwell.

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**Figure 1** Map of Scottish Health Boards showing the number of all urgent (left panel) and short stay urgent admissions (right panel) of children less than 16 years old to hospital between 2015 and 2017 per 1000 under 16 years. adm/1000/year = number of admissions per 1000 children (<16 years) per annum.
supplemental table 4 describes the number of participants recruited in each Health Board. Characteristics of health professionals and parents are described in online supplemental tables 5 and 6.

**Overview of themes**

Broad themes identified from the interviews and relating to the a priori propositions were:

1. **Access to services (primary and secondary care)**, which included two subthemes: (1) proximity to hospital and (2) navigating pathways through the NHS (including structure of local services and national policy which impacted on admissions).

2. **Socioeconomic circumstances and deprivation**.

3. **Readmissions**.

**Access to services (primary and secondary care)**

**Proximity to hospital**

Referring clinicians discussed how the distance to hospital can impact on their decision of whether or not to refer. In situations that would require a long journey to hospital, primary care clinicians used their professional judgement about safe management: deciding whether the long journey to hospital was necessary and considering the risk of deterioration in a child managed at home.

So when you’re in [City] you wouldn’t have a qualm about saying to someone ‘can you nip up to the kids

<table>
<thead>
<tr>
<th>NHS Health Board</th>
<th>All urgent admissions 2015–2017 (n=171,039)</th>
<th>Short stay urgent admissions (SSA) 2015–2017 (n=92,229)</th>
<th>No of readmissions between (n/1000 children/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayrshire and Arran</td>
<td>Absolute no 19,583</td>
<td>Absolute no 12,797</td>
<td>No/1000/year (rank, 1=highest) 68.8 (1) 65 (1) 1.99</td>
</tr>
<tr>
<td>Borders</td>
<td>4799</td>
<td>2,729</td>
<td>48.1 (3) 57 (5) 1.31</td>
</tr>
<tr>
<td>Dumfries and Galloway</td>
<td>5,827</td>
<td>2,471</td>
<td>34.9 (6) 42 (9) 1.39</td>
</tr>
<tr>
<td>Fife</td>
<td>7,171</td>
<td>2,680</td>
<td>13.9 (11) 37 (11) 0.80</td>
</tr>
<tr>
<td>Forth Valley</td>
<td>11,063</td>
<td>5,236</td>
<td>33.0 (7) 47 (8) 0.96</td>
</tr>
<tr>
<td>Grampian</td>
<td>17,016</td>
<td>8,794</td>
<td>29.5 (9) 52 (7) 1.47</td>
</tr>
<tr>
<td>Greater Glasgow and Clyde</td>
<td>34,159</td>
<td>18,400</td>
<td>31.5 (8) 54 (6) 1.13</td>
</tr>
<tr>
<td>Highland</td>
<td>9,000</td>
<td>5,784</td>
<td>36.3 (5) 64 (2) 2.52</td>
</tr>
<tr>
<td>Lanarkshire</td>
<td>21,682</td>
<td>13,768</td>
<td>38.8 (4) 64 (2) 1.88</td>
</tr>
<tr>
<td>Lothian</td>
<td>21,777</td>
<td>8,707</td>
<td>19.6 (10) 40 (10) 1.13</td>
</tr>
<tr>
<td>Tayside</td>
<td>18,681</td>
<td>10,749</td>
<td>52.8 (2) 58 (4) 1.57</td>
</tr>
</tbody>
</table>

Figure 2  Bar chart showing the coefficient of variation (expressed as %) for short stay urgent admissions where the diagnosis was one of the ten most common diagnoses. The horizontal dashed line is the coefficient of variation for all short stay admissions (41%). LRTI, lower respiratory tract infection; SoB, shortness of breath; URTI, upper respiratory tract infection.
ED and they’ll check you over and might do an x-ray and send you home’ but you’re not going to do that for someone who’s, you’re talking about a six or seven hour round trip, so you would be thinking I’m only going to really do that if it’s absolutely necessary or can we manage that maybe a bit more conservatively at home, but yeah if you get it wrong then yeah you’ve taken all the risk and you’re sort of opening yourself up to a complaint or a problem. (GP HB4)

Referring clinicians explained how those with less experience of acutely unwell children were less comfortable and confident in decision-making. Parents described their experiences of having to make the difficult decision between travelling a long distance to hospital or ‘waiting it out’ at home and balancing up which is the safer approach.

Most of the time that I’ve needed to use [NHS24] they’ve been fantastic, particularly here where the decision to go to ED can be quite a difficult one because it’s not necessarily on your doorstep, and the weather conditions as well, like, if there’s a blizzard or something, you’re asking yourself do I really want to risk taking my child out in this to go to hospital or am I safer waiting it out at home? (Parent 4 HB4)

For paediatric staff, a shorter distance from home to hospital influenced decision-making with participants having a lower threshold to send a child home if they were confident that the family could return to hospital fairly quickly should the child deteriorate.

I guess one thing with our geography… whenever [junior doctors] ask me for advice about kids I’m always like ‘where do they stay?’ and they’re like ‘why does that matter?’ but once you get to know our geography, so we cover the whole of [area] and that can be down as far as [town] for example which can be over an hour to get back to the hospital, so I’d be more likely to bring those kids in, particularly out of hours, if they’ve got croup or bronchiolitis or something, sometimes they’d get watched overnight, whereas if they were very close to the hospital you would send them home. (Consultant HB1)

Time of day influenced professionals’ decision-making around whether to refer, admit or discharge a child both in situations where the family lived a considerable distance from hospital as well as situations where they lived relatively close to hospital.

In [Health Board region], especially because of the distance, sometimes we do keep them overnight because they go all the way back to say, [place name], so we don’t feel safe to send them home, you know, at midnight. (Consultant HB4)

So sometimes we might just put them in a bed [admit child] if we’ve got beds for overnight and then send them home in the morning, that can play a lot into the decision making, you know, say it’s like three in the morning, I don’t often feel like sending a baby home at that time, so sometimes we just keep them. (Non consultant doctor HB4)

There is some contrast in findings from quantitative analysis (patients with SSA lived marginally further from their local hospital compared with those with longer admissions) and qualitative analysis (strong theme for shorter admissions for those living closer to the hospital). This is likely explained by confounding quantitative findings by factors such as the threshold for admitting children living closer to the hospital being higher than for children living further away.

Navigating pathways through the NHS
Ease of access to services influenced how and where families first sought healthcare. Despite media campaigns by the NHS encouraging people to call NHS 24 for initial advice, health professionals reported parents often continue to take their children directly to the ED. The ED was perceived by health professionals as being the place where parents felt most confident going when they are worried about their acutely unwell child.

They don’t phone NHS24, they just come up with their kids, but again I think the service in [City] has evolved in that way and it’s not really fair to criticise parents for that. I think they just come up [to out of hours or ED] when they’re worried and many parents that I meet in general practice are worried appropriately because they’ve tried lots of different measures, you know, they’ve given [anti-pyretic], they’ve done the usual sort of common-sense things and they’re coming up because they just feel the child isn’t picking up. (GP HB3)

Some referring clinicians experienced local hospital policy which required their child to be transferred to another hospital for ongoing care if not well enough for discharge home within 24 hours.

But they have a rule in the ward in Healthboard11 that they won’t keep children longer than 24 hours, that’s their rule. If the child needs to stay in hospital beyond 24 hours the child needs to go to Hospital and I think that’s a good sort of… I don’t know if it’s written down. (GP HB9)

Parents reported mixed experiences with some describing relative ease in accessing primary care, and others struggling to get GP appointments or prompt guidance from NHS24 and resorting to attending the ED. With EDs being so busy and under constant pressure, families often experience extended waiting times and, arguably, would not be seen any quicker.

I phoned NHS24 who obviously were too busy and asked me to hold on for a nurse to call me back. In that hour his temperature raised to over 39 so I took him to the children’s hospital in [City]. I was there at
half eleven. They were very, very busy at the time so I wasn’t seen until half two. (Parent I HB3)

Local policy and structure impacting on admission data
Parents reported how due to their local hospital’s paediatric unit being closed at certain times, such as evenings or weekends, they were admitted directly to another hospital.

It was a Friday morning and that’s when [health professional] said they’re ‘not comfortable that he’s well enough to go home yet, however it’s a Friday, our ward will shut over the weekend, you need to stay in, we’re not going to discharge you so you need to now go to [hospital] and I was like ‘well, I don’t have transport’ and they were like ‘that’s okay, we don’t have an ambulance for you but we do have a taxi’ so they put me in a taxi to [hospital]. (Parent HB5).

Clinicians described how during the evening, some short stay assessment units (SSPAU) closed and children were admitted directly to a paediatric medical ward elsewhere in the hospital, but might have been discharged later in the evening had the SSPAU remained open.

When a child is admitted during the night, we don’t have nursing staff for our Paediatric Assessment Unit so therefore the child goes straight to inpatients and is admitted as an inpatient overnight, cause generally the majority of them that come in overnight stay for the morning anyway. (Non consultant doctor, HB 4)

Secondary care professionals explained how children may also be admitted directly to a more distant hospital in order to receive specialist paediatric care.

Yeah, so I suppose being [City] we get a fair number of referrals over the course of various different shifts from the likes of [Towns], all these sorts of places and I guess, as you say, yeah these are the sorts of families that even if the child is reasonably well the initial referring centre either might be worried about the child clinically whenever they present or they might feel that they don’t quite have the experience from a paediatric perspective to manage them and they then get referred down. (Non-consultant hospital doctor, HB3)

Hospital clinicians observed that the structural configuration of different hospitals was believed to impact on their levels of recorded admissions. Hospitals in some regions had dedicated SSAU which allowed children to be moved out of the ED for ongoing observation beyond the 4-hour ED target. A UK-wide government directive that requires a patient arriving in an ED to be either admitted, transferred or discharged within 4 hours. The SSAUs were located close or adjacent to the hospital’s ED or in smaller regions the SSAU could consist of a few beds in the main paediatric ward.

The qualitative analysis (online supplemental figure 2) found no link between SSA and either population density or number of beds, but qualitative analysis suggested that SSAs might be higher in hospitals which are continuously open and surrounded by larger populations. Quantitative data may be confounded, for example, by larger hospitals having paediatric EDs where children are seen and discharged without being ‘admitted’.

National policy impacting on admission data
Individual regional targets and data recording approaches could also impact on the number of children admitted for SSA. Secondary care professionals explained how the national 4-hour ED target was a factor informing their practice.

[…] all of the patients that come through our emergency department are subject to the Scottish Government’s unscheduled care four hour target, so obviously that target does drive our practice and behaviour to a certain extent. […] we had set up an adjacent area and badged it as a clinical decision unit to essentially allow our department to continue to function with the volume of patients that we expected to allow patients to flow in and flow out of the back, whilst still obviously being able to meet that target. (Consultant, September HB3)

Clinicians also commented that differences in definitions of an admission contributed to the quantitative variation in SSA data.

you’re right it gets terribly confusing—how do you actually count referrals, admissions, turnarounds, whatever? The way our unit is set up, the assessment unit has [number] beds in it and it is physically, geographically next door to the ward and I think if, for whatever reason, the child is transferred through to the ward, then that becomes an admission. Otherwise, it is not counted as an admission. (Consultant, HB6)

The paediatric ward does have a short stay area so some of our ‘admissions’ will be zero day admissions because they’ll go straight to the short stay ward and then subsequently be discharged. (Consultant HB1)

Socioeconomic circumstances and deprivation
Health professionals acknowledged the impact of inequalities on child health outcomes, recognising that area deprivation was an influencing factor that may account for regional variations in SSAs. However, a note of caution to avoid any widespread generalisations with respect to deprivation was raised by several participants.

In my experience I think most children are admitted on their clinical grounds not their social grounds. The pattern of use of out of hours might be slightly different and I don’t know the data and obviously that would be interesting to look at deprivation—use of out of hours, A&E, paediatric A&E by deprivation, but my feeling is that having worked in out of hours where we see people across the whole spectrum of, because out of hours is for everybody, it's not just localised to [deprived district] or whatever, some of
the sickest children that I’ve seen are from very middle-class households, babies in particular where the parents have been persisting with what they think is appropriate supportive treatment when it’s been a really unwell baby and they just haven’t picked that up. And that’s been interesting to me... So I don’t really think that class deprivation is really the biggest issue about the patterns of referral into short stay admissions. (GP HB3)

Instead, participants emphasised the importance of assessing a parent’s ability to cope and manage their child’s illness without prejudice. Secondary care professionals also emphasised that when giving safety netting advice, they require some assurance that the family will be able to return to hospital if their child’s condition worsens. Another health professional emphasised the importance of assessing parents’ ability to cope and manage with their child’s illness without prejudice.

Often people are living a very difficult life or are socioeconomically deprived but it doesn’t mean that they’re not a good parent with good coping skills, so I think we can be a bit judgemental about that are well. But yeah, it’s definitely part of an assessment that you make. (Consultant HB1)

A common finding across both primary and secondary care professionals was the requirement to assess health literacy and the extent to which parents understand the safety netting advice being given to them including signs and symptoms to be concerned about, worsening advice and the point at which they should seek further medical help either from their GP, NHS24 or the ED via an ambulance. One participant explained how in situations where they have judged that understanding to be lacking, this would lower their threshold to ensure the child is reviewed at hospital. Identifying parents who may be struggling to cope with safely managing the child’s illness at home, regardless of socioeconomic status, was a factor prompting referral or admission. Identifying parents who may be struggling to cope to safely manage the child’s illness at home, regardless of socioeconomic status, was a factor prompting admission:

Certainly I think there’s some families who have less resilience, less resources to cope with problems at home. I think that’s a very individual basis. It’s hard to make broad sweeps about that. But there are a number of these families who are frequent attenders with their young children. (GP HB4)

Socioeconomic circumstances can impact on families’ ability to access services for an acutely unwell child.

We’re in quite a mixed area where we are so bits of it are quite deprived and lots of it are quite deprived and lots of families don’t have a car, they don’t have money that they could take, you know, they could get a taxi up. Sometimes they will be able to get a family member or a friend to run them up but there has been occasions that we’ve had to get an ambulance to take them to hospital. If they’re very acutely unwell then that’s absolutely fine and if not they can be here for between two to four hours waiting on transport. (Primary care nurse, HB1)

In some situations, a child who is well enough to go home is admitted to hospital because the family do not have access to transport.

There are very occasional what I would regard inappropriate admissions where, for social reasons, you will admit the child to a bed. For example, if the child is referred up at three o’clock in the morning, comes by ambulance and the parents have no transport then you might admit them to a bed, and that I guess would be one definition of an inappropriate admission. (Consultant HB6)

The quantitative and qualitative analyses were consistent and suggested that higher areas of deprivation were associated with higher SSA (figure 2). The analysis additionally found that clinicians considered factors other than the financial resources of the child’s family within a more holistic and nuanced approach to deprivation.

Readmissions

Readmissions were reported for parental anxiety, for children who had previously presented early in an infection (particularly bronchiolitis) and were now worsening. Clinicians did not see readmission as a bad thing and parents were generally encouraged to reattend if they were unsure how their child’s condition was progressing. After a few presentations, referring clinicians sometimes felt it was prudent to admit.

ED has quite a high return rate and it’s when a child comes back the second or third time that they then kinda maybe say ‘well maybe we should just bring them in overnight’. But yeah, there certainly is here seemingly that people come back a lot more for reassurance and to check that things are right. (Doctor, HB5)

Similarly, some children presented to ED or direct to the ward after an SSA, but were not admitted. This was reported as parents needing reassurance or the clinicians in ED able to change medication without the need for longer observation.

So we got out say about lunchtime-ish. I was given an inhaler to take home. He was much more settled during the day but of course at night that’s when he clearly, clearly struggled and yeah I just phoned, I think I got to about four o’clock in the morning and I phoned the ward and said ‘no he’s just not, he’s struggling’ and they said ‘not a problem, straight back in’. So I was straight back into the assessment bay, straight onto the nebuliser with him, that settled him and obviously helped and then we left and we just went to the short stay triage area, we weren’t admitted to the
ward and we were discharged from the triage area at
probably about half past six in the morning, and then
he was home and he slept most of the morning. It
clearly had an impact cause even sleeping propped
up he had struggled so he just needed that little bit
extra. (Parent, HB4)

Clinicians acknowledged that with shift work and open
access they might not be aware of children being read-
mitted unless readmissions were specifically audited.
Many perceived rates to be low and more likely in winter,
with diagnoses of bronchiolitis and winter vomiting virus.

So I think it’s [readmission] probably something that we see
more frequently in winter particularly with kids that have bron-
chiolitis and I guess the other cohort that we might see it in is kids
that have a vomiting illness. … not that it’s expected but given
the progression of the disease we do expect to see some children as
they progress through day kinda four to day six they might get a
bit worse and we do expect to see some of them again. (Doctor,
HB3)

Yeah, yeah, yeah we do and indeed that is one of our whatever
you want to call it, one of our performance indicators, we look at
readmissions, those that have been turned away and we specif-
ically look at each of the cases. Again part of it is about confi-
dence in assessing the child, sometimes it’s a health professional
that has re-referred the child, sometimes it’s the parents that come
back again having felt that their child is getting more unwell. For
a significant proportion of them again turned away or turned
round quickly and they do not need admission, and these ones it’s
harder to say whether the admission is purely for medical reasons
or to try and support parents who have become a little bit more
anxious. So it’s a relatively small number and the number that
actually end up sick is very small, so they’re a complicated group
of youngsters but we do look at them closely and there hasn’t be-
en a single factor that has been identified or any specific factors that
can help you predict which of these children might come back
or which ones are going to get sick or whatever. (Consultant,
HB7).

A number of reasons were described that could explain
the regional variation in readmission rates. For examples,
the presence of a dedicated paediatric ED, where a child
representing after an SSA may be more likely to be seen
and sent home; availability of primary care staff who could
support parents and children at home, and in some cases,
proactively saw children after discharge from an SSA.

There was also variation in how ‘open access’ was
managed postdischarge. Most hospitals offered children
a 24 or 48 hours open access to phone or return directly
without referral, however, this varied as to whether chil-
dren returned to the ward, through ED or to the SSAs
unit. As discussed previously this impacts on whether a
child returning is counted as an ‘admission’ in the quan-
titative data.

No we do see readmissions. So if they’re within probably a week
if they’ve been up with the same issue and they represent they
will come directly into [short stay assessment unit]; if they’re a
medical patient, so they will come directly in and they will be reas-
sessed again. If they represent certainly a couple of times we will
have a look at them to see whether actually they need to stay in to
give the parents more support. (Nurse, HB3)

Interviewees also reported that the offer of open access
actually lowered readmission rates, possibly by supporting
parents and reducing parental anxiety about access to
services.

So we’ve actually found, that [open access] came in quite a
number of years ago, I’d say about over five/six years ago that
came in, and we found actually that it dropped our readmission
rate surprisingly, we actually thought it would increase it but it
actually dropped it and I think it’s just because it’s reassuring
for the parents to know that they’ve got somewhere to come to if
need be, some things we can manage over the phone so it ends up
stopping them re-attending. Yeah, so it has actually helped and
it’s quite reassuring for them (Doctor, HB4)

Parents also reported feeling reassured that they could
phone for advice, or that readmission was an option if
their child’s condition worsened.

They basically came through and said that there was no point
keeping her in the hospital any longer and to send her home
but they had an open admission for her for so they said ‘if she has
another seizure you don’t need to phone 111, you don’t need to
do anything, just come straight here, even if it’s the middle
of the night, and we’ll take her straight in’ and they gave me the
direct telephone number for the paediatric department as well,
so it meant I didn’t have to keep trying to go through on the
general A&E number or anything like that, so that was reas-
suring knowing that if anything happened that I could take her
straight in, and in the meantime they just arranged further tests
for her to be done. (Parent, HB4)

The quantitative analysis identified how readmissions are
positively correlated with SSA, and thus variable across
the country. Our interviews identified how some health-
care staff were more aware of readmissions than others.
Healthcare staff identified parental anxiety while parents
identified recurring symptoms as drivers for readmissions.

DISCUSSION

Our study used a sequential mixed-methods approach
to improve understanding of SSA rates in Scotland. Our
main finding was a fivefold variation between SSAs across
regions confirming our a priori proposition, and this
variation was higher for some conditions compared with
others. Themes identified as explaining this variation
included proximity to hospital, local service structure,
national policy, socioeconomic factors and readmission
process. For some factors, for example, proximity to
hospital, the relationships with SSA seen in quantitative
and qualitative analyses were apparently contrary. These
results give insight into the complexity of understanding
decision-making in urgent care pathways, and the bene-
fits of taking a mixed methodology approach.

Bronchiolitis admissions are known to vary by fivefold13
and our study confirms and extends these findings by
demonstrating other conditions have more or less than
a fivefold difference. The reason for such variation across
a nation might be explained by differences in health


9
seeking behaviour or disease severity and prevalence. However, our mixed-methods approach suggests that differences are a manifestation of regional differences in healthcare systems and processes, including configuration of local services and targets which are set nationally.

There is a low level of evidence for community-based or hospital-based interventions being effective in reducing urgent admissions, and studying variation in healthcare resources may give insight into how to develop healthcare services. The regions with relatively higher number of admissions for a given individual clinical presentation also tended to have higher admissions for other conditions, and this suggests that a whole system rather than condition-specific approach is needed to reduce SSA.

Low SSAs were not explained by some regions having a policy of keeping children in hospital for a longer period of time, as regions with relatively lower SSAs also had lower SSA rates relative to all urgent admissions. There is evidence that hospital support of community services, for example, professional to professional communication, can reduce admissions and a hypothesis emerging from our exploratory analyses is that regions where community services are more able to manage mild symptoms in children will have fewer SSAs.

This is the first Atlas of Healthcare Variation study to consider all urgent admissions in children and to include qualitative interview data to assist interpretation. This compliments Atlases of Healthcare Variation for England and Scotland and regional variations for admissions are described. Limitations are the exploratory nature of our results as there are only eleven NHS Health Boards with inpatient facilities, limiting meaningful quantitative comparison. Our quantitative analysis preceded the SARS-CoV-19 pandemic and qualitative study was during the pandemic which meant face to face recruitment and site visits were impossible. Staffing resources, health-seeking behaviour and use of remote consulting technology have changed since our analyses. As our health professional interview data identified, some of the variation in SSA may be explained by differences in coding practice between regions and this warrants further investigation.

Quantitative data for our study were collected before the SARS-CoV-2 pandemic and our qualitative data were collected during the pandemic. It is possible that changes in parent/carer health-seeking behaviour as a direct consequence of the pandemic and pressures on the NHS which have followed the pandemic may have affected the generalisability of our results. However, we believe that the themes of access to services, socioeconomic circumstances and readmissions remain relevant to parent and healthcare staff in today’s NHS, and potentially also in healthcare systems in other nations.

This Atlas of Healthcare variation for children’s admissions complemented by insights from qualitative interviews with health professionals and parents reveals the complexity of urgent paediatric care systems and can provide a baseline for the design of care pathway interventions for acutely unwell children in future. A separate paper will describe recommendations which arose from interviews and at a stakeholder event for interventions which could provide an alternative to SSAs.

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Patient consent for publication Not applicable.

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Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. Data are available on request to the Privacy and Public Benefit Panel.

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REFERENCES
Family Interview Topic Guide

This preliminary interview schedule will be finalised by the research team in partnership with the project’s PPI Advisory Group. In particular the wording of the questions posed to families will be refined according to the PPI Advisory Group recommendations. The questions will be informed by and reflect the findings emanating from Phase 1 of the project and are expected to cover the following topic areas:

Past medical history
- Brief history of child’s health and past hospitalisations (purpose to determine the frequency of zeroday admissions experienced and identify the admission that the family want to talk about)

Explore the events and experiences leading up to the child’s most recent or most memorable zero-day hospital admission, asking families to tell their story from the start...
- What symptoms were observed and any perceived risks (ie. same as symptoms experienced in past? different? worrying?)
- What reasons do families recall for seeking support regarding their child’s current health?
- Who did the family seek support from? (ie. services and professionals such GP, pharmacist, NHS 24 111, internet, minor injuries unit, A&E; family; friends; other)
- What reasons do the families recall for consulting the above individuals or services?
- What happened next, what were the outcome/s of these initial consultations?

Explore the family’s experience of a zero-day hospital admission, asking families to tell their story from when they walked through the door of the hospital...
- Who did they see first, what happened next, recall any feelings experienced. Who made the decision that the child would be admitted? What involvement did the family have in any decision making related to the admission?
- What thoughts and feelings did the family have surrounding the decision to admit child to hospital?
- Explore the family’s confidence in the care team around their child and the level of consistency in information received.

Explore the family’s experiences of going home after the admission...
- Explore how the decision was made to be discharged home and their involvement in decision making
- Explore what happened once back at home - did any questions or concerns arise the first few days after discharge from hospital? Was their anything the family felt unsure about or wanted further advice on
- Explore how their experience might have changed the way they might react if a similar situation occurred again

Explore how the family’s experiences could be improved in future...
- How satisfied were families with the process of accessing services for their child?
- How effective was communication between services and professionals involved in the child’s care and subsequent hospital admission?
- What (if anything) would they have liked to be different about their story?
- What other stories have they heard amongst their family and friends about zero-day admissions?
• Recommendations and suggestions for how zero-day hospital admissions can be avoided.

The interviews are expected to be largely guided by the adults in the families who will be asked to tell their story about their most recent (or memorable) zero-day admission. Children and young people will be encouraged to offer their perspectives and accounts where appropriate.

**Demographics.** At the end of the interview, the researcher will complete a short, anonymised checklist asking about key demographics relevant to reporting the diversity of the sample in publications and reports including the following details:

1. Number of children in the family
2. Number of children who have had zero-day admissions; number of admissions, age when admitted and health condition requiring admission
3. SIMD and Urban rural classification of postcode (using web look up, so that postcode is not stored)
4. Parental occupations
5. Distance to Hospital; Distance to GP surgery
6. Ethnicity
7. **1** Language

**Closing the interview...**

Thank the family for sharing their experiences.

Explain how they can get in touch with the research team if they have any thoughts or concerns after the interview.

Explain how they will find out about the results of the research.
Professional Interview Topic Guide

Can you start by confirming what your role is and your employer?
Probes – confirm role, employer, how long they have been in this role.

Experience of zero-day admissions
We are interested in unplanned or emergency hospital admissions in children, particularly zero-day admissions. By zero-day admissions, we are referring to situations where a child is admitted and then discharged from hospital on the same day (less than 24 hours). This does not include overnight stays.

Can you tell me about your experiences of zero day admissions of children?
Probes: frequency; typical reasons for them; referral sources – self, GP, NHS 111 etc; conditions, different decision makers (e.g. junior or senior paediatrician, A+E doctor, nurse practitioner) any other care pathways that we haven’t talked about.

[When mentioned] Could I just clarify your understanding of the terminology.
  1. NHS 111 and NHS 24 (difference between these two) – start with whichever they mention first
  2. How does an emergency department differ from A+E and from minor injuries? - start with whichever they mention first

Have you had experience (may be personal - family - which is OK) of any other hospital(s) / emergency services for children in Scotland? Are there any differences?

HOSPITAL STAFF ONLY. Please tell me about your experiences of receiving referrals for/admitting/r a child where you suspected they did not need to be admitted to hospital.
(Probe – can you give me a specific example...)

COMMUNITY STAFF ONLY Can you think of any examples of where a child was admitted to hospital where you thought it was inappropriate?

Do you think that any hospital admissions of less than 24 hours could be safely avoided?
(Probe – how?)

What involvement does the child and family have in the referral and admission decision-making process?

What role do the child and family’s circumstances have in the referral and admission decision-making process, if any?

What role do other staff in the hospital (probe - e.g. nurses, e.g. managers) or in the community (e.g. information from the GP about the family). Can you think of any examples?

Some people we have talked to refer to appropriate and inappropriate admissions. What are your thoughts about these terms....? What do you consider to be an appropriate referral of an unwell child to a hospital for a short (zero day) stay? Tell me about some of your experiences.
Readmissions
Can you think of occasions where a child was admitted to hospital for less than 24 hours and then required re-admission within a week or so for the same episode?

Tell me about your experiences of readmissions.
Probes: is this something that happens frequently/infrequently; when these types of readmissions do occur, what do you think are the reasons; factors which contribute to this; typical presentation – child/family)

Communication processes between the professional referring and the professional admitting child to hospital
Can you think of an example where communication, between the professional referring and the professional admitting child to hospital, went really well?
  o What helped?

Can you think of an example where communication, between the professional referring and the professional admitting child to hospital, did not run so smoothly?
  o What were the issues, what were the consequences, how could this be improved?

Question for Referrers only
Please tell me about your experiences of referring a child where you were uncertain if they needed to be admitted, to hospital.

  • how do families that you know feel about referral to hospital and short admissions of < 24 hours

What factors trigger a decision for you to refer a child [when you suspect a zero day admission might be the outcome]?
Probe: for example, the family/parental circumstances

Thinking about the range of different children and families who access our emergency care service:
  • Do family social issues have any impact on decisions (give examples)
  • Do language issues (such as when English is not the first language) have any impact on decisions to admit children?
  • Does the distance to hospital/transport issues/rurality have any impact on decisions to admit children?
  • What are your reflections on health inequalities or deprivation and the potential impact on children’s admissions, particularly short zero-day admissions?

If not already raised:
  • What about normally health children – as opposed to children with long-term conditions/complex health needs?
  • Do you have any personal experiences that you think may impact on your decision making of whether or not to admit a child? (could also ask in appropriate and inappropriate referrals).

Final questions- looking forward
Thinking about moving forward and zero day hospital admissions in children...
  • What would be your recommendations for change regarding admissions of less than 24 hours?
Probes- change in the short/medium/ longer term? Who, where, in what circumstances, training? Is there a potential role for VC and technology in preventing zero day admissions (share vignette)?

Vignette:
GP calls paediatric registrar in a large hospital
5 year old child with fever and worrying rash
Registrar calls consultant
Consultant assesses the child over VC with the GP and parent present
Decision not to give antibiotics
Safety netting put in place (i.e. if the rash spreads, fever becomes more frequent phone back)
Everyone happy

What are your thoughts?– (probe - benefits/risks/any unintended consequences)
• Are there any particular issues or health conditions you’d highlight for the next stages of our research?
• What do you think will be happening with children’s zero day admissions in 5 years’ time?
• Is there someone you work with/a clinician you know of who has views very different to yours with respect to admitting children to hospital. =Who do suggest we should be speaking to gain different perspectives on short (zero day) admissions? Would you be willing to approach them/ give them a leaflet/ and get back to me if they are interested?

Demographic questions
1. Which health board do you currently work in? (Will be given a code in our records)
2. Are you from that area originally? (Know people)
3. (GP – distance to nearest hospital)
4. What is your current job?
5. How many years of experience working in paediatrics do you have?
6. (If in Primary Care – Have you any experience working in hospital paediatrics?)
7. Do you have any post-grad qualifications in paediatrics? (e.g. DCH)
8. (Is English your first language?)
9. Do you speak any languages in addition to English?

If yes, please list languages:
10. Do you have experience of working in a health system outside of the UK?

If yes, please list countries:

11. Would you like to be informed of project publications?

12. Would you like to be invited to project dissemination event in November 2020?
Supplemental table one. How the most common ten composite diagnoses were defined using individual diagnoses categorised in the International Categorisation of Disease-10 (ICD-10).

<table>
<thead>
<tr>
<th>Condition/condition group</th>
<th>ICD-10 code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asthma</strong></td>
<td></td>
<td></td>
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<tr>
<td>J45.0</td>
<td>Predominantly allergic asthma</td>
<td></td>
</tr>
<tr>
<td>J45.9</td>
<td>Other and unspecified asthma</td>
<td></td>
</tr>
<tr>
<td>J46X</td>
<td>Status Asthmaticus*</td>
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<tr>
<td><strong>Bronchiolitis</strong></td>
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<td>J12.1</td>
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<tr>
<td>B34.9</td>
<td>Viral infection, unspecified</td>
<td></td>
</tr>
<tr>
<td><strong>Tonsillitis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J03.9</td>
<td>Acute tonsillitis unspecified</td>
<td></td>
</tr>
<tr>
<td>J02.9</td>
<td>Acute pharyngitis, unspecified</td>
<td></td>
</tr>
<tr>
<td>J03.8</td>
<td>Acute tonsillitis due to other organisms</td>
<td></td>
</tr>
<tr>
<td>J03.0</td>
<td>Streptococcal tonsillitis</td>
<td></td>
</tr>
<tr>
<td><strong>Lower respiratory tract infection</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J12.0*</td>
<td>Adenoviral pneumonia</td>
<td></td>
</tr>
<tr>
<td>J12.2*</td>
<td>Parainfluenza virus pneumonia</td>
<td></td>
</tr>
<tr>
<td>J12.8*</td>
<td>Other viral pneumonia</td>
<td></td>
</tr>
<tr>
<td>J12.9*</td>
<td>Viral pneumonia unspecified</td>
<td></td>
</tr>
<tr>
<td>J13X*</td>
<td>Pneumonia due to Streptococcus pneumoniae</td>
<td></td>
</tr>
<tr>
<td>J14X*</td>
<td>Pneumonia due to Haemophilus influenzae</td>
<td></td>
</tr>
<tr>
<td>J15.1*</td>
<td>Pneumonia due to Pseudomonas</td>
<td></td>
</tr>
<tr>
<td>J15.2*</td>
<td>Pneumonia due to Staphylococcus</td>
<td></td>
</tr>
<tr>
<td>J15.4*</td>
<td>Pneumonia due to other streptococi</td>
<td></td>
</tr>
<tr>
<td>J15.7*</td>
<td>Pneumonia due to Mycoplasma pneumoniae</td>
<td></td>
</tr>
<tr>
<td>J15.8*</td>
<td>Pneumonia due to other specified bacteria</td>
<td></td>
</tr>
<tr>
<td>J15.9*</td>
<td>Unspecified bacterial pneumonia</td>
<td></td>
</tr>
<tr>
<td>J18.0*</td>
<td>Bronchopneumonia unspecified organism</td>
<td></td>
</tr>
<tr>
<td>J18.1*</td>
<td>Lobar pneumonia, unspecified organism</td>
<td></td>
</tr>
<tr>
<td>J18.1D*</td>
<td>Lobar pneumonia with pleural effusion</td>
<td></td>
</tr>
<tr>
<td>J18.8*</td>
<td>Other pneumonia with effusion</td>
<td></td>
</tr>
<tr>
<td>J18.9*</td>
<td>Pneumonia, unspecified organism</td>
<td></td>
</tr>
<tr>
<td>J22X*</td>
<td>Unspecified acute lower respiratory infection</td>
<td></td>
</tr>
<tr>
<td><strong>Cough, wheeze or shortness of breath</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R05X</td>
<td>Cough</td>
<td></td>
</tr>
<tr>
<td>R06.2</td>
<td>Wheezing</td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------</td>
<td></td>
</tr>
<tr>
<td>R06.0</td>
<td>Dyspnoea</td>
<td></td>
</tr>
<tr>
<td>R06.8</td>
<td>Other abnormalities of breathing</td>
<td></td>
</tr>
</tbody>
</table>
Supplemental table two. Mean admissions per 1000 under 16 year olds for short stay admissions with the ten most common conditions stratified by health board. The number in brackets is the rank (1=highest)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Ayrshire and Arran</th>
<th>Borders</th>
<th>Dumfries and Galloway</th>
<th>Fife</th>
<th>Forth Valley</th>
<th>Grampian</th>
<th>Greater Glasgow and Clyde</th>
<th>Highland</th>
<th>Lanark</th>
<th>Lothian</th>
<th>Tayside</th>
<th>Coefficient of variation</th>
<th>Ratio of highest to lowest admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>1.14 (2)</td>
<td>0.40   (10)</td>
<td>0.68 (6)</td>
<td>0.27 (11)</td>
<td>0.53 (7)</td>
<td>0.41 (9)</td>
<td>0.98 (4)</td>
<td>0.88 (5)</td>
<td>1.42 (1)</td>
<td>0.42 (8)</td>
<td>1.00 (3)</td>
<td>50</td>
<td>5.3 5.3 2.8 3.6 8.6 10.1 4.5 6.2 5.0 8.6</td>
</tr>
<tr>
<td>Bronchiolitis</td>
<td>5.03 (1)</td>
<td>2.32 (4)</td>
<td>1.84 (8)</td>
<td>1.08 (11)</td>
<td>2.01 (7)</td>
<td>1.15 (10)</td>
<td>2.15 (6)</td>
<td>2.32 (4=)</td>
<td>3.29 (3)</td>
<td>1.28 (9)</td>
<td>4.25 (2)</td>
<td>52</td>
<td>4.7 4.7 2.8 3.6 8.6 10.1 4.5 6.2 5.0 8.6</td>
</tr>
<tr>
<td>Convulsions</td>
<td>1.48 (1)</td>
<td>1.26 (2)</td>
<td>0.83 (6)</td>
<td>0.60 (10)</td>
<td>0.87 (5)</td>
<td>0.79 (9)</td>
<td>0.81 (8)</td>
<td>1.07 (4)</td>
<td>0.82 (7)</td>
<td>0.53 (11)</td>
<td>1.24 (3)</td>
<td>31</td>
<td>31 40 55 64 38 45 59 60</td>
</tr>
<tr>
<td>Croup</td>
<td>2.04 (1)</td>
<td>1.23 (4)</td>
<td>1.37 (3)</td>
<td>0.57 (11)</td>
<td>0.78 (9)</td>
<td>0.83 (8)</td>
<td>0.85 (7)</td>
<td>0.75 (10)</td>
<td>1.21 (5)</td>
<td>0.53 (6)</td>
<td>1.61 (2)</td>
<td>40</td>
<td>40 40 55 64 38 45 59 60</td>
</tr>
<tr>
<td>Gastroenteritis</td>
<td>5.21 (1)</td>
<td>2.61 (4)</td>
<td>2.30 (5)</td>
<td>0.61 (11)</td>
<td>2.08 (6)</td>
<td>1.93 (7)</td>
<td>1.49 (9)</td>
<td>1.73 (8)</td>
<td>2.69 (3)</td>
<td>1.12 (10)</td>
<td>3.90 (2)</td>
<td>40</td>
<td>40 40 55 64 38 45 59 60</td>
</tr>
<tr>
<td>Upper respiratory tract infection</td>
<td>8.69 (1)</td>
<td>6.11 (2)</td>
<td>4.11 (4)</td>
<td>0.86 (11)</td>
<td>2.35 (7)</td>
<td>1.78 (10)</td>
<td>2.18 (8)</td>
<td>2.88 (6)</td>
<td>3.79 (5)</td>
<td>1.83 (9)</td>
<td>4.65 (3)</td>
<td>55</td>
<td>55 55 64 38 45 45 59 60</td>
</tr>
<tr>
<td>Viral infection</td>
<td>6.97 (1)</td>
<td>3.25 (8)</td>
<td>3.57 (7)</td>
<td>1.56 (11)</td>
<td>2.57 (9)</td>
<td>3.96 (5)</td>
<td>3.60 (6)</td>
<td>4.30 (4)</td>
<td>5.18 (2)</td>
<td>2.47 (10)</td>
<td>4.36 (3)</td>
<td>64</td>
<td>64 64 64 64 64 64 64 64</td>
</tr>
<tr>
<td>Lower respiratory tract infection</td>
<td>1.80 (1)</td>
<td>1.25 (5)</td>
<td>0.92 (7)</td>
<td>0.29 (11)</td>
<td>1.07 (6)</td>
<td>0.71 (8)</td>
<td>0.65 (9)</td>
<td>1.35 (3)</td>
<td>1.27 (4)</td>
<td>0.57 (10)</td>
<td>1.68 (2)</td>
<td>45</td>
<td>45 45 45 45 45 45 45 45</td>
</tr>
<tr>
<td>Respiratory symptoms</td>
<td>1.55 (5)</td>
<td>1.58 (4)</td>
<td>0.78 (9)</td>
<td>0.58 (11)</td>
<td>1.32 (7)</td>
<td>1.79 (6)</td>
<td>3.06 (1)</td>
<td>1.06 (8)</td>
<td>0.60 (10)</td>
<td>0.36 (12)</td>
<td>1.75 (3)</td>
<td>60</td>
<td>60 60 60 60 60 60 60 60</td>
</tr>
<tr>
<td>Tonsillitis</td>
<td>3.43 (1)</td>
<td>1.75 (4)</td>
<td>2.03 (3)</td>
<td>0.40 (11)</td>
<td>1.51 (5)</td>
<td>0.85 (8)</td>
<td>0.83 (9)</td>
<td>1.17 (7)</td>
<td>2.38 (2)</td>
<td>0.59 (10)</td>
<td>1.33 (6)</td>
<td>59</td>
<td>59 59 59 59 59 59 59 59</td>
</tr>
</tbody>
</table>

Coefficient of variation: 50
Ratio of highest to lowest admission: 5.3 5.3 2.8 3.6 8.6 10.1 4.5 6.2 5.0 8.6
Supplemental table three. Characteristics of the five Health Board cases. SSA=Short Stay Urgent Admission

<table>
<thead>
<tr>
<th>NHS Board</th>
<th>SSA/1000/y</th>
<th>Population density</th>
<th>Paediatric-specific Emergency Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health board 1</td>
<td>Higher than median</td>
<td>61.1</td>
<td>No</td>
</tr>
<tr>
<td>Health board 2</td>
<td>Lower than median</td>
<td>67.1</td>
<td>No</td>
</tr>
<tr>
<td>Health board 3</td>
<td>Lower than median</td>
<td>15.3</td>
<td>Yes</td>
</tr>
<tr>
<td>Health board 4</td>
<td>Higher than median</td>
<td>27.7</td>
<td>No</td>
</tr>
<tr>
<td>Health board 5</td>
<td>Lower than median</td>
<td>27.1</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Supplemental table four. The number of individuals who participated with interviews, stratified by parent or health care professional (and healthcare professional type) and health board.

<table>
<thead>
<tr>
<th>Boards</th>
<th>GP</th>
<th>Nurse (community)</th>
<th>Doctor (hospital)</th>
<th>Consultant (hospital)</th>
<th>Nurse (hospital)</th>
<th>Total Clinicians per board</th>
<th>Total families per board</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthboard 1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Healthboard 2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Healthboard 3</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Healthboard 4</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Healthboard 5</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Healthboard 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Healthboard 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Healthboard 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Healthboard 9</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Totals by type</td>
<td>10</td>
<td>5</td>
<td>7</td>
<td>10</td>
<td>16</td>
<td>48</td>
<td>21</td>
</tr>
</tbody>
</table>
Supplemental table five. Characteristics of clinicians interviewed, showing the range of experience in hospital paediatrics and knowledge of healthcare systems outside the UK. Data were not obtained in all 45 individuals interviewed.

<table>
<thead>
<tr>
<th></th>
<th>Mean year’s experience 18.8 (range 4-35) n=36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experience in hospital paediatrics</td>
<td>13/34</td>
</tr>
<tr>
<td>Post-graduate qualifications in Paeds</td>
<td>13/37</td>
</tr>
<tr>
<td>Worked in health system outside UK</td>
<td>11/38</td>
</tr>
</tbody>
</table>
Supplemental table six. Characteristics of the parents who participated in the interviews

<table>
<thead>
<tr>
<th>Chronic health condition</th>
<th>N=4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parent’s relationship to child:</strong></td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td>N=14</td>
</tr>
<tr>
<td>Father</td>
<td>N=1</td>
</tr>
<tr>
<td><strong>Gender of child:</strong></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>N=3</td>
</tr>
<tr>
<td>Male</td>
<td>N=12</td>
</tr>
<tr>
<td><strong>Age of child at time of admission:</strong></td>
<td></td>
</tr>
<tr>
<td>0-6 months</td>
<td>N=3</td>
</tr>
<tr>
<td>7-12 months</td>
<td>N=2</td>
</tr>
<tr>
<td>1-5 years</td>
<td>N=7</td>
</tr>
<tr>
<td>6-10 years</td>
<td>N=3</td>
</tr>
<tr>
<td>11-16 years</td>
<td>N=0</td>
</tr>
<tr>
<td><strong>Have other children</strong></td>
<td>N=11</td>
</tr>
<tr>
<td><strong>Special care baby unit admission</strong></td>
<td>N=4</td>
</tr>
<tr>
<td><strong>Two parents in household</strong></td>
<td>N=15</td>
</tr>
<tr>
<td><strong>Parents English first language (n= 30)</strong></td>
<td>N=29</td>
</tr>
<tr>
<td><strong>Parents born in UK (n= 30)</strong></td>
<td>N=28</td>
</tr>
<tr>
<td><strong>Average distance to GP (range), miles (Parental self-report)</strong></td>
<td>1.3 (0.25-4)</td>
</tr>
<tr>
<td><strong>Average distance to hospital (range), miles (Parental self-report)</strong></td>
<td>10.5 (0.8-25)</td>
</tr>
<tr>
<td><strong>Average SIMD 2020 Decile (range)</strong></td>
<td>5.1 (1-10)</td>
</tr>
<tr>
<td><strong>Average Rural Index 2016 (range)</strong></td>
<td>3 (1-7)</td>
</tr>
</tbody>
</table>
Figure one. Bar charts showing the number of all urgent admissions (left panel) and short stay urgent admissions of children less than 16 years old to hospital between 2015-2017 per 1000 under 16 year olds stratified by Scottish Index of Multiple Deprivation (SIMD) and Health Boards. SIMD1=most deprived. A&A=Ayrshire and Arran. D&G=Dumfries and Galloway. GGC=greater Glasgow and Clyde.
Figure two. Scatter plot comparing the number of short stay urgent admissions (SSA) per 1000 children per year in eleven Scottish Health Board and the number of readmissions within one month per 10000 children per year.
Figure three. Scatter plots comparing the number of short stay urgent admissions (SSA) per 1000 children per year in eleven Scottish Health Board and: the number of children per square mile (panel A); the number of General Practitioners (GPs) per capita (panel B); the typical distance from home to hospital (panel C): and the number of paediatric beds per 1000 children (panel D) in each Board.