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Variability in Hospital Admission Rates for Neonates With Fever in North Carolina

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Abstract

Background. Despite multiple guidelines recommending admission, there is significant variation among emergency departments (EDs) regarding disposition of neonates presenting with fever. We performed a statewide epidemiologic analysis to identify characteristics that may influence patient disposition in such cases within North Carolina. *Methods*. This study is a retrospective cohort study of infants 1 to 28 days old with a diagnosis of fever presenting to North Carolina EDs from October 1, 2010, to September 30, 2015, using data from the NC DETECT (North Carolina Disease Event Tracking and Epidemiologic Collection Tool) database. We analyzed various patient epidemiology characteristics and their associations with patients being admitted or discharged from the emergency room setting. *Results*. Of 2745 unique patient visits for neonatal fever, 1173 (42.7%) were discharged from the ED, while 1572 (57.3%) were either admitted or transferred for presumed admission. Age, sex, region within North Carolina, and the presence of a pediatric service did not significantly influence disposition. An abnormal documented ED temperature was associated with higher likelihood of admission ($P < .01$). The size of the hospital was also found to be significant when comparing large with small hospitals ($P < .01$). Government-funded insurance was associated with lower likelihood of admission ($P < .01$). *Conclusions*. A high number of neonates diagnosed with fever were discharged home, inconsistent with current recommendations. An association with a government-funded insurance represents a possible health care disparity. Further studies are warranted to further understand these variations in practice.

Keywords

neonates, fever, emergency

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Introduction

Febrile neonates (≤28 days) represent a common reason for visits to the emergency department (ED).[1,2] The source of the fever may be as benign as a self-resolving viral illness or represent a more serious bacterial infection (SBI) such as bacteremia, meningitis, urinary tract infection, pneumonia, or osteomyelitis. The non-specific symptoms and inconsistent examination findings can make diagnosis of SBIs difficult.[3-5]

With the potential for poor outcomes, and with the proven lack of accuracy of the commonly available complete blood count to screen for possible SBI,[6-9] it has long been advised that febrile neonates undergo a complete septic workup and hospitalization for empiric antibiotics.[10] Various algorithms and guidelines have been developed to further stratify febrile infants according to risk[11-13]; however, studies have shown inconsistent results with regard to their accuracy in the inherently high-risk neonatal age group.[14-19] The original guidelines such as the Boston, Philadelphia, and Rochester studies are >20 years old. At the time of these guidelines, SBI rates in neonates were as high as 20%,[20] but

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recent studies cite lower rates, with 2.8% to 3.1% for bacteremia and 1% or lower for bacterial meningitis.[21-23] Some have proposed that these long followed guidelines are in need of an update, including changes such as lowering the age of the high-risk group to 21 days[24] and utilizing procalcitonin assays in medical decision making.[24,25]

The above issues may help explain the large variation of practices with regard to the febrile infant workup and disposition in the ED.[26-29] Variation has been demonstrated in testing, treatment, and disposition from these studies.

Hospitalizations for febrile neonates from the ED have ranged from 78% to 84%[26,27,29] despite the guidelines that advise admission. Only 54% of pediatric emergency directors report full compliance with these published guidelines in the febrile neonate age group.[30] In response to the variation in hospital practice, the American Academy of Pediatrics is currently conducting a nationwide quality improvement project to reduce variability in infant sepsis evaluation that reinforces that neonates be admitted regardless of risk factors.[31]

To our knowledge, there has not been a statewide epidemiological analysis of variation in practices with regard to neonatal fever. While focusing on disposition, we hypothesized that there would be variation in hospital practices based on patient and ED visit characteristics, such as expected source of payment.

Methods

Data Source

For this retrospective cohort study, ED visit data were obtained from the North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT). NC DETECT is a statewide syndromic surveillance system run by the North Carolina Division of Public Health in collaboration with the University of North Carolina at Chapel Hill to address the need for early event detection and timely public health data. NC DETECT collects data from all 24/7civilian hospital-affiliated EDs in North Carolina. All data are de-identified, with assignment of unique patient identifiers that permit tracking of both ED visits and revisits.

Ethics Approval and Informed Consent

The Institutional Review Board at the University of North Carolina waived the need for ethics approval and the need to obtain consent for the collection, analysis, and publication of the retrospectively obtained and anonymized data for this non-interventional study.

Study Population

All neonates with ages ranging from 1 to 28 days presenting to a participating ED from October 1, 2010, through September 30, 2015, were eligible for inclusion. Neonates <1 day were excluded, as these infants likely represent a population managed by the neonatal intensive care unit as opposed to the ED. A diagnosis of fever was then obtained by using the following International Classification of Diseases, Ninth Revision, Clinical Modification codes: 780.6 (fever and other physiologic disturbances of temperature regulation), 780.60 (fever, unspecified), 780.61 (fever presenting with conditions classified elsewhere), and 778.4 (other disturbances of temperature regulation of newborn). Patients were only included in the final analysis if there was a documented disposition code of admitted, discharged, or transferred.

ED transfers are assumed to be for the purpose of admission and were counted as such. Other dispositions were excluded: died (3), left against medical advice (32), left without being seen (44), observation (3), or documented as "other disposition, not elsewhere defined" (121).

Study Definitions

Hospital size was defined as small (1-99 beds), medium (100-249), or large (250+).[32] For geographical reference, the 7 NC DETECT regions were utilized as they are already incorporated into the database (Figure 1). Neonatal hypothermia was defined as less than 36.5°C,[33] while fever is universally defined as equal to or greater than 38.0°C. An abnormal neonatal temperature included both fever and hypothermia. There are 10 hospitals with pediatric EDs in North Carolina. A revisit was defined as a return visit to the ED within 3 days of an initial ED evaluation.[26]

Data Analysis

Selected patient characteristics were summarized as median and interquartile range (IQR) for continuous variables and percentages for categorical variables.

Pearson's χ^2 and Fisher's exact tests (for variables with expected cell counts <5) were used to compare categorical variables. Logistic regression was used to examine the relationship between hospital admission and patient characteristics and summarized using unadjusted odds ratios (ORs) and adjusted ORs (aORs) and 95% confidence intervals (CIs). For the multivariate analysis, insignificant variables were progressively omitted using a backward elimination procedure. Adequacy of the fit

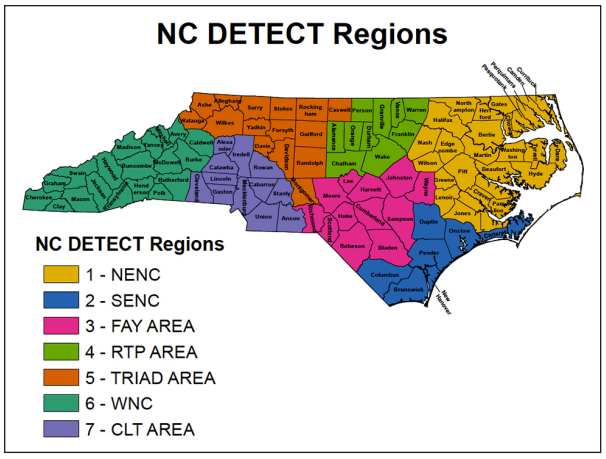

Figure 1. NC DETECT predesignated regions within North Carolina. NENC, Northeastern North Carolina; SENC, Southeastern North Carolina; FAY, Fayetteville; RTP, Research Triangle Park; WNC, Western North Carolina; CLT, Charlotte.

was assessed by estimation of the model deviance statistics. The final model was adjusted for age, sex, temperature, payment, hospital size, and hospital type. Statistical analysis was performed using JMP software (version 12.1.1; SAS institute, Inc, Cary, NC). Statistical significance was set at a 2-tailed $P < .05$.

Results

During the 5-year study period, a total of 41 059 neonates ages 1 to 28 days were evaluated in an ED in North Carolina. Of these, 3003 were diagnosed with a fever syndrome. There were 23 patients with return visits, totaling 46 visits all together, which were removed from the cohort for separate analysis as they were assumed to be a continuation of the disease process from the initial visit. Within the return visit group, no statistically significant trends were revealed. This resulted in 2957 unique visits for neonatal fever.

On exclusion of other disposition groups, a final cohort of 2745 neonates was produced (Figure 2). Discharges accounted for 1173 visits (42.7%), admissions accounted for 1253 visits (45.6%), and transfers for 319 visits (11.6%). As previously noted, transfers were considered to be equivalent to admissions for the purposes of analysis. Therefore, the total admission rate for this study is 57.3%.

Annual admission rates for 2010 to 2015 through the course of the study were 61%, 65%, 61%, 51%, 46%, and 63%. The median age was 18 days, with 58% of patients being male. Among payment sources, 67% were

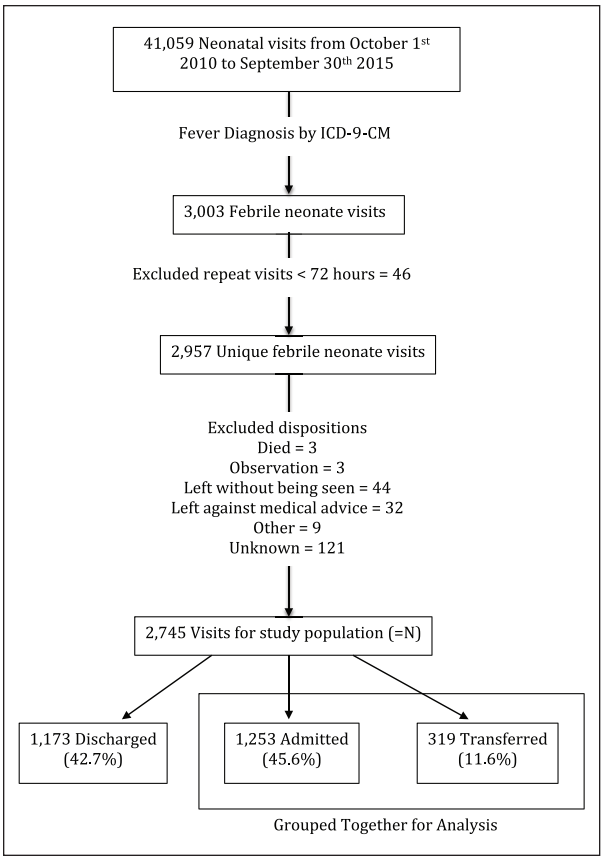

Figure 2. Derivation for study population.

covered by a government-funded insurance, 20% by private insurance, and 13.4% by self-pay. The NC DETECT region with the largest proportion of neonatal visits was RTP (Research Triangle Park), a region that includes the North Carolina state capital (Table 1).

Initial χ^2 analysis revealed initial ED temperature, region, expected source of payment, hospital size, and hospital type to be significant factors in disposition ($P < .001$; Table 2). When calculating unadjusted ORs, initial ED temperature, expected source of payment, hospital size, and type remained significant ($P < .001$; Table3). A final multivariate analysis confirmed initial ED temperature, expected source of payment, and hospital size as significant predictors of disposition ($P < .001$; Table 3).

Abnormal initial ED temperature was associated with higher likelihood of admission, while government-funded insurance was associated with lower likelihood of admission. Nearly twice as many neonates were discharged home as compared with neonates with commercial insurance (aOR = 0.51, 95% CI = 0.44-0.60; Table 3). Being evaluated at a large hospital resulted in

Table 1. Selected Characteristics of Neonates With a Diagnosis of Fever: North Carolina, 2010 to 2015.

Total	N = 2745[a]
Age (days), median (IQR)	18 (12-24)
Age (categorical), n (%)	
1-7 days	338 (12.3)
8-14 days	647 (23.6)
15-21 days	786 (28.6)
22-28 days	974 (35.5)
Sex, n (%)	
Female	1159 (42.2)
Male	1586 (57.8)
Initial ED temperature, n (%)	
Abnormal	587 (44.1)
Normal	743 (55.9)
Not available	1415
Region, n (%)	
NENC	264 (9.9)
SENC	175 (6.6)
FAY	344 (12.9)
RTP	612 (22.9)
TRIAD	547 (20.5)
WNC	127 (4.8)
CLT	598 (22.4)
Total	2667
Missing	78
Expected source of payment, n (%)	
Government	1585 (66.7)
Commercial	475 (20.0)
Self-pay	318 (13.4)
Total	2378
Missing	367
Hospital size, n (%)	
Large	1781 (64.9)
Medium	775 (28.2)
Small	155 (5.6)
Stand-alone ED	34 (1.2)
Hospital type, n (%)	
Pediatric hospital	1356 (49.4)
Non-pediatric hospital	1389 (50.6)
Disposition, n (%)	
Admitted	1572 (57.3)
Discharged	1173 (42.7)

Abbreviations: IQR, interquartile range; ED, emergency department; NENC, Northeastern North Carolina; SENC, Southeastern North Carolina; FAY, Fayetteville; RTP, Research Triangle Park; WNC, Western North Carolina; CLT, Charlotte.
[a]The columns total to 100%.

significantly more admissions when compared with evaluations at a small hospital.

When isolating hypothermic patients with initial ED temperatures $<36.5°C$, there was a 50% admission rate.

Discussion

This is the first statewide specific analysis of disposition practices for febrile neonates seen in an emergency room setting.

Although prior literature has established a wide variation, the results of this study reveal a much more significant discrepancy between guidelines and clinical practice within North Carolina. An admission rate of 57.2% is one of the lowest published admission rates for febrile neonates. Given the fact that transfers were considered as likely admissions, the percentage of admissions would be even lower if transfers were removed. Although no outcome data were available for this study, it has been shown that hospitals with lower rates of admissions for febrile neonates experience higher 3 day revisits with subsequent hospitalizations.[26]

We can only surmise why the percentage of admission is so low. It may include provider knowledge gaps regarding guidelines, provider knowledge of a low incidence of bad outcomes, or inability to perform clinical skills such as neonatal intravenous placement and lumbar punctures.

Perhaps the most striking finding was the significance of payer on admission rates. It is unclear why government-funded insurance types had significantly lower admission rates. This finding contradicts prior studies, which found a more intuitive trend of Medicaid patients having higher admission rates, with the presumption that these patients often require more inpatient resource utilization given possible poor access to care and outpatient follow-up.[34,35] This may represent a possible health disparity as it may reflect different approaches to patients based on payer or represent unwillingness or inability to explain or encourage appropriate care to certain patient populations.

A documented abnormal temperature was associated with higher admission rate. The accuracy of parental reported tactile fevers has long been debated, particularly if a neonate is afebrile at time of ED evaluation and well appearing. Studies have found varying conclusions. One recent large study found a lower risk of SBI in neonates with only parental reported fever when compared with neonates found to be febrile in the ED. However, given the small risk reduction, the authors concluded that they would be unlikely to alter decision making.[36] Another large study comparing absence or presence of fever in the ED found no significant difference in rates of invasive bacterial infections in infants less than 90 days old.[37] When divided into weeks of life, age was not significant in this study.

Visits to a large hospital were associated with significantly more admissions than visits to a small hospital.

Table 2. Selected Characteristics of Neonates With a Diagnosis of Fever, Stratified by Disposition: North Carolina, 2010 to 2015.

	Admitted, n (%)	Discharged, n (%)	Total, n	*P*
Total[a]	1572 (57.3)	1173 (42.7)	2745	
Age (categorical)				.06
1-7 days	196 (58.0)	142 (42.0)	338	
8-14 days	398 (61.5)	249 (38.5)	647	
15-21 days	443 (56.4)	343 (43.6)	786	
22-28 days	535 (54.9)	439 (45.1)	974	
Sex				.13
Female	683 (58.9)	476 (41.1)	1159	
Male	889 (56.1)	697 (43.9)	1586	
Initial ED temperature				<.001
Unknown	724 (51.2)	691 (48.8)	1415	
Abnormal	435 (74.1)	152 (25.9)	587	
Normal	413 (55.6)	330 (44.4)	743	
Region				<.001
NENC	158 (59.8)	106 (40.2)	264	
SENC	84 (48.0)	91 (52.0)	175	
FAY	216 (62.8)	128 (37.2)	344	
RTP	440 (71.9)	172 (28.1)	612	
TRIAD	286 (52.3)	261 (47.7)	547	
WNC	36 (28.3)	91 (71.4)	127	
CLT	312 (52.2)	286 (47.8)	598	
Expected source of payment				<.001
Government	892 (56.3)	693 (43.7)	1585	
Commercial	360 (75.8)	115 (24.2)	475	
Self-pay	185 (58.2)	133 (41.8)	318	
Hospital size				<.001
Stand-alone ED	19 (55.9)	15 (44.1)	34	
Small	65 (41.9)	90 (58.1)	155	
Medium	404 (52.1)	371 (47.9)	775	
Large	1084 (60.9)	697 (39.1)	1781	
Hospital type				<.001
Pediatric hospital	828 (61.1)	528 (38.9)	1356	
Non-pediatric hospital	744 (53.6)	645 (46.4)	1389	

Abbreviations: ED, emergency department; NENC, Northeastern North Carolina; SENC, Southeastern North Carolina; FAY, Fayetteville; RTP, Research Triangle Park; WNC, Western North Carolina; CLT, Charlotte.
[a]The rows total to 100%.

The size of a hospital may represent a proxy for teaching hospital status, increased pediatric volumes, and more subspecialty care availability. Each of these characteristics have been shown to lead to increased compliance with national pediatric guidelines, or increased preparedness for pediatric emergencies.[38-40]

There was significant variation in practice across local regions in the state. A pediatric service at the hospital was found not be significant despite the assumption that this factor would contribute to higher compliance with guidelines. It is possible that an individual provider's background training significantly affects clinical decision making with regard to febrile infants. Multiple studies have shown that those with training in pediatrics are more likely to admit febrile infants when compared with adult emergency and family medicine physicians.[41-43]

Though the definition of neonatal hypothermia is not universally agreed upon, there was no increased rate of admission for neonates with documented low temperature in the ED. Future studies are warranted to further elucidate a more specific definition of neonatal hypothermia and the risk of sepsis.

A significant portion of patients were noted to be self-pay. It is possible that on entrance to the ED the patients were noted to be self-pay but they may have

Table 3. Unadjusted and Adjusted Odds Ratios of Potential Predictors of Hospital Admission Among Neonates With a Diagnosis of Fever: North Carolina, 2010 to 2015.

	Crude OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*
Age				
1-7 days	1.13 (0.88-.145)	.33	1.05 (0.79-1.42)	.70
8-14 days	1.31 (1.07-1.61)	.01	1.15 (0.91-1.45)	.23
15-21 days	1.06 (0.88-1.28)	.55	1.09 (0.88-1.35)	.43
22-28 days	REF		REF	
Sex				
Female	1.13 (0.97-1.31)	.13	1.08 (0.91-1.29)	.36
Male	REF		REF	
Initial ED temperature				
Unknown	0.84 (0.70-1.00)	.05	0.78 (0.63-0.97)	.02
Abnormal	2.29 (1.81-2.89)	<.001	3.43 (2.53-4.68)	<.01
Normal	REF		REF	
Region				
SENC	0.62 (0.42-0.91)	.01		
FAY	1.13 (0.81-1.57)	.46		
RTP	1.72 (1.27-2.32)	<.001		
TRIAD	0.74 (0.55-0.99)	.04		
WNC	0.27 (0.17-0.42)	1.00		
CLT	0.73 (0.55-0.98)	.04		
NENC	REF			
Expected source of payment				
Government	0.41 (0.33-0.52)	<.001	0.51 (0.40-0.66)	<.01
Self-pay	0.44 (0.33-0.60)	<.001	0.58 (0.42-0.80)	<.01
Commercial	REF		REF	
Hospital size				
Stand-alone ED	1.16 (0.58-2.32)	.67	0.59 (0.27-1.29)	.18
Small	0.66 (0.47-.094)	.02	0.49 (0.33-0.72)	<.01
Medium	0.70 (0.59-0.83)	<.001	0.76 (0.59-0.99)	.04
Large	REF		REF	
Hospital type				
Pediatric hospital	1.36 (1.17-1.58)	<.001	1.00 (0.77-1.28)	.99
Non-pediatric hospital	REF		REF	

Abbreviations: OR, odds ratio; CI, confidence interval; ED, emergency department; SENC, Southeastern North Carolina; FAY, Fayetteville; RTP, Research Triangle Park; WNC, Western North Carolina; CLT, Charlotte; NENC, Northeastern North Carolina.

been enrolled in Medicaid by time of disposition. The data from the time frame of this study mostly predates the affordable care act.

Limitations

There were several limitations of this study.

The largest limitation was incomplete documentation of measured temperature available in the database. However, because our study population was derived from actual discharge diagnosis codes for fever and not from initial triage complaints, we would expect that those infants who presented simply tactile fever, which the treating provider determined non-concerning, or with other complaints that did potentially warrant a sepsis workup, would have been initially excluded from our study population.

The use of diagnosis codes predisposes this study to misclassification bias.

Although this study included neonates found to have hypothermic temperatures, we did not include the diagnosis code of hypothermia of a newborn (P80.9) during data collection.

There is lack of covariates available in the data. Insurance status was found to be significant in this study but is also likely a proxy for other socioeconomic factors that this study could not take into account. This study is only a preliminary analysis and warrants further studies to analyze this relationship in a prospective manner.

There was very limited access to clinical data, such as examination findings, clinical decision making, workup, antibiotic usage, and eventual outcomes. We were unable to exclude high-risk patients given this lack of clinical data. We also cannot comment on trends or outcomes in the 23 patients with return visits. There were 3 expired patients excluded from our study population, but otherwise we cannot comment on any deaths that may have occurred after evaluation in the ED.

This is a statewide study including both rural and large urban hospitals. The data from North Carolina has limited generalizability to other states.

Author Contributions

Winston Wu MD conceived and designed the analysis, collected data, performed analysis, and wrote the paper. Katie Harmon PhD conceived and designed the analysis, performed analysis, and edited the paper. Anna Estelle Waller ScD conceived and designed the analysis, and edited the paper. Courtney Mann MD FACEP FAAP conceieved and designed the analysis, and edited the paper.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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