High rate of missing vital signs data at triage in a paediatric emergency department

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BACKGROUND: Vital signs measurement is considered standard practice in paediatric emergency department triage assessment, but studies have shown variable incidence of missing data.
OBJECTIVES: To evaluate the rate of missing data for vital signs at triage and to determine clinical and environmental predictive factors.
METHODS: A retrospective cohort design was used to study a database of consecutive patients registered at a tertiary paediatric emergency department during randomly chosen shifts. Demographic and clinical data were collected. Univariate and multivariate logistic regression analyses were performed to evaluate the determinants of missing data for body temperature, heart rate, respiratory rate, blood pressure and pulse oximetry.
RESULTS: There were 2081 patients triaged during the study periods. On multivariate logistic regression analysis, triage level (from 1 = priority to 4 = nonurgent) was an independent predictor of missing data for heart rate, respiratory rate, blood pressure and pulse oximetry (OR 1.48 to 2.05). Patients visiting the emergency department during the day shift (OR 1.08 to 4.72) and the evening shift (OR 1.38 to 9.24) had a higher rate of missing data than those visiting during the night shift. A decreased level of consciousness, an immunocompromised state and referral by a physician did not meet statistical significance as predictive factors.
CONCLUSIONS: There was a high rate of missing data for vital signs. Factors related to patients' clinical characteristics, such as acuity of triage level, were associated with a higher rate of vital signs documentation at triage. An environmental factor, shift of presentation, was also independently associated with a higher rate.

Key Words: *Emergency; Triage; Vital signs*

Un taux élevé de données manquantes sur les signes vitaux au triage dans un département d'urgence pédiatrique

HISTORIQUE : La mesure des signes vitaux est considérée comme une pratique standard du triage au département d'urgence pédiatrique, mais les études révèlent une incidence variable de données manquantes.
OBJECTIF : Évaluer le taux de données manquantes sur les signes vitaux au triage et déterminer les prédicteurs cliniques et environnementaux.
MÉTHODOLOGIE : Une cohorte rétrospective a été utilisée pour étudier une base de données de patients consécutifs inscrits au département d'urgence d'un centre pédiatrique de soins tertiaires pendant des quarts de travail choisis au hasard. Des données démographiques et cliniques ont été colligées. Des analyses de régression logistique univariée et multivariée ont été effectuées pour évaluer les déterminants des données manquantes à l'égard de la température corporelle, de la fréquence cardiaque, de la fréquence respiratoire, de la tension artérielle et de l'oxymétrie.
RÉSULTATS : Deux mille quatre-vingt-un patients ont passé au triage pendant les périodes d'étude. D'après l'analyse de régression logistique multivariée, le niveau de triage (de 1 = prioritaire, à 4 = non urgent) était un prédicteur indépendant de données manquantes sur la fréquence cardiaque, la fréquence respiratoire, la tension artérielle et l'oxymétrie (RR 1,48 à 2,05). Les patients qui se rendaient à l'urgence pendant le quart de jour (RR 1,08 à 4,72) et le quart de soir (RR 1,38 à 9,24) présentaient un taux plus élevé de données manquantes que ceux qui s'y rendaient pendant le quart de nuit. La diminution du niveau de conscience, une immunosuppression et un aiguillage par un médecin n'atteignaient pas un taux statistiquement significatif à titre prédicteur.
CONCLUSIONS : Le taux de données manquantes sur les signes vitaux était élevé. Les facteurs reliés aux caractéristiques cliniques des patients, tels que l'acuité du niveau de triage, étaient associés à un taux plus élevé de documentation des signes vitaux au triage. Un facteur environnemental, soit le quart de travail à l'arrivée à l'urgence, était également indépendamment associé à un taux plus élevé.

The practice of emergency medicine is based on triage systems. Patients are usually evaluated on their arrival to the emergency department (ED) and their priority of treatment is decided according to their level of urgency rather than on a 'first-come, first-served' basis. The patient's level of acuity is determined by a combination of symptoms and a focused screening physical examination by the triage nurse. Performance of vital signs measurement (body temperature, heart rate, respiratory rate, blood pressure and pulse oximetry) is considered a standard part of the triage examination in both children and adults (1). However, little is known regarding the relevance of performing each of these vital signs measurements as a standard routine in all children presenting to the ED.

Previous articles have reported that missing data for vital signs is common in emergency medicine. For example, a study involving trauma patients (2) reported that 23% of patients did not have a temperature recording. In another study of paediatric emergency care (3), blood pressure measurement was measured in only 66% of the patients.

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Furthermore, in those patients with measurements, 52% had a measurement higher than the 90th percentile for age and sex, most of which had decreased considerably by the second measurement. As such, the routine measurement of all vital signs may be neither informative nor necessary in all patients. A recent prospective cohort study (4) evaluating the predictive value of the Paediatric Risk of Admission score reported a high incidence of missing vital signs data, the importance of which is unclear.

There are few studies evaluating factors predictive of missing data for vital signs measurement in paediatric EDs. The main hypothesis of the investigators in the present study was that there may be factors that contribute to the decision not to perform vital signs measurement at triage. The objectives of the present study were to evaluate the rate of missing data at triage for the measurement of each vital sign and to determine whether there were clinical, demographic or environmental factors predictive of not measuring the vital signs at triage in a paediatric ED.

METHODS

Study design

A retrospective cohort study of an established database was conducted.

Study setting

The study was carried out in a university-affiliated paediatric hospital. The hospital serves a catchment area for a population of approximately three million. The ED was staffed with medical students and paediatric, emergency and family practice residents supervised by paediatricians and board-eligible and board-certified paediatric emergency physicians. The ED annual census was approximately 65,000 patient visits. Patients were first triaged by registered nurses with at least six months of experience in the ED. They triaged the patients using a four-level institutional triage scale for the first seven months and the Paediatric Canadian Triage and Acuity Scale (PaedCTAS) for the last five months of the study. The policy of the ED mandates nurses to perform the routine baseline assessments, including all vital signs measurements, for every patient at triage and to document them in the patient's chart.

Study population

The study was conducted from November 1, 2000, to October 31, 2001. During this period, three shifts per month (one day [07:30 to 15:30], one evening [15:30 to 23:30] and one night [23:30 to 07:30]) were randomly selected using a computer-generated table. All consecutive patients registered to the ED during these periods were evaluated.

Data collection

The database was initially constructed to evaluate the predictive abilities of a severity assessment tool for paediatric EDs. Medical information prospectively collected by the investigator was that required for the calculation of the Paediatric Risk of Admission score (4). This score is based on 21 components gathered from medical history, physiological data and therapies. All of the data were prospectively collected by a single investigator (JG) not involved in the treatment of the patients. Baseline demographics and clinical variables were prospectively abstracted from chart review at many points in time (just after triage, after each evaluation by a nurse or a physician, on reception of blood results, and at the time when the physician filed a hospitalization request or discharged the patient). To minimize bias, nurses and physicians were made aware that a study was being conducted in the ED, but they were not informed of its purpose and hypothesis.

Outcomes

The primary outcomes were the absence of documentation for body temperature, heart rate, respiratory rate, blood pressure or pulse oximetry at the triage of the patients.

Independent variables

Independent variables were considered based on a consensus agreement of experts. Some variables were related to patients' characteristics (age, arrival by ambulance, being referred, being asthmatic, immunocompromised state and decreased level of consciousness), while others were related to environmental factors (waiting time to triage and time of visit to the ED [day, evening or night]). Finally, the level of triage (from 1 = priority [encompassing categories 1 and 2 of the PaedCTAS] to 4 = nonurgent [corresponding to level 5 in PaedCTAS]) was evaluated as an independent predictor.

Data analysis

Data were entered into a Microsoft Excel database (Microsoft Excel 2001, Microsoft Corporation, USA) and analyzed using SAS version 8.2 (SAS Institute Inc, USA). A univariate analysis using logistic regression was performed to detect independent variables associated with missing data for each vital sign (temperature, heart rate, respiratory rate, blood pressure and pulse oximetry). All variables that were statistically significant in the univariate analysis were evaluated in a multivariate analysis. A general rule of thumb stipulates that at least 10 observations are needed for each independent variable in an analysis using logistic regression. Considering that the existing database used for the study had 2081 patients, it seemed sufficient to evaluate the nine independent variables.

The study was approved by the Institutional Review Board of Centre hospitalier universitaire Sainte-Justine (Sainte-Justine UHC, Montreal, Quebec).

RESULTS

Study population characteristics

There were 64,509 patient visits to the ED from November 1, 2000, to October 31, 2001. During the randomly selected study periods, 2081 consecutive patients visited the ED; all of the patients have been included in this analysis. A description of the study population is outlined

in Table 1. The number of patient visits was similar between the day and evening shifts (n=858 versus n=994, respectively), which was considerably higher than the number seen in the overnight shift (n=229). The majority of patients (83.8%) were triaged as level 2 (urgent) or 3 (semiurgent). Most patients were walk-ins (94%) and were self-referred (83.7%). A very small proportion of patients was known to be immunocompromised (1.4%) or had an altered level of consciousness (0.8%).

Dependent variables

The temperature documentation was missing from the charts of 343 of 2081 patient visits (16.5±1.6%). Percentages of missing data were higher for heart rate (42.3±2.1%), respiratory rate (60.0±2.1%), blood pressure (69.3±2.0%) and pulse oximetry (74.1±1.9%).

Univariate analysis of the independent variables as a predictor of missing data for vital signs measurement

Univariate logistic regression was performed for each variable of interest, and the results are summarized in Table 2.

The variables of age, arrival by ambulance, referral by a physician, immunocompromised state, altered level of consciousness and waiting time failed to be predictive of missing data for most outcomes. Triage level was found to have a statistically significant association with vital signs documentation on univariate analysis. With respect to the shift of presentation, patients presenting during the evening shift had significantly higher ORs for missing vital signs data than did patients presenting during the night shifts (OR 1.25 to 7.90). A similar trend was seen for the day shift in comparison with the night shift, but it failed to reach statistical significance.

Multivariate analysis

Multivariate modelling was performed. Table 3 summarizes the ORs for the significant variables on the multivariate analysis. When the items that were significant on univariate analysis were subjected to multivariate analysis, the variables of triage level and shift of presentation remained significant. This means that patients with the highest acuity (lower triage level) had less missing data than those being triaged as nonurgent. Patients assessed during the evening nursing shifts were more likely to have missing data for their vital signs than were patients seen during the night nursing shifts. There was a trend toward a higher rate of missing data for patients seen during the day nursing shifts compared with patients seen during the night shifts, but this association failed to reach statistical significance for two of the five vital signs.

TABLE 1
Description of the study population (n=2081)

Age (years)	
Mean ± SD	5.1±4.7
Median (range)	3.3 (0–20.1)
First and third quartiles	1.3 and 8.0
Wait time to triage (min)	
Mean ± SD	21±23
Median (range)	15 (0–160)
First and third quartiles	5 and 30
Triage level, n (%)	
1 = priority	69 (3.3)
2 = urgent	746 (35.9)
3 = semiurgent	996 (47.9)
4 = nonurgent	270 (13.0)
Shift of presentation, n (%)	
07:30 – 15:30	858 (41.2)
15:30 – 23:30	994 (47.7)
23:30 – 07:30	229 (11.0)
Arrival at emergency department, n (%)	
Walk in	1958 (94)
Ambulance	123 (6)
Referral by a physician, n (%)	339 (16.3)
Immunocompromised state, n (%)	28 (1.4)
Decreased level of consciousness, n (%)	17 (0.8)
Missing data for temperature, n (%)	343 (16.5±1.6)
Missing data for heart rate, n (%)	921 (42.3±2.1)
Missing data for respiratory rate, n (%)	1249 (60.0±2.1)
Missing data for blood pressure, n (%)	1442 (69.3±2.0)
Missing data for pulse oximetry, n (%)	1542 (74.1±1.9)

DISCUSSION

The present study evaluated the factors associated with a higher risk of not recording vital signs measurements during triage assessment of paediatric patients visiting a university-affiliated paediatric ED. Characteristics associated with patients' clinical severity, including triage level, altered level of consciousness and arrival by ambulance, were highly correlated with documentation of vital signs measurements during triage in the univariate analysis.

Patient age failed to be a predictor for vital signs recording. This was in contrast with previous literature showing that, in many situations, the rate of missing vital signs data is lower for older children (3).

Interestingly, the shift of presentation (day, evening or night) was a significant predictor of vital signs documentation once adjusted for all other factors. In the present study, we have shown that patients visiting the ED in the evening were less likely to have their vital signs recorded than those arriving during the day shift, who were in turn less likely to have their vital signs documented than patients presenting during the night shift (adjusting for all clinical factors). Considerably more patients present to the ED during the day and evening shifts than during the night shift. Therefore, in an attempt to control for possible imbalance in the nurse-patient ratio during day and evening shifts as compared with the night shift, wait time to triage was used as a surrogate marker of the ED activity level. This is the time between registration at the ED and the actual time of triage. This was hypothesized to be a reflection of the nurse workload, with a higher wait time suggestive of nurse work

TABLE 2
Univariate logistic regression: Odds ratio (OR) of having missing data for temperature, heart rate, respiratory rate, blood pressure or pulse oximetry

Variable	Temperature OR (95% CI)	Heart rate OR (95% CI)	Respiratory rate OR (95% CI)	Blood pressure OR (95% CI)	Oximetry OR (95% CI)
Age (per year increase)	1.02 (1.00–1.06)	1.01 (0.99–1.03)	0.99 (0.98–1.01)	0.99 (0.98–1.01)	1.01 (0.99–1.03)
Wait time					
Less than 5 min (n=453)	33.5 (17.0–66.0)	1.51 (1.19–1.92)	1.70 (1.33–2.17)	0.92 (0.71–1.19)	2.20 (1.67–2.89)
5 min to 15 min (n=571)	7.6 (3.7–15.4)	1.21 (0.94–1.55)	1.14 (0.89–1.55)	0.85 (0.65–1.46)	1.43 (1.10–1.88)
15 min to 30 min (n=488)	3.3 (1.5–7.1)	1.24 (0.96–1.62)	1.11 (0.96–1.62)	0.85 (0.64–1.13)	1.45 (1.10–1.92)
More than 30 min (n=569)	1.00	1.00	1.00	1.00	1.00
Triage level (from 1 to 4)	0.93 (0.80–1.09)	1.91 (1.68–2.17)	1.36 (1.20–1.53)	1.64 (1.43–1.87)	1.63 (1.42–1.87)
Shift of presentation					
Day	4.23 (2.04–8.80)	1.20 (0.89–1.64)	1.90 (1.41–2.57)	1.06 (0.78–1.44)	1.81 (1.34–2.46)
Evening	7.90 (3.84–16.2)	2.16 (1.60–2.91)	3.89 (2.89–5.24)	1.25 (0.92–1.70)	2.42 (1.78–3.28)
Night (reference)	1.00	1.00	1.00	1.00	1.00
Arrival at ED by ambulance	3.09 (2.10–4.56)	0.40 (0.27–0.61)	0.78 (0.55–1.13)	0.44 (0.31–0.64)	0.66 (0.45–0.97)
Referral by a physician	1.33 (1.10–1.57)	1.03 (0.89–1.19)	0.96 (0.83–1.12)	0.89 (0.76–1.04)	1.05 (0.86–1.26)
Immunocompromised state	1.00 (0.001–999.9)	0.87 (0.69–1.11)	1.34 (1.00–1.92)	0.84 (0.67–1.04)	1.13 (0.84–1.52)
Altered level of consciousness	0.32 (0.04–2.4)	1.00 (0.001–999.9)	0.59 (0.23–1.53)	0.06 (0.01–0.26)	0.31 (0.12–0.80

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TABLE 3
Multivariate logistic regression: Odds ratio (OR) of having missing data for temperature, heart rate, respiratory rate, blood pressure or pulse oximetry

Variable	Temperature OR (95% CI)	Heart rate OR (95% CI)	Respiratory rate OR (95% CI)	Blood pressure OR (95% CI)	Oximetry OR (95% CI)
Wait time					
Less than 5 min (n=453)	35.15 (17.8–69.5)	1.51 (1.78–2.33)	1.69 (1.31–2.18)	0.91 (0.70–1.19)	2.24 (1.70–3.00)
5 min to 15 min (n=571)	7.45 (3.67–15.1)	1.24 (0.96–1.61)	1.13 (0.87–1.45)	1.87 (0.66–1.14)	1.48 (1.12–1.94)
15 min to 30 min (n=488)	3.32 (1.53–7.20)	1.25 (0.95–1.65)	1.11 (0.85–1.47)	0.85 (0.64–1.13)	1.50 (1.12–2.01)
More than 30 min (n=569)	1.00	1.00	1.00	1.00	1.00
Triage level (from 1 to 4)	0.98 (0.83–1.17)	2.05 (1.80–2.33)	1.48 (1.30–1.68)	1.67 (1.46–1.91)	1.74 (1.50–2.00)
Shift of presentation					
Day	4.72 (2.25–10.0)	1.28 (0.93–1.76)	1.98 (1.46–2.68)	1.08 (0.79–1.48)	1.92 (1.40–2.62)
Evening	9.24 (4.40–19.42)	2.54 (1.86–3.48)	4.26 (3.14–5.80)	1.38 (1.01–1.89)	2.73 (1.99–3.74)
Night (reference)	1.00	1.00	1.00	1.00	1.00

overload. However, adjusting for wait time to triage as a potential confounder did not change the association between missing data and shift of presentation. This result can be interpreted in several ways. First, in our institution, the experience and seniority of the nurses tend to be different in the different shifts involved, which could lead to differences in triage performance and completeness. Second, the use of wait time to triage may not be an appropriate surrogate marker for ED activity. Rather, the missing vital signs data may be a reflection that the nurses in triage visually monitor the volume of patients awaiting triage and choose to cut corners in the standard triage procedure to prevent a longer wait time to evaluation in triage. Whether this is appropriate remains unclear.

There are studies evaluating the contribution of vital signs data in the care of ED patients. For example, the utility of routine pulse oximetry measurement in paediatric triage was evaluated in a prospective study of 305 children, and found that in a small but clinically significant proportion, workup, therapy or decision to admit was changed by the provision of these vital signs data to physicians (5). Conversely, in one study where triage levels were assigned to patients before and after knowledge of vital signs information, only a minority of patients had their triage designations changed by knowledge of the vital signs (1). It is believed by some that complete vital signs assessment of all paediatric patients in triage is not useful and, furthermore, slows down the triage process. As such, the staff of one ED has published its hospital's vital signs policy, which outlines the patients it feels can safely be exempt from routine vital signs evaluation at triage (6). Despite the policy of performing vital signs measurement selectively in some institutions, the centre at which this study took place (Sainte-Justine UHC) has no such policy in place.

Selection bias in this study was prevented in a couple of ways. First, the shifts that underwent evaluation were selected randomly throughout the study period. Second, both the triage nurses and the data extractor were blinded to the study hypothesis.

A limitation of the study was that the outcome measured, missing vital signs documentation, could in turn influence some of the independent predictive factors examined. For example, unexpected heart rate values (either very high or very low) could influence the assigned triage level for the patient. However, it would be uncommon to have a triage level altered solely on the basis of one such clinical finding, as was shown in the vital sign study by Cooper et al (1). Also, the low incidence of some factors with high potential as independent predictors of low rates of missing data (eg, an immunocompromised state) limited our power to detect a statistically significant association with these variables. Another limitation comes from the fact that the recording performance of each individual nurse was not recorded. Consequently, we were unable to adjust for inter-rater variability for nurse's assessments. Finally, the present study was performed in a single tertiary care paediatric ED. There is a strong possibility that the rate of missing data would be very different in different settings according to their individual ED staffing variation, patient volume, acuity level and nursing protocol. This should be evaluated in a multicentre study.

CONCLUSIONS

The present study showed that the rate of missing data for vital signs at triage is high in the ED at the Sainte-Justine UHC. However, triage took place despite the absence of many vital signs recorded. Our data challenge the dogma that triage vital signs are 'vital'. The clinical necessity of recording all vital signs for all patients in paediatric ED should be further evaluated.

There are factors associated with a higher risk of not having vital signs measured at triage in a paediatric ED. Some factors are related to the patient's clinical severity, but others, notably the shift of presentation, are environmental and have little to do with the patient's clinical situation. The independent and elevated correlation between missing vital signs information and shift of presentation deserves a more thorough evaluation to identify possible ways to modify this situation. Future research is needed to find other factors that are the true determinants of triage acuity that the nurses use.

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ERRATUM

In the Evidence for Clinicians article entitled "In children with bacterial meningitis, does the addition of dexamethasone to an antibiotic treatment regimen result in a better clinical outcome than the antibiotic regimen alone?" (Paediatr Child Health 2006;11[1]:33-4), the dosage for dexamethasone should have read as follows: 0.4 mg/kg/d to 0.6 mg/kg/d divided into 4 doses daily for a duration of 4 days.

We apologize for this error and any inconvenience that this may have caused. We also thank the sharp eye of the fourth-year paediatric resident from Université de Montréal.