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Pediatric Interfacility Transfers – Association of Pre-transfer Vital Signs with Length of Stay at a Tertiary Care Center

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ORIGINAL RESEARCH

Pediatric Interfacility Transfers: Association of Pre-Transfer Vital Signs with Length of Stay at a Tertiary Care Center

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Introduction: We set out to determine which abnormal pre-transfer vital signs predict longer length of stay (LOS) for pediatric patients transferred to a tertiary care center.

Methods: A retrospective study of all patients transferred to Maine Medical Center's pediatric inpatient units, pediatric intensive care unit, and emergency department with pediatric consult during a six-month period. Charts were examined for pre-transfer vital signs and diagnosis. The primary outcome of interest was LOS. Vital signs were determined to be normal or abnormal using the 2015 Pediatric Advanced Life Support Guidelines.

Results: Two hundred thirty-six pediatric patients were included. Median LOS was 42.5 hours; median age was 67.5 months. Patients with abnormal respiratory rates (RRs) before transfer had significantly longer LOS than patients with normal RRs ($p = 0.017$). Abnormal heart rate, temperature, and oxygen saturation did not predict LOS. Abnormal blood pressure (BP) predicted a significantly longer LOS ($p = 0.035$), although BP was only obtained from 47.9% of patients.

Discussion: The predictive value of an abnormal vital sign in pediatric patients at pre-transfer hospitals varied. In our tertiary care center, RR significantly correlated with LOS, whereas heart rate, temperature, and oxygen saturation did not. While abnormal BP was only captured in fewer than half of patients, it was associated with longer LOS.

Conclusions: With more consistent monitoring in children, BP may be a good predictor of LOS after transfer. These results may help guide decision-making by both referring and accepting providers.

Key Words: interfacility transfer, pediatric, vital signs, length of stay

Most children evaluated in emergency departments (ED) are seen in community hospitals (89%) rather than larger tertiary institutions.[1,2] This situation often leads to the transfer of children from smaller EDs to tertiary care facilities for access to specialist care and pediatric-focused resources.[2] Rural patients are 1.6 times more likely to be transferred than urban patients.[3]

Interhospital transfers are time-consuming, burdensome, and expensive. These transfers require hours of travel and may involve helicopter transport. Also, many patient caregivers feel that physicians lack awareness of the stress placed on families during transfer.[4] In 2012, the total cost of pediatric hospitalizations admitted via transfer was $19.5 billion.[3] A recent study found an average hospital charge to be US $4843 per transferred pediatric patient.[2] There is variability between institutions in the percentage of transferred patients who are discharged either directly from the receiving ED or within 12 hours of admission. One study also found that more than a quarter of those transferred patients did not have any further diagnostic work-up, and they were discharged within 12 hours of arrival.[2] Another study found that of the 24,905 pediatric patient transfers evaluated over a year, just over 24% of these patients were

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discharged from the tertiary care center's ED.[5] At a pediatric level I trauma center, 10% of pediatric trauma patients transported by ground ambulance were discharged directly from the ED.[6] Importantly, many patient transfers are for patients who need access to the specialized care that is available only at the receiving hospitals. With over 27 million visits by children to US EDs annually, evidence-based decision support may better predict the clinical course and acuity of patients being considered for transfer.[7]

Prior studies explored many aspects of pediatric transfers, such as provider type, diagnostic category, family-physician interactions, injury severity, urgent care center transfers, and cost. [2,4,8,9,10] However, the reasoning behind the referring provider's decision to transfer is less well studied. According to a nationwide study on pediatric interfacility transfers published in *Pediatrics*, understanding the reasons for transfer in the context of the entire health-care system could improve pediatric care outside of academic centers.[5]

Vital signs are objective data points used to evaluate the clinical status of children and inform decision making. However, we do not know if pre-transfer vital signs in the referring hospital can help predict the clinical course at a tertiary care center. Our objective in this study was to determine which abnormal pre-transfer vital signs predict longer length of stay (LOS) for pediatric patients at the receiving facility.

METHODS

Study design, setting, and selection of participants

A retrospective single-center analysis of pediatric (0–18 years old) patients that were transferred to the Barbara Bush Children's Hospital at Maine Medical Center (MMC), a 637-bed academic hospital located in a small urban setting. The pediatric patients were transferred to the Pediatric Inpatient Unit (IPU), Pediatric Intensive Care Unit (PICU), Pediatric Short-Stay Unit (PSSU), and MMC's ED for evaluation by the Pediatric Hospitalist Service between August 2016 and January 2017. Vital signs were obtained from pre-transfer paperwork. Diagnostic category, medical complexity, unexpected transfer from IPU to PICU in 24 hours, and LOS were calculated after review of MMC's electronic health record. This study was determined to not be human subjects research by the MMC Institutional Review Board.

Patients were excluded from this study if they:

1. Were transferred from home or an outpatient office (n = 51), as this study focused only on ED, urgent care center, and rare community IPU transfers. Community IPU transfers were included because of their similar need for more specialized resources.
2. Died during admission (n = 2), as the LOS was the primary outcome of interest, and death would artificially create a shorter admission.
3. Were back-transferred from a quaternary facility, as it was a planned part of the treatment process and not for a higher level of care (n = 9).

Methods and measurements

Vital signs. Data included pre-transfer vital signs located in scanned pre-transfer documentation, automatic electronic health record communication, and/or Maine's statewide health information exchange tool, HealthInfoNet. For each vital sign, we used the age-stratified normal values outlined in the 2015 Pediatric Advanced Life Support (PALS) guidelines.[11]

When obtaining pre-transfer vital signs, the most abnormal value was selected for each individual vital sign. We used this approach because vital signs often changed throughout the patient's stay at the referring hospital, either improving with treatment or worsening with clinical deterioration. For example, many patients who entered the ED with an elevated temperature were often afebrile upon transfer because they received an antipyretic. These patients were still being transferred to a tertiary care center with concern of fever, even though the vital sign was stable at the time they arrived. This same theory applied to respiratory rate (RR) and oxygen saturation after supplemental oxygen administration. For body temperature, records inconsistently stated the "method" by which temperature was obtained. To avoid overstating the number of patients with fevers or hypothermia, temperatures of less than 35.5ºC or greater than 38.0ºC were considered abnormal. For heart rate (HR), patients were considered awake unless stated otherwise. PALS does not provide a set of normal values for peripheral capillary oxygen saturation (spO_2). Using common medical consensus, spO_2

was considered abnormal when ≤ 92%, or when no room-air oxygen saturation was recorded and the patient was placed on high flow supplemental oxygen (n = 2).

Any patient who did not have a vital sign listed was excluded from that individual vital sign's evaluation. If the physician specifically described the patient in their physical exam as "febrile," "tachycardic," and/or "tachypneic" (11 individual vital signs, 9 patients total), the vital sign was counted as abnormal.

Complexity. The Center of Excellence on Quality of Care Measures for Children with Complex Needs (COE4CCN) Medical Complexity[11] algorithm was used to assign all patients to three complexity subgroups: non-chronic condition, non-complex chronic condition, and complex chronic condition.

Diagnosis. A diagnostic category was determined for each patient based on the diagnosis upon discharge from MMC. Diagnostic categories were determined by the study team.

Analysis. Data were summarized descriptively as median (range) or frequency (n,%) as appropriate, both overall and after stratification by study subgroup. Categorical data were compared between study subgroups by a chi-square test, and continuous data were compared by Mann-Whitney U test or Kruskal-Wallis test, as appropriate. The relationships between continuous variables were explored by Spearman's correlation. All analyses were performed using SPSS statistical software, version 25 (IBM SPSS Inc., Armonk, NY).

RESULTS

Two hundred thirty-six pediatric patients who transferred to MMC met the inclusion criteria and were entered into the study. Table 1 reports demographic data. Median LOS was 42.5 hours; median age was 67.5 months (5.6 years). Of all patients, 107 were admitted through transfer to MMC's ED (not direct), 51 were directly admitted to the PICU, and 78 to the Pediatric IPU or PSSU. Discharge from the tertiary care center ED and unexpected transfer from MMC IPU to PICU were also examined. Thirteen (5.5%) of the 236 patients were discharged from MMC's ED, whereas 10 (4.2%) were unexpectedly transferred from the IPU to the PICU within the first 24 hours of arrival. Seventy-three patients (30.9%) were discharged in less than 24 hours.

Most vital signs were reliably obtained (HR, 93.6%; RR, 90.7%; temperature, 87.3%; spO_2, 92.4%). However, only 47.9% had a recorded BP. When compared to LOS, each vital sign had a different predictive value. As shown in Table 2, a patient with an abnormal RR before transfer had a significantly longer LOS than a patient with a normal RR (61 vs. 38 hours, p = 0.017). However, in the small subgroup of patients discharged directly from the ED (LOS range of 2.8–5.9 hours), there was no significant difference between normal and abnormal pre-transfer RRs. A patient with an abnormal BP prior to transfer also had a significantly longer LOS than a normal pre-transfer BP (57 vs. 31 hours, p = 0.035). Abnormal HR, temperature, and spO_2 alone did not correlate with LOS.

Vital signs were analyzed in subgroup analyses. When controlling for temperature, there was no significant difference in LOS for patients with abnormal pre-transfer HRs. The relationships between LOS and both abnormal RR and spO_2 were adjusted for respiratory diagnosis and medical complexity (Table 3). Results showed there was still a significant difference in median LOS between abnormal and normal RRs prior to transfer (105.6 vs. 85.8 hours, p = 0.012). Oxygen saturation was not significantly different.

We also examined other measures of the transfer process, such as ED discharge from the tertiary care center in less than 24 hours, as well as unexpected transfer to the PICU or quaternary hospital from the IPU in less than 24 hours (Table 4). Out of the 8 patients transferred to the PICU/quaternary hospital in 24 hours, 6 patients had an abnormal RR.

The relationship between a recorded BP and age was also compared. Younger patients were less likely to have a recorded BP ($p \leq 0.001$). Patients with a collected BP had a median age of 12.2 years, and those without a BP had a median age of 1.5 years (Table 5).

In addition, LOS varied significantly between complexity groups (p = 0.018). The median LOS for the non-chronic subgroup was 38.6 hours (n = 118), the non-complex chronic was 41.9 hours (n = 80), and the complex chronic group was 66.2 hours (n = 38) (Table 1).

Table 1. Demographic and clinical characteristics of pediatric patients transferred to MMC. (N=236)

Variable	Median [range], or n (%)
Age (months)	67.5 [0–225]
LOS (hours)	42.5 [2.6–1392]
Male sex	122 (51.7)
Medical complexity	
Non-chronic	118 (50.0)
Non-complex chronic	80 (33.9)
Complex chronic	38 (16.1)
Admission type	
Direct to IPU/PSSU	78 (33.1)
Direct to PICU	51 (21.6)
Not direct	107 (45.3)
Primary diagnosis	
Respiratory	70 (29.7)
Seizure	13 (5.5)
Altered mental status	14 (5.9)
Intoxication	16 (6.8)
Musculoskeletal complaint	12 (5.1)
Skin or soft-tissue infection	13 (5.5)
Fever; r/o sepsis, serious bacterial	24 (10.2)
Gastrointestinal	17 (7.2)
Renal	6 (2.5)
Cardiac	9 (3.8)
Oncology	6 (2.5)
Diabetic ketoacidosis	13 (5.5)
Other	23 (9.7)
Length of stay	
< 6 hours	4 (5.9)
6–12 hours	14 (5.93)
Total <12 hours	28 (11.9)
12–24 hours	45 (19.1)
Total <24 hours	73 (30.9)
Early discharge/transfer	
Discharge from MMC ED	13 (5.5)
Transfer to PICU within 24 hours	10 (4.2)
Transfer to other hospital within 24 hours	1 (0.4)

Table 2. The relationship between LOS and abnormal vital signs.

Vital signs	n	Length of stay (hours) median [range]	p-value*
Heart rate			
Normal	118	43.9 [2.6–1393]	0.90
Abnormal	103	43.4 [2.8–1150]	
Respiratory rate			
Normal	127	38.0 [2.6–1393]	0.017
Abnormal	87	61.4 [2.9–739]	
Temperature			
Normal	148	42.5 [2.6–1393]	0.40
Abnormal	58	54.7 [2.8–359]	
Blood pressure			
Normal	26	31.2 [3.6–1393]	0.035
Abnormal	87	57.4 [2.6–739]	
Oxygen saturation			
Normal	175	43.0 [2.6–173]	0.73
Abnormal	43	51.9 [2.9–359]	

*Mann-Whitney U test

Table 3. The relationship between abnormal respiratory rate, oxygen saturation, and LOS (adjusted for respiratory diagnosis and medical complexity).

Vital sign	n	Length of stay (hrs) Mean (95% CI*)	p-value Unadjusted†	p-value Adjusted‡
a. Respiratory rate				
Abnormal	87	105.6 (78.2–133.0)	0.017	0.012
Normal	127	85.8 (54.7–116.8)		
b.Oxygen saturation				
Abnormal	43	73.5 (518–95.2)	0.73	0.54
Normal	175	100.0 (74.2–125.7)		

*Confidence Interval

†Mann-Whitney U test

‡Analysis of covariance; adjusted for respiratory diagnosis (yes/no) and medical complexity. LOS data are not normally distributed and were converted to ranks for calculation of the adjusted p-value.

Table 4. The distribution of discharge/transfer status by vital sign status.

Vital sign status	Discharge/Transfer Status n (%) Inpatient	ED discharge	Transfer to PICU/ Tertiary hospital <24 hours n (%)
Heart rate			
Normal	106 (89.8)	4 (3.4)	8 (6.8)
Abnormal	93 (90.3)	7 (6.8)	3 (2.9)
Respiratory rate			
Normal	118 (92.9)	7 (5.5)	2 (1.6)
Abnormal	76 (87.4)	5 (5.7)	6 (6.9)
Temperature			
Normal	137 (92.9)	5 (3.4)	6 (4.1)
Abnormal	50 (86.2)	5 (8.6)	3 (5.2)
Blood pressure			
Normal	22 (84.6)	2 (7.7)	2 (7.7)
Abnormal	83 (95.4)	2 (2.3)	2 (2.3)
Oxygen saturation			
Normal	162 (92.6)	7 (4.0)	6 (3.4)
Abnormal	34 (79.1)	5 (11.6)	4 (9.3)

Table 5. The relationship between blood pressure data collection and patient age.

BP collection	n	Age (months) median [range]	p-value*
Collected	112	147 [0–225]	<0.001
Not collected	123	18 [0–213]	

*Mann-Whitney U test

DISCUSSION

This study explored the relationship between pre-transfer vital signs at referring community hospitals and LOS at our accepting tertiary care center. We found that only abnormal RR and BP correlated with increased LOS. Patients transferred to the PICU within 24 hours also had abnormal RR. These findings are consistent with previous research showing that a higher peak RR was more predictive of respiratory decompensation in infants with bronchiolitis.[13] In our population, nearly a third of patients had a respiratory diagnosis on discharge. However, even after controlling for both respiratory diagnosis and medical complexity, there was still a significant difference in LOS between abnormal and normal RRs prior to transfer. This result supports that an abnormal pre-transfer RR may predict a longer LOS regardless of diagnosis. According to a previous study, RR is the most difficult vital sign to measure accurately in pediatric patients.[14] Our results support that RR must be consistently monitored while patients are in the ED.

Although abnormal BP was associated with longer LOS, BP was obtained in fewer than half of the patients. This low collection rate may indicate selection bias, as 77% of BPs acquired were abnormal. This finding suggests that only less-stable patients had their BP obtained prior to transfer. The disproportionately low percentage of recorded BPs in younger children was an interesting result in this study. Our findings are consistent with previous research that showed measurement of BP in children ranges from 23–89%, depending on the institution.[15] Another study indicated that the wide variation in measuring BP results from equipment variability and differences in operator technique.[16] BP is also unique because it is has two values that must be considered when determining if the vital sign is abnormal or normal. As a potentially useful predictor of post-transfer LOS, community hospitals may consider investing in pediatric equipment and training for staff to obtain accurate BPs.

Another interesting finding in this study was the lack of association between LOS and abnormal pre-transfer HR, temperature, and spO_2. We further analyzed HR and found that fever is not the confounding variable. Instead, fear, pain, and dehydration, among other factors, cause children to be tachycardic when they are not otherwise clinically deteriorating. As for the lack of association between spO_2 and LOS, we suspect that the ability for children to maintain a normal spO_2 during many respiratory illnesses may have led to the relatively low number of abnormal values. Prior research found that hypoxemia is a good predictor of decompensation in infants with bronchiolitis; however, this study contained patients with a broad range of respiratory and non-respiratory diagnoses.[13]

In addition, the data support that there is a notable percentage of pediatric patients who are transferred to tertiary care centers and only admitted for short periods of time. In this study, under a third (30.9%) of patients were discharged within 24 hours of being transferred, and 11.9% after 12 hours. While another study found that approximately a quarter of transferred pediatric patients were discharged within 12 hours, this percentage varies greatly by hospital.[2] Identifying the factors that predict quick stabilization, supporting discharge to home, or that predict clinical deterioration, may help to develop decision-support tools that assist community EDs in determining who to transfer and who to hold and observe, potentially saving families the cost and stress associated with hospital transfer.

Limitations include that this is a single-center retrospective study, which may limit generalizability of findings. However, this approach gave us the ability to review charts in detail for each patient in the time period. Additionally, while this study includes all patients that were directly transferred to inpatient pediatric services, it does not include patients who were transferred to MMC's ED for evaluation by services other than the pediatric hospitalist service, or patients transferred to MMC's ED and discharged from the ED by emergency physicians without pediatric consultation. However, most pediatric transfers were accepted by pediatric residents, and most of these patients had a pediatric consult while at MMC. This study also presents valuable strengths that support the conclusions. First, charts were obtained between August and January, capturing a variety of seasons (summer through winter) that are important considerations for a northern rural community. This wide range increased the generalizability to different time periods within the year. Also, this single-center study involved a tertiary care facility for a large portion of Maine and parts of New Hampshire. This unique perspective provides insight into the most and least severe cases requiring transfer over a large rural area.

Further research is needed to increase the generalizability of this study, such as the addition of other hospitals in various locations and within different environments. In future clinical practice, it may be worthwhile to create guidelines in which accepting pediatric providers obtain all five vital signs from the transferring physician before accepting the patient. This guideline would support further research on the correlation between another objective-composite measure of decompensation, such as Bedside Pediatric Early Warning System (BPEWS) and LOS.

CONCLUSIONS

This study demonstrates a significant association between both abnormal pre-transfer RR and BP with longer LOS in pediatric patients at a tertiary care facility. It also shows no significant correlation between LOS and abnormal HR, temperature, and spO_2. These results may help both referring and accepting providers to predict the clinical course for transferred patients from community hospitals.

Conflicts of Interest: None

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