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Predictors of fever-related admissions to a paediatric assessment unit (PAU), ward and re-attendances in a South London Emergency Department. The CABIN 2 study.

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Abstract

Objective To explore the risk factors for ward and Paediatric Assessment Unit (PAU) admissions from the emergency department (ED).

Design Prospective observational study.

Setting and patients Febrile children attending a large tertiary care ED during the winter of 2014-2015.

Main outcome measures Ward and PAU admissions, NICE guidelines classification, re-attendance to the ED within 28 days and antibiotic use.

Results A total of 1097 children attending the children's ED with fever were analysed. Risk factors for PAU admission were tachycardia (RR=1.1, 95 % CI (1-1.1)), ill-appearance (RR=2.2, 95 % CI (1.2-4.2)), abnormal chest findings (RR=2.1, 95% CI (1.2-4.3)), categorized as NICE Amber (RR 1.7 95 % CI (1.2-2.5)). Predictors of ward admission were a systemic (RR=6.9, 95% CI (2.4-19.8)) or gastrointestinal illness (RR=3.8, 95% (1.4-10.4)) and categorized as NICE Red (RR= 5.9, 95 % CI (2.2-15.3)). 30% of children at triage were incorrectly categorised for NICE risk status. Only 51 children had probable bacterial pneumonia (4.6%), 52 children had a proven UTI (4.2%), with just 2 (0.2%) positive blood cultures out of 485 (44%) children who received an antibiotic. 15 % of all children re-attended by 28 days and were more likely to have been categorised as Amber and had investigations on initial visit.

Conclusions Risk factors for PAU and ward admissions are different in this setting with high re-attendance rates and very low proportion of confirmed/probable serious bacterial infections. Future studies need to focus on reducing avoidable admissions and antibiotic treatment.

What is known about this topic

- The rate of serious bacterial infections in children presenting to an emergency department with fever is reported as low (7%).
- Acute admissions to paediatric units are paradoxically increasing, but length of stay is short (< 48 hours) highlighting the low-risk nature of the infections encountered.
- The NICE traffic light system for the feverish child are designed to rapidly identify the children aged less than 5 years with an increased risk of serious bacterial infection, but their implementation and compliance at triage has not been evaluated.

What this study adds

- Rates of bacteraemias (0.18%) in a children's emergency department are now substantially lower than reported in NICE 2013 Guidelines.
- The risk factors associated with admissions of children to the ward and those admitted to PAU are different.
- Admission and re-attendances could potentially be reduced by increasing PAU efficiency.

Introduction

Acute febrile illness is a common presentation to the children's Emergency Department (ED) [1]. In the largest study on a highly immunised population on febrile children in the ED, the likelihood of serious bacterial infection (SBI) was 7% [2]. Invasive infections such as bacteraemia were present in fewer than 1 in 250 febrile children under the age of 5 years [2]. Paradoxically, as rates of childhood SBI continue to fall, hospital admission rates have been increasing, particularly in infants with uncomplicated short-stay admissions for acute infections [3 4]. Improving the ability of ED clinicians to confidently 'rule-out' SBI in the ED could make a valuable contribution to rational decision-making and to reliably predict safe discharge.

The recently updated National Institute for Health and Care Excellence (NICE) guidelines for the management of fever in children under the age of 5 years rely on both subjective and objective clinical evaluations of the child, augmented by biomarkers (C-reactive Protein (CRP), White Blood Cell counts), to define three risk categories; Red (high), Amber (medium) and Green (low) [5]. These guidelines lack the support of large prospective studies to aid clinical decision-making relating to admission and safe discharge and they are also insufficiently sensitive or specific for the diagnosis of SBI [6]. There are alternative models demonstrating additional value of CRP that can discriminate effectively between pneumonia and other SBI but have no impact on patient outcome. [7] [8]

What poses an even greater challenge than recognising SBIs is correctly identifying low-risk children. If this is achieved, it would avoid unnecessary hospitalisation and medical interventions. A recent systematic review summarised the published studies using clinical prediction rules with specific emphasis on how they could be used to support the safe discharge of children from the ED. [9] To complement the available tools, an evidence-based clinical algorithm integrating Point-of-Care diagnostic tests (POCT), could aid the admission and discharge decision-making process for children with low-risk infections and significantly

reduced attendance times [10 11]. Improved diagnostics may also have a role in rationalising antibiotic prescribing in children and reduction in chest x-rays performed. [12] [13 14].

We present a prospective observational study in a busy tertiary children's ED during one winter season to explore risk predictors for hospital admission in low-risk febrile children including secondary outcomes of antibiotic prescription, investigations performed, time spent in the ED and applicability and accuracy of the NICE guidelines at triage.

Methods

St George's Hospital Children's ED is a tertiary level unit with over 35,000 annual attendances. Prior to commencing the study, ED triage staff were trained in the use of the NICE Traffic Light System.[5 15] All children younger than 16 years of age presenting to the children's ED with fever ($\geq 38^{\circ}\text{C}$) or parental report of fever were eligible for inclusion. Only children with significant chronic comorbidities (e.g. sickle cell disease, cancer, immunodeficiencies) were excluded. Data were collected from October 2014 to March 2015.

Clinical information was systematically collected using a standard ED pro-forma and included variables from the NICE fever guidelines [5 15]. Data on time of arrival and transfer discharge were also collected. In addition, antibiotic prescriptions before, during and after ED care were documented. Diagnoses were categorised by clinical syndromes: respiratory, gastrointestinal, urinary and systemic illness (illness affecting more than one system). Bacterial infection was defined as: any microbiological cultured confirmed result (urine, blood, CSF, respiratory) and/or radiological consolidation in the absence of microbiological respiratory specimens. All clinical care and investigations were performed at the discretion of the attending clinician following local clinical protocols and guidelines.

Outcome measures

The main outcome of the study was to explore the determinants of admission to the paediatric ward and the paediatric assessment unit (PAU) which is adjacent to the main ED, where children can receive care for up to 24 hours. Secondary outcomes included compliance with the NICE guidelines[15], ED re-attendance rates within 72 hours and within 28 days, re-admission to the ward after re-attendance, final confirmed diagnosis or exclusion of SBIs (pneumonia, meningitis, urinary tract infection, bacteraemia) and departmental outcomes such as patient hours in the department (including PAU), antibiotic prescription rates and investigations performed.

Data Analysis

Data was entered in ACCESS 2013 (Microsoft®) and analysed in STATA (*Stata Statistical Software: Release 13*. College Station, TX: StataCorp LP). Crude associations between the main outcomes of interest and potential explanatory candidates were investigated using a univariate analyses. P-values less than 0.05 considered statistically significant. Multivariable logistic regression analyses (multinomial or ordinal) were constructed using backward, forward, stepwise selection or a combination of them. Models choice criteria such as Akaike Information Criterion (AIC) were used. Criteria for goodness of fit such as Hosmer-Lemeshow were employed to check the appropriateness of the best selected model. Survival analysis was also employed to infer the daily cumulative probability of ED re-attendance. Patterns in the missing data have been assessed and multiple imputation (MI) techniques [16] were performed under missing at random assumption (MAR) [17]. Test-training analysis was applied to evaluate the performance of NICE classification. This analysis the best model performance on the available data.

Ethics

Ethics approval was sought from the St George's University Hospitals NHS Foundation Trust R&D department. Informed consent was not necessary because data on routine clinical episodes were collected anonymously as part of a service evaluation of the management of acute febrile illness in the children's ED and there was no intervention.

Results

Data summary

A total of 1,117 children with fever were recruited to the study and 1,097 children were included in the final analysis (**Figure 1**). The median age of febrile children was 2 years (IQR 1-4 years). 49% of all children were categorised as Green (low-risk), 45% as Amber (medium-risk) and 5% as Red (high-risk) according to the NICE guidelines. 805 (73.3%) children attending the ED with fever were sent home. Forty percent had an investigation performed and 44% had antibiotics either prior to attendance or prescribed in the ED. (**Table 1**)

Clinical results and length of stay

Respiratory illnesses were responsible for 73% of the final diagnoses. (**Table 2**). Gastrointestinal illnesses (80, 7.2%) were the next most common, followed by systemic illnesses (76, 6.9 %) and urinary tract illnesses (38, 3.4 %).

Overall rates of culture-confirmed bacterial infections were low (56/1,097, 5.1 %) and only two (0.18 %) were bloodstream infections. Of the microbiological samples taken, 2/140 (1.4%) blood, 52/217 (24%) urine and none (0/18) of the CSF cultures were positive, while 2/18 (11%) throat swab cultures were positive for group A streptococci (GAS) and 22/58 (37.9%) nasopharyngeal aspirates were RSV positive. One patient with a positive blood culture (*S. pneumoniae*) also had consolidation on CXR.

Children in the main ED had a median length of stay of 3.3 hours (IQR 2.4-4) and those in PAU had a median length of stay of 5 hours (IQR 2.4-9.3).

Compliance with NICE guidelines

Overall, 29% (153/536) of ‘Green children’, 46% (217/474) of ‘Amber children’ and 73% (36/49) of ‘Red children’ had at least one investigation performed in the ED.

Associations with NICE categories by ascending order of severity (red>amber>green) before and after adjusting for potential confounders are shown in **Table 3**. As per test-training analysis, NICE categories were correctly assigned in 70% (767/1,097) of children (**Supplemental Table 1**).

PAU and paediatric ward admission predictors

Figure 2 summarises the different predictors for PAU and ward admission. Overall children admitted to the ward were more ill appearing and tachypnoeic than those admitted to PAU, who were more tachycardic and likely to have a gastrointestinal illness. Children admitted to both places were more likely to have had an investigation.

Short stay admissions (<48 hours)

Short-stay ward admissions (<48 hours) were considered as surrogate markers for potentially avoidable admissions. Overall, 62/123 (51%) ward admissions were short stays. When presenting to the ED, children with short-stay admissions were less likely to appear unwell, have investigations performed or receive antibiotics, but more likely to have a respiratory illness compared to those admitted for ≥ 48 hours (**Supplemental Table 2**).

Re-attendance to the ED

Of the children discharged from the ED, re-attendance rates at 72 hours and 28 days were 9% (103/1097) and 15% (163/1097), respectively. Of the 103 children re-attending at 72

hours NICE categories on initial attendance were; 41 (7.6 %), Green, 56 (11.8%) Amber and none Red . The highest cumulative probability of re-attendance was among children triaged in the Amber category who had investigations performed during their initial visit to the ED (**Figure 3**). Children who appeared ill and those with a gastrointestinal presentation were also more likely to re-attend. Of the 163 re-attenders, 26 % (n=42) were admitted to the ward on their second visit to the ED. The rest were discharged home

Discussion

In this large observational study, we have confirmed the extremely low proportion of culture confirmed bacterial infections (5%) from our first CABIN study [18] and also identified predictors for hospitalisation in previously healthy children with community-onset fever attending a busy paediatric ED. Significant clinical differences were found between children admitted to either the ward or PAU compared to those who were discharged home from the main ED. As per our test-training model, overall, 30% of children were misclassified at triage mainly as a result of medium-risk children (Amber) being classified as low-risk (Green), without impact on clinical or departmental outcomes. Given the relatively low rates of confirmed or suspected bacterial infections in febrile children (bacteraemia 0.2%, UTI 4.7%, GAS tonsillitis 0.1% and radiological consolidation 4.6%), antibiotic prescription rates were disproportionately high (44%). Only 26 % of children attending the ED with fever were admitted to the PAU (15%) or the ward (11%). Of the 805 children who were discharged home, 9% returned within 72 hours and 15% within 28 days. Children who re-attended were more likely to have been categorised as Amber risk at triage and had investigations performed at the initial ED visit and, of the re-attenders, 26% were subsequently admitted to the ward.

Previous studies have found the NICE traffic light system as having poor discriminatory ability for identifying SBI in febrile children [19]. In our cohort, in spite of the low culture confirmed bacterial infections, it was reassuring to note that both bacteraemias found were categorised as

high-risk or “red” and managed accordingly. We did find a considerable proportion of triage misclassifications (30%), which is likely to be the consequence of subjective assessment at triage. This could reflect our approach to NICE as a triage tool and limiting its use to nursing staff and not other clinical staff. The Traffic light system in our study was also applied to children of all ages and not only under five years of age. Despite this, subjective assessment that was in theory ‘missclassified’ had no adverse clinical outcomes. Tachypnoeic children who were otherwise well, for example, were often triaged as “Green” instead of “Amber” or “Red”. Increasing staff triage training, with the use of NICE at triage, could improve risk classification and might help identify medium-risk children more rapidly. **(Figure 4)** Other triage tools, like the Manchester score rely on similar parameters for risk-stratification of the patient. [20]

The strength of this study relies mostly on the multi-level results from a large cohort of febrile children attending a busy tertiary ED. This gives valuable information on disposition, re-attendance and antibiotic use. Our low rates of bacteraemia (1.8/1000 febrile attendances) are comparable to those recently reported in a large UK center (1.4/1000 all attendances) [21], making our results generalizable across the UK. We acknowledge as a limitation the lack of information regarding attendances to other hospitals and primary care providers that could increase our estimate of re-attendance rates. Also the study ran over 6 months only limiting the seasonality of the associations found. However our results on bacteraemia

There are only limited published retrospective data on PAUs in a UK setting. [22] PAUs are a safe alternative to short-stay hospitalisation where stabilisation, observation, diagnosis, treatment and discharge can reasonably be expected within 24 hours [23], such as managing dehydration, monitoring orthopaedic injuries and treating asthma exacerbations [24-28]. A recent systematic review describing PAU structure and function in the United States revealed great heterogeneity in mean length of stay (10-35 hours), inpatient admission rates, re-attendance and costs [23]. The American College of Emergency Physicians introduced the concept of an ‘observation failure,’ defined as an admission to the ward after a period of

observation or after unscheduled re-attendance, with admission rates of >30% from PAU to the ward considered unacceptably high [29]. In our cohort, only one child (0.5 %) ‘failed’ observation on the PAU and was admitted to the ward, whilst 24/169 children (14%) re-attended the ED within 72 hours of being discharged from PAU. The median length of stay in PAU was 5 hours after an average 4 hour stay in the main ED. Our findings highlight clear differences in the characteristics of children admitted to the ward compared to those admitted to PAU, with the former being sicker overall with systemic illnesses and receiving more clinical interventions, including antibiotics. This separation could help shape future interventions for service improvement, with ample opportunities to optimise the care of children admitted to PAU. We observed, for example, that clinical reviews in PAU were irregular and highly variable in their timings, especially at night. Standardising the timings of nursing and clinical assessments, using pre-defined checklists, for example, could significantly reduce PAU length of stay and allow for earlier discharges with appropriate safety net advice (**Figure 4**).

Re-attendance rates found in our cohort (15%) were high. Children that re-attended had not been categorised as high risk in their initial presentation and were mostly low or medium risk. Unplanned reattendances at 72 hours (9%) were higher than previously described in the UK (4-5%). [30] Exploring potential causes for this, we found associations between baseline investigations and re-attendance suggesting that the children were initially sufficiently unwell to warrant a work-up but were subsequently discharged because of normal or pending results. Their re-attendance is therefore likely to be a consequence of safety net measures whereby parents are advised to return to the ED if their child’s condition deteriorates. However only 26 % of these re-attenders were subsequently admitted to the ward. Other possible explanations for re-attendance include parental anxiety, diagnostic uncertainty at initial ED visit and low-threshold for referrals from primary care among recent ED attenders. Integrating qualitative research to understand the social determinants of re-admissions is essential for developing implementation tools (e.g. educational interventions) to reduce unnecessary re-attendances.

We also identified a clear need to reduce antibiotic prescriptions in the ED. Implementing strategies for antibiotic use reduction include a web-based tool for respiratory infections in primary care [31 32]. The integration of point-of care tests in the ED (**Figure 4**) may reduce the diagnostic uncertainty and the amount of investigations, leading to unnecessary use of empiric antibiotics.[33]

Conclusions

There has been a considerable literature to-date focussing on the now rare SBI in the febrile child. In the resource rich setting we suggest that the focus should now shift towards how best to identify the very common low risk children, who can be safely discharged back to the community without antibiotics. Data from this observational study could be used to develop integrated pathways to reduce PAU and ward admissions in children with self-limiting infections.

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Table 1. Characteristics of 1,097 children attending the Children's Emergency Department with fever.

Variables	N (%)
Demographic	
Sex	
Females	516 (47.1)
Males	581 (52.9)
Age	
median years (IQR)	2 (1,4)
<1 yo	225 (20.5)
1-2 yo	415 (37.8)
3-5 yo	264 (24.0)
>5 yo	193 (17.5)
Clinical Parameters	
Fever	
Reported (< 38 ° C at triage)	529 (48.6)
Documented (≥38 ° C)	568 (51.4)
Duration of fever	
< 24 h	30 (2.75)
1-2 days	676 (62.1)
>3 days	391 (35.6)
Investigations	
Total	436(39.7)
Blood culture	141(12.8)
Urine culture	217(19.7)
CSF culture	18 (1.6)
NPA	70 (6.3)
Chest X-ray	177(16.1)
ED process outcomes	
NICE categories	
Green	536 (48.8)
Amber	474 (44.7)
Red	49 (4.6)
Visit to the GP <72 h	
Yes	476 (43.4)
No	621 (56.6)
Patient referral	
Home	942 (85.9)
GP	144 (13.1)
Urgent care	7 (0.64)
Hospital	4 (0.36)
Disposition	
Home	805 (73.3)
PAU	169 (15.4)
Ward	123 (11.2)
Length of stay	
Main ED (median hours, IQR)	3.3 (2.4,4)
PAU (median hours, IQR)	5 (2.4-9.3)
Ward	
< 48 h	62 (50.4)
< 72 h	90 (73.1)
Re-attended ED	
72 h	103 (9.39)
28 days	163 (14.8)

Table 2. Diagnosis by system clinical syndrome for 1,097 children attending the Children's Emergency Department with fever, categorised by NICE "Traffic Light" categories.

Clinical syndrome	Total N=1097 (%)	GREEN N=536 (50 %)	AMBER N=474 (44.7 %)	RED N=49 (4.6 %)
Respiratory	808(73.6)	393(73.3)	364(76.7)	28(57.1)
Gastric	80(7.2)	41(3.7)	32(6.7)	4(8.1)
Urinary	38(3.4)	13(2.4)	21(4.4)	3(6.1)
Systemic	76(6.9)	28(5.2)	32(6.7)	10(20.4)
Other	43(3.9)	24(4.4)	14(2.9)	3(6.1)

Table 3. Predictors of NICE traffic light system by multivariable ordinal logistic model. Ascending order of severity (green <amber <red)

	Unadjusted OR	95 % CI	<i>P value</i>	Adjusted OR*	95 % CI	<i>P value</i>
Age				1.01	(1.01-1.02)	<0.001
Ill appearing	4.50	(3.00-6.75)	<0.001	2.71	(1.69-4.33)	<0.001
Temperature	2.31	(2.03-2.64)	<0.001	2.00	(1.69-2.37)	<0.001
Respiratory rate	1.06	(1.05-1.07)	<0.001	1.04	(1.02-1.06)	<0.001
Heart rate	1.04	(1.03-1.04)	<0.001	1.03	(1.02-1.04)	<0.001
Rash	1.97	(1.39-2.79)	<0.001	1.82	(1.20-2.76)	0.004
Chest findings	2.14	(1.55-2.96)	<0.001	0.60	(0.34-1.06)	0.082
Grade of doctor**	1.95	(1.44-2.63)	<0.001	1.82	(1.29-2.56)	0.001
Chest exam *age	-	-	-	1.01	(1.00-1.02)	0.016
Ill* temperature	-	-	-	0.60	(0.41-0.86)	0.007

*Multiple chain imputation assuming the data are missing at random (MAR).

**Paediatric Specialist registrar vs any other grade (junior doctors, consultants, GPs, clinical fellows).

Figure legends

Figure 1: Flowchart of recruitment of patients.

Figure 2: Relative risk factors for admissions to the ward vs home (A), PAU vs home (B) and PAU vs ward (C). Different colours represent different reference for RR=1. The three different panels per group represent the three different multinomial models for each outcome. Gr= Green by NICE guidelines; Amb= Amber per NICE guidelines; Red=Red per NICE guidelines; SPR= Specialist paediatric registrar; Rash*age= interaction term; Gastro= gastrointestinal illness; Uro=urinary illness; Resp=respiratory illness; Syst= systemic illness.

Figure 3: Predicted daily cumulative probabilities of re-attendance to the ED by NICE category in children that had investigations on the first visit (PanelA) and children that did not have investigations (Panel B).

Figure 4: Suggested points of intervention for implementation