Shivering in Febrile Children: Frequency and Usefulness in Predicting Serious Bacterial Infections – A Prospective Case-Control Study

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A prospective case-control study was conducted in a pediatric emergency department to describe the proportion of febrile children experiencing shivering and its clinical significance. Shivering was reported in 186 of 645 febrile children (28.8%). The rate of serious bacterial infection was similar in 86 children with shivering and 86 matched controls. *(J Pediatr 2017;■■:■■-■■).*

Fever is a common complaint that, when localizing signs are absent, poses a diagnostic dilemma.[1] While examining a child with fever, classic signs of severe disease may not be apparent.[2] Serious bacterial infection (SBI) is defined as bacteremia, meningitis, pneumonia, osteomyelitis, septic arthritis, and pyelonephritis.[3] In an environment of low prevalence, as is the case with most developed countries, the positive predictive values of clinical parameters for SBI are low.[4]

Shivering (rigors, chills), a common phenomenon among febrile children, is the result of rhythmic, clonic activation of the head, neck, back, and upper limbs skeletal muscles mass. It has a vital function in raising the metabolic rate and in increasing body temperature.[5,6]

Shivering is presumed to be more common in children with SBIs. In the National Institute for Health and Care Excellence "traffic light" scale, used to identify children with fever and serious disease, shivering is considered an intermediate risk factor.[7] A systematic literature review uncovered only 1 study that investigated this assumption.[8] The authors concluded that shivering is associated with an increased risk of bacterial infection.[9]

Similarly, in the adult population, a single study concluded that shivering with fever had the highest clinical predictive value in assessing the risk of bacteremia.[10] The objectives of the present study were to describe the frequency of shivering among febrile children brought to an emergency department (ED), and to determine whether shivering with fever is associated with increased risk of SBI.

Methods

A prospective case-control study was conducted in a pediatric ED of a tertiary academic medical center in central Israel. Children, 3 months to 18 years of age, arriving at the ED with fever (>38°C) were studied. Enrollment occurred on randomly chosen days, in 24-hour periods starting at 7 a.m., between January and September 2016.

Inclusion criteria as a case was fever (>38°C, oral or rectal measurement) plus shivering reported by the caregiver or witnessed by the medical staff. Exclusion criteria were presentation after febrile convulsion, antibiotic treatment within 48 hours before presentation, known immunodeficiency, and non–Hebrew-speaking guardians. For each case in the study group, a match was made with the subsequent patient arriving with fever and no shivering. Controls were matched to cases by (1) age group (3 months-1 year, 1-5 years, 5-18 years), (2) maximal temperature range (38°C-40°C, >40°C), and (3) fever duration (<3 days, ≥3 days).

The guardians of children with fever (>38°C) completed a questionnaire providing information about the immunization status of the patient, duration of the current febrile illness, the peak temperature range, and asking whether shivering was witnessed. To reduce report bias, guardians also were asked whether they had been caring for the patient for the majority of the day during the course of their child's illness. When the guardians were unsure whether they had witnessed shivering, they were shown a video of a shivering infant (https://www.youtube.com/watch?v=M3HK8Mgz4PY). When shivering with fever was documented, and the patient met the inclusion criteria, the legal guardian (and if the patient were >10 years of age) signed an informed consent. The next patient, with fever and no history of shivering, matched for age group, peak temperature range, and duration of febrile illness, was invited to join the study in the control group.

All subjects had blood drawn for a complete blood count, C-reactive protein, and culture. Urine samples for urinalysis were obtained from all female and uncircumcised males under 2 years of age, circumcised male patients under 6 months of age, in cases with urinary symptoms, and in other cases at the discretion of the treating physician. Pathologic urinalysis (positive for leukocyte esterase or nitrite) was followed by performance of a urine culture. Chest radiography was performed when fever duration was longer than 48 hours or on clinical basis (tachypnea for age, dyspnea, asymmetric lung sounds, and crackles). A stool culture was obtained in children with

ED	Emergency department
SBI	Serious bacterial infection

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suspected dysentery. Additional tests such as lumbar puncture or arthrocentesis were performed when indicated clinically. The decision to hospitalize the patient or to treat with antibiotics was based solely on the judgment of the treating pediatrician, and was not influenced by study participation. A follow-up was conducted 7 days after patients' discharge to check for return visits.

Outcome Measures

SBI was defined as at least 1 of the following: positive blood culture (excluding common skin commensals or contaminants), positive urine culture (excluding common contaminants), positive cerebrospinal fluid culture, alveolar infiltrate on chest radiograph, positive joint fluid culture and confirmed bacterial gastroenteritis.

Secondary outcome measures included elevated inflammatory markers (defined as white blood cells of >15 000 μL or C-reactive protein of >10 mg/L), number of patients treated with antibiotics, and number of patients hospitalized.

Statistical Analyses

Descriptive statistics were used to describe the study population. Univariate analysis was conducted. Cases and controls were compared using the χ^2 test or Fisher exact test (as appropriate) for categorical variables and the Student *t* test or Mann-Whitney *U* test for continuous variables. Continuous variables were tested for normal distribution using the Kolmogorov–Smirnov test. A *P* value of <.05 was considered significant.

The study was approved by the institutional review board. Informed consent was signed by the guardian of each patient participating in the study. The study was registered at ClinicalTrials.gov (NCT02760745).

Results

A total of 645 children with fever arrived at the ED during 41 study sampling days, between January 15 and September 13, 2016 (average of 5 random days a month); 186 (28.8%) had shivering episodes, 41 of whom were excluded owing to 1 or more of the exclusion criteria. Twenty-nine guardians refused to consent. Of the remaining 116 children with febrile shivering recruited, 86 were matched with febrile children without shivering (**Figure**; available at www.jpeds.com).

Almost 94% of the guardians reported watching the patients most of the day. Demographic data for all 645 patients are presented in **Table I**. In the group of shivering patients, a maximum temperature of more than 40°C was observed in approximately 33%, as opposed to approximately 14% in the group of patients without shivering ($P < .01$). Mean age in the patients with shivering was 4.4 ± 4.2 years compared with 3.1 ± 3.5 years in patients with no shivering ($P < .01$). **Table II** (available at www.jpeds.com) presents demographics and matching data specifically for the case and control groups, and shows identical distribution of age range, peak temperature, and duration of illness.

Fever workup in both the study and the control group was similar, as shown in **Table III** (available at www.jpeds.com).

Table I. Patient demographics

Demographics	Shivering (n = 186), %	No shivering (n = 459), %	*P* value
Age (y), mean (SD)	4.4 (4.2)	3.1 (3.5)	<.01
Immunization status up to date*	93	93.7	.54
Age group			
3 mo-1 y	16.7	28.5	<.01
1 y-5 y	55.9	53.6	
5 y-18 y	27.4	17.9	
Max fever (°C)			
38-40	66.2*	85.8	<.01
>40	33.3	14.2	
Fever duration (d)			
<3	67.2	78.9	<.01
>3	32.8	21.1	
Female sex	45.2	45.1	1

*In 1 record, data were not available.

Table IV presents the measured outcomes including the rate of positive cultures, lobar pneumonia as demonstrated on chest radiography, and clinical decisions (ie, admission and antibiotics treatment). For all measures, no difference was found between the shivering and nonshivering groups.

Summarizing the SBIs in the cases and control groups shows no significant difference with 18 (20.9%) and 16 (18.6%) in the shivering vs no-shivering groups, respectively ($P = .848$).

During 1 week of follow-up, 11 patients (6 from the no-shivering and 5 from the shivering group) returned to the ED; among them there were no cases of SBI.

Discussion

Our study shows that shivering is reported commonly, with almost one-third of cases experiencing at least 1 episode. Patients with reported shivering were older than patients without shivering, had higher peak temperatures, and a longer duration of febrile illness.

Inflammatory markers such as C-reactive protein and white blood cells were similar in children with and without shivering, and shivering was not associated with a higher risk for SBI.

Table IV. Results of measured outcomes

Demographics	Shivering (n = 86), n (%)	No shivering (n = 86), n (%)	*P* value
WBC (k/μL)	13.3 (5.7)	13.3 (6.6)	.987
WBC > 15 000 μL	26 (30.2)	23 (26.7)	.736
ANC (k/μL)	8.8 (4.6)	9.2 (10.4)	.726
CRP (mg/L)	44.4 (46.8)	45.2 (55.1)	.910
CRP > 10 mg/mL	64 (74.4)	60 (69.8)	.61
Antibiotics started	34 (39.5)	40 (46)	.369
Admitted	10 (11.6)	19 (22.1)	.102
SBI	18 (20.9)	16 (18.6)	.848
Positive blood culture	0 (0)	0 (0)	
Positive urine culture	7 (8.1)	8 (9.3)	.702
Lobar pneumonia	6 (7)	7 (8.1)	.920
CSF culture	0 (0)	0 (0)	
Positive stool culture*	5 (5.8)	1 (1.2)	.058

ANC, Absolute neutrophils count; *CRP*, C-reactive protein; *CSF*, cerebral spinal fluid; *WBC*, white blood cells.
*Shigella in 5 cases and *Campylobacter* 1 case.

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