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National trends in emergency department use of urinalysis, complete blood count, and blood culture for fever without a source among children ages 2–24 months in the PCV-7 era

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Abstract

Objective—The epidemiology of serious bacterial infections (SBI) in children has changed since the introduction of the pneumococcal conjugate vaccine (PCV-7) in 2000. Whether Emergency Department (ED) physicians have changed diagnostic approaches to fever without source (FWS) in response is unknown. We examine trends in rates of complete blood counts (CBC), urinalyses (UA), and blood cultures among 2–24 month old children with FWS since the introduction of PCV-7.

Methods—The National Hospital Ambulatory Medical Care Survey-ED, 2001–2009 was used to identify visits to the ED by 2–24 month old children with FWS. Rates of CBC, UA, neither CBC nor UA, and blood culture were tracked across time. Trends were identified using Joinpoint regression, bivariate, and multivariate logistic regressions with year as the independent variable and ordering of each test as dependent variables.

Results—In bivariate and multivariate analysis, CBC orders declined between 2004 and 2009 for visits by all children 2–24 months, children 2–11 months, and boys 2–24 months (adjusted OR (aOR): 0.88 per year, $p < 0.01$; aOR: 0.88, $p < 0.05$; and aOR: 0.83, $p < 0.01$, respectively). Between 2004 and 2009 ordering neither CBC nor UA increased among all children 2–24 months (aOR: 1.10, $p < 0.05$) and among boys (aOR=1.16, $p < 0.05$). Orders for blood cultures declined across the time period in bivariate, but not multivariate analysis.

Conclusion—The rate of ordering a CBC for children in the 2–24 month age group presenting to the ED with FWS declined, a change coincident with the changing epidemiology of SBI since the PCV-7 vaccine was introduced.

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Keywords

fever; pcv-7; emergency department; testing

INTRODUCTION

The introduction of the pneumococcal conjugate vaccine (PCV-7) in 2000 changed the epidemiology of serious bacterial infections (SBIs) in children. Evidence suggests that the incidence of occult bacteremia and invasive pneumococcal disease has declined since the introduction of the PCV-7 vaccine[1–7], and vaccination coverage of children has increased since its introduction.[8] In response, the recommendations found in the literature for the workup of children beyond the newborn and young infant age groups (beyond 2 or 3 months of age) with fever without a source (FWS) have changed as well.

In 1993, Baraff, et al. issued guidelines based on expert consensus for the management of FWS in the 3–36 month old age group,[9] and over time Baraff has revised these recommendations.[10, 11] More recently, in 2008, Baraff modified his recommendations to reflect changes in the epidemiology of SBIs, recommending use of urinalysis (UA) for children 2–24 months at higher risk of urinary tract infection (e.g., girls and uncircumcised boys) and questioning the utility of complete blood counts (CBC) for well-appearing, vaccinated children in this age group.[12] In 1999, the American Academy of Pediatrics (AAP) issued guidelines on the evaluation of urinary tract infection (UTI) in the 2–24 month age group, which suggested children with FWS in this age group should receive a urinalysis (UA).[13] The AAP guidelines were updated in 2011 to help clinicians assess the risk of UTI in a child with FWS based on his or her characteristics, and do not suggest a single rule for determining who should receive a UA, but rather that it will vary by clinician based on a variety of factors.[14]

While many studies have informed these guidelines, few studies have focused on the actual practice patterns of physicians when confronted with a patient with FWS. Several studies have surveyed practitioners and asked how the practitioner believes they would approach a child with FWS using short cases or vignettes.[15–24] However, it is not clear that physician practice mirrors their stated behavior.[25–27]

With the exception of our previous work in this field,[30] we know of no previous studies of FWS that have collected data on physician practice patterns in the U.S after the introduction of the PCV-7 vaccine. This paper builds on our previous study that explored the kinds of tests ordered for children 3–36 months who present to the ED with FWS and associations of patient and ED characteristics with the use of complete blood count (CBC) and UA.[30] In the current study, we newly explore changes across time in test ordering to determine whether changes have occurred in testing practice over the PCV-7 era. Additionally, because our previous study showed that children 24–36 months were significantly less likely to receive a CBC or a UA than their younger counterparts, and because recent AAP guidelines on UTI focused specifically on children 2 to 24 months, we have chosen to focus this analysis on the 2–24 month age group.

Specifically, this study aims to examine changes over time in rates of ordering a CBC, UA, neither CBC nor UA, or blood culture for children who present to the ED with FWS in the 2–24 month age group since the introduction of the PCV-7 vaccine. We hypothesize that a decline in the rate of ordering a CBC would have occurred since the introduction of the PCV-7 vaccine, as rates of bacteremia have declined over time.[31]

METHODS

This study is a retrospective cross-sectional analysis of the National Hospital Ambulatory Medical Care Survey-Emergency Department (NHAMCS-ED) from 2001 through 2009. The NHAMCS-ED is a national probability sample survey conducted by the National Center for Health Statistics (NCHS) to make national estimates of characteristics of in-person visits to EDs of nonfederal, short-stay hospitals in the United States (hospitals with an average stay of less than 30 days). The ED's specialty may be general (medical or surgical) or children's general. The survey uses a four-stage complex survey design with the four stages made up of geographic primary sampling units (PSUs), hospitals and emergency departments within PSUs, emergency service areas (ESAs) within emergency departments, and then patient visits within ESAs. In addition, this is supplemented with a three stage design specifically for children's hospitals. These data were weighted by NCHS to produce nationally representative estimates of visits to EDs. The weights were calculated based on the reciprocal of the selection probability and were adjusted for non-response. The NHAMCS-ED survey instruments may be found online[32] and details of the NHAMCS-ED survey can be found elsewhere as well.[33] Unweighted response rates for the survey years ranged from 79.5% in 2007[34] to 90.8% in 2002.[35] The NHAMCS-ED has received approval by the NCHS Research Ethics Review Board. This study used NHAMCS-ED data and did not require separate institutional review board approval. Data analysis began with 2001, the earliest year patient temperature (an important variable in the decision of whether to order laboratory tests) was collected and ended with 2009, the most recent year available.

Visits to the ED for FWS were identified using reason for visit codes and *International Classification of Diseases-9th Revision Clinical Modification* (ICD-9-CM) discharge diagnosis codes. Reason-for-visit codes are a classification system developed by NCHS to classify patients' complaints, symptoms, or other reasons for seeking care, as stated in the patient's own words.[34] In contrast, discharge diagnoses represent the physician's final assessment of the patient's diagnosis. Visits were included in the analysis if the patient was between 2 and 24 months of age and either "fever" was a reason for visit or the patient had a temperature $\geq 38^{\circ}$ Celsius upon presentation to the ED. Visits were excluded when a source for the fever was mentioned in the reason-for-visit codes, including sore throat, symptoms referable to ears, diarrhea, and urinary symptoms (dysuria). In addition, visits were excluded that had an ICD-9-CM code for a source of fever that would likely be diagnosed prior to ordering tests. These were acute otitis media, pneumonia, croup, bronchitis, bronchiolitis, cellulitis/abscess, group-A strep pharyngitis, scarlet fever, herpangina, HSV stomatitis, coxsackie virus, roseola, varicella, lymphadenitis, and sinusitis. Additionally, children diagnosed with meningitis or sepsis, and those admitted to the hospital or the observation unit, were excluded, as these may represent children that were not well-appearing, and hence these infections would not be considered occult. To characterize the discharge diagnoses of the analytic sample, the most frequent primary diagnoses were assessed. Although up to three diagnoses are reported for each visit, the first represents the primary diagnosis at the visit while the other two represent "other conditions related to the visit." [36] Whether a CBC, UA, or blood culture was ordered for each visit was ascertained by the check-box for each of these tests on the NHAMCS-ED abstraction form. In 2005 and 2006, data on ordering of blood cultures were not collected by the NHAMCS-ED.

Rates of ordering CBC, UA, and neither CBC nor UA, and blood culture were calculated for visits by all children 2–24 months of age for each year, 2001 to 2009. Estimates were considered reliable if relative standard errors were $\leq 30\%$ and the estimate was based on at least 30 unweighted observations. Resulting estimates of CBC, urinalysis, and neither CBC nor UA rates, as well as standard errors for each estimate were entered into a Joinpoint

regression using the National Cancer Institute's Joinpoint 3.4.3 software[37] using year as the independent variable and CBC rate, UA rate, or rate of having neither test ordered as the dependent variable. Joinpoint was used to identify time points (joinpoints) where linear trends changed during the time period examined. The software fits the simplest linear model with no joinpoints (a straight line) and, using a series of Monte Carlo permutation tests, tests whether 1 or more joinpoints (changes in linear trend) are statistically significant and should be added to the model. Results were considered significant if p -values were less than 0.05. Because blood culture data were missing for 2005 and 2006, these results were not entered into Joinpoint to identify trends within the period from 2001 to 2009, as the missing data could significantly affect changes in the linear trends found.

To further investigate the linear trends identified in Joinpoint, we conducted logistic regressions using Stata for each outcome (CBC, UA, and neither test) for each time period identified as an individual linear trend for that outcome in Joinpoint. For blood cultures, we conducted logistic regression across 2001 to 2009 to examine whether a trend existed across the entire time period. Both bivariate and multivariate logistic regressions were conducted. The main independent variable of our analysis was the survey year. Multivariate analyses controlled for other factors available in the data that may be related to physician diagnostic practice. Covariates considered in each analysis included: age (2–11 months, 12–23 months), sex, race/ethnicity (non-Hispanic white (NH white), non-Hispanic black (NH black), Hispanic, Asian/other), median income of patient ZIP-code (from 2000 U.S. census for all years), temperature on presentation to ED—the initial temperature taken in the ED[36] (<38° C, 38–38.9° C, 39–39.9° C, 40.0° C), U.S. Census region, expected source of payment (private, Medicaid/SCHIP, self-pay, no charge/charity/Medicare/other), hospital metropolitan statistical area status (metropolitan statistical area (MSA), non-metropolitan statistical area (non-MSA)), teaching hospital status (yes, no), ED volume (<30,000, 30,001–50,000, 50,001–70,000, >70,000 visits per year), and Pediatric ED status (no, yes). Race was imputed on the NHAMCS file where missing (16.1% of those with FWS between 2–24 months of age) for all years, but ethnicity was only imputed on the NHAMCS file for 2003–2009 (12.2% of those with FWS between 2–24 months of age), leaving 3.1% of unweighted observations with missing ethnicity. Missing categories were used to retain observations in the analysis with missing data for race/ethnicity, expected source of payment, and teaching hospital status. Because temperature may be an important predictor of testing, we did not create a missing category for temperature but excluded observations with missing values for temperature altogether in multivariate models (3.5% of unweighted observations, $n=120$). Observations with missing data for median income of ZIP code (5.0% of unweighted observations, $n=171$) were excluded as this variable was treated continuously.

All variables were included in multivariate analysis, as the intention was to control for possible confounders to the trend over time, rather than determine the effects of additional variables. Polychoric correlation was conducted on all ordinal variables, and separate models were used to avoid entering selected variables with correlation >0.4 into the same model. ED volume, Pediatric ED status, teaching hospital status, and hospital metropolitan statistical area status were highly correlated. Since results for each variable were nearly identical in the four models, only models using ED volume are reported. Variance inflation factors were then calculated on each model to search for debilitating collinearity, but no values greater than 2 were observed.

We conducted additional models stratified by sex because we hypothesized that diagnostic practice would vary by gender due to the higher risk of urinary tract infection (UTI) in girls. In addition we conducted an additional model for children 2–11 months of age separately due to the increased risk of serious bacterial infection at younger ages.[38–40] Due to

limited sample sizes for blood cultures, only trends across all children 2–24 months could be examined.

All analyses were conducted using Stata version 12.1, taking into account the sample weights to obtain national estimates and the complex survey design to obtain correct variances. Statistical tests with $p < 0.05$ are considered statistically significant, with no adjustment for multiple comparisons. A sensitivity analysis was conducted that removed from the model all observations with missing data for race/ethnicity, expected source of payment, and teaching hospital status.

RESULTS

The study population of children 2–24 months of age with FWS was comprised of 3,398 observations (Figure I) between 2001 and 2009. FWS accounted for approximately 20.0% (CI: 19.1–20.8) of visits to the ED among children in the 2–24 month age group across all years. Over the 9 years, this percentage ranged from 15.3% (CI: 13.3–17.6) in 2001 to 22.9% (CI: 20.8–25.2) in 2009. In 2009, there were approximately 1,646,000 visits (CI: 1,315,000–1,977,000) for FWS in this age group. The characteristics of children 2–24 months presenting to the ED with FWS across the years 2001 to 2009 are presented in Table I. The 10 most frequent primary diagnoses for visits in the analytic sample are presented in Table II, although it should be noted that these do not include secondary and tertiary diagnoses. Nonetheless, the diagnoses of fever, upper respiratory infection, and viral (not otherwise specified) account for 64% of primary diagnoses in the sample. The percentage of visits of all children 2–24 months with FWS, girls 2–24 months with FWS, boys 2–24 months, and children 2–11 months with FWS who have CBC, UA, blood culture, and neither CBC nor UA are shown by year in Table III.

In Joinpoint regression for CBC among all children with FWS aged 2–24 months, a single significant joinpoint, or change in linear trend was found at 2004. In bivariate analysis, between 2001–2004, no significant trend in the rate of CBC was found ($p > 0.05$) for all children 2–24 months, girls 2–24 months, boys 2–24 months, or both boys and girls 2–11 months (Table IV). Similarly, no significant trend for CBC was found between 2001–2004 in multivariate analysis for all groups except all children 2–11 months for whom a significant increase in the rate of CBC was observed (OR=1.28 per year, $p < 0.05$). Between 2004 and 2009, however, a significant decline in the rate of CBC for all children 2–24 months was found in both bivariate and multivariate analysis (OR=0.88 per year, $p < 0.01$ for both). This trend for 2004–2009 was also found in the subgroup of only boys (OR=0.80, $p < 0.01$ in bivariate and OR=0.83, $p < 0.01$ in multivariate analysis), but not in girls. In children 2–11 months of age, the trend for CBC for 2004–2009 was significant for both bivariate (OR=0.86, $p < 0.01$) and multivariate analysis (OR=0.88, $p < 0.05$).

For UA, one significant change in trend (or joinpoint) was found in Joinpoint regression in 2006. No significant trends in the rate of urinalysis were found for 2001–2006, across all children 2–24 months of age, or in any of the subgroups examined. Between 2006 and 2009, in bivariate analysis, no significant trends over time were observed in any of the groups. However, while for UA for girls alone between 2006 and 2009, bivariate analysis did not show a significant change, multivariate analysis showed a significant decline (OR=0.82, $p < 0.05$), suggesting a possible decline in UA independent of those covariates controlled for in the regressions. No other subgroups had significant declines for UA in multivariate analysis.

For neither test (no CBC nor UA), a single change in trend (joinpoint) was found in Joinpoint analysis in 2004. Prior to 2004, only children 2–11 months had a significant trend

(OR=0.82, $p<0.05$ in bivariate analysis and OR=0.75 per year, $p<0.01$ in multivariate analysis), a decline in rates of receiving neither test. Between 2004 and 2009, a significant increase in receiving neither test was observed for all children 2–24 months in both bivariate (OR=1.11, $p<0.01$) and multivariate (OR=1.10, $p<0.05$) analyses. This increase trend was also seen in boys only (OR=1.21, $p<0.01$ in bivariate and OR=1.16, $p<0.05$ in multivariate analysis), and in children 2–11 months in bivariate analysis only (OR=1.11, $p<0.05$).

In bivariate analysis, a significant decline was observed in the rate of ordering blood cultures (OR=0.92 per year, $p<0.05$). However, this finding lost significance in multivariate analysis (OR=0.93, $p>0.05$), suggesting either reduced power or a shift in characteristics of patients or hospitals accounting for the change over time in ordering rates.

In sensitivity analysis that removed all observations with missing data, all odds ratios for year and p-values were generally similar to the results presented thus far, with the exception that when we excluded missing data, we no longer found a significant decline in UA for girls from 2006–2009 (OR=0.87, $p=0.16$), and the decline in ordering blood cultures became significant in multivariate analysis (OR=0.92, $p<0.05$).

DISCUSSION

Between 2004 and 2009, we observed a decrease in ordering a CBC in ED visits for children 2–24 months with FWS. This finding is robust across both bivariate and multivariate analyses, suggesting that the change in physician practice over time was independent of changes in patient demographic characteristics or in hospital characteristics. In subgroup analysis, the decline in CBC ordering was apparent for boys with FWS and all children 2–11 months, but not girls. During the same time period, ED visits where neither a CBC nor UA was ordered increased, independent of changes in patient demographics or hospital characteristics. In subgroup analysis this finding was limited to boys. For ordering a UA, the only change found was a decrease in girls between 2006 and 2009 in multivariate analysis. However, this finding was no longer apparent on sensitivity analyses.

The observed decrease in ordering a CBC between 2004 and 2009 is coincident with the increase in PCV-7 vaccination coverage and with declines in invasive pneumococcal disease and bacteremia.[1–7, 31] As bacteremia has become less common, the practice of evaluating a CBC becomes less likely to identify a child with a SBI. What is unknown, however, is whether the changes in practice observed across the U.S. have been more or less successful in identifying SBIs. Despite significant changes in practice patterns observed in this study time period, the change between 2004 and 2009 may be less than expected given the reductions in the rates of bacteremia.[6] Also, the change in the rate of ordering a CBC appears to be more concentrated in boys and children 2–11 months. Further research should examine whether the magnitudes of these trends sufficiently responds to the changing epidemiology of SBIs. Also unknown is whether the driver for changes in practice was physician knowledge of the changing epidemiology of SBI, knowledge of updated physician guidelines during this time,[10, 11] or other interventions or events that may have occurred during that time.

Because of the inconsistency of the result in sensitivity analysis, it is not clear whether the rate of UA declined in girls between 2006 and 2009. However, it is clear that the rate of UA did not increase during this time period for any group. Although the rate of UTI among 2–24 month old children has not changed over this time period [41], it may be of interest that the rate of testing for UTI also did not change. That the rate of UA did not increase may be of note given emphasis on the value of UA presented in Baraff's 2008 guidelines, [12] which

were informed by literature from recent years concerning the benefits of different tests for children with FWS.

The results of this study should be of interest to all ED physicians, as nearly 30% of visits in this study occurred in pediatric EDs, while the remainder were in non-pediatric EDs. Additionally, we did not observe pediatric ED status as a significant factor in testing of any outcome for any subgroup, suggesting that behavior is likely similar for physicians in both settings.

Also of interest was whether or not the practice of ordering blood cultures had changed over time. Specifically, we considered the possibility that practitioners might substitute the use of CBC with blood cultures. Although ordering of blood cultures was not collected in the NHAMCS in 2005 or 2006, preventing us from identifying changes in linear trends within the time period, the overall trend in blood cultures for all children 2–24 months showed a decline in the ordering of blood cultures over time in bivariate analysis. Given the differences between the results of the main multivariate analysis and our sensitivity analysis, it is unclear whether this change was due to changes in the characteristics of patients or hospitals over time, rather than changes in physician practice. Still, these data suggest that it is unlikely that physicians are substituting blood cultures for CBC.

This study has some important limitations. First, identification of both the presence of fever and sources for fever from the available visit data are imperfect. Only initial temperature in the ED, and not maximal temperature in the ED was available in the NHAMCS-ED data. Also, we identified common sources for fever that are apparent prior to diagnostic testing, but certainly others exist. Second, although we controlled for several factors, and showed little change over time in the distributions of several covariates, it is impossible to be sure that the changes in practice over time are due to physicians' responses to the changing epidemiology of SBIs. Indeed, some important variables were not available to us including the clinical presentation of patients with FWS in the ED, vaccination, and circumcision status, all likely drivers of testing. We also did not attempt to identify patients who were immune-compromised, as the number was likely to be small and challenging to identify. Similarly, we know of no comorbidity score that has been validated in the ED setting that could be applied to these data, although such a score would have been helpful in our analysis.

In summary, physician practice for children 2–24 months of age presenting to the ED with FWS changed between 2004 and 2009 to include ordering fewer CBCs. We also found the likelihood that physicians ordered neither a CBC nor a UA increased over time. The decline in ordering of CBCs is coincident with the changing epidemiology of SBIs due to the PCV-7 vaccine, suggesting that ED physicians may have taken these changes into account in their diagnostic testing approach to children with FWS in this age group.

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Figure I.
Flow diagram of study population, NHAMCS 2001–2009

Table I

Percentage distribution and confidence interval of characteristics of visits among children aged 2–24 months presenting in a US Emergency Department with fever without source, 2001–2009 (National Hospital Ambulatory Medical Care Survey-Emergency Department).

Variable	n	Percent (SE)	95% CI
	3,398		
Age			
2–11 months	1,700	49.4	47.3–51.5
12–24 months	1,698	50.6	48.5–52.7
Sex			
Male	1,836	54.4	52.1–56.7
Female	1,562	45.6	43.3–47.9
Race/Ethnicity			
white non-Hispanic	1,256	40.4	36.7–44.2
black non-Hispanic	841	22.9	20.2–25.9
Hispanic	984	28.6	24.5–33.1
Asian/Other	211	4.8	3.7–6.3
Missing	106	3.3	2.3–4.6
Median Income of Patient's ZIP-code (Mean value)	3,227	\$39,662	\$38,672–\$40,652
Quartile of Median Income of ZIP-code*			
Lowest (poorest) Quartile	733	20.2	17.6–23.0
2 nd	740	23.6	21.1–26.3
3 rd	852	26.3	23.7–29.1
Highest Quartile	902	25.2	22.7–27.9
Missing	171	4.7	3.6–6.0
Temperature on Presentation to ED			
Temp <38.0	1091	33.3	30.5–36.2
Temp 38.0 and 38.9	1170	32.6	30.6–34.6
Temp 39.0 and 39.9	769	22.2	20.2–24.3
Temp 40.0	248	7.5	6.3–8.9
Missing	120	4.5	3.1–6.4
Region			
Northeast	746	17.0	14.5–19.7
Midwest	667	20.0	16.0–24.8
South	1247	43.3	37.5–49.2
West	738	19.8	16.5–23.5
Expected Source of Payment			
Private insurance	939	28.7	26.4–31.1
Medicaid/SCHIP	1854	52.0	49.2–54.8

Variable	n	Percent (SE)	95% CI
Self-pay	277	8.3	7.1—9.7
No charge/charity/Medicare/other	114	3.8	2.9—5.1
Unknown	214	7.1	5.2—9.8
MSA/Non-MSA			
MSA **	3055	86.6	83.3—89.3
Non-MSA **	343	13.4	10.7—16.7
Teaching Hospital Status			
Teaching	915	20.2	16.9—24.0
Non-Teaching	2429	78.3	74.4—81.8
Missing	54	1.5 ***	0.8—2.8
ED Volume (visits/yr)			
30,000	940	28.2	22.0—35.5
30,001–50,000	964	24.7	20.8—29.0
50,001–70,000	686	19.4	15.6—23.8
70,001	808	27.8	23.3—32.7
Pediatric ED			
No	2234	70.3	62.7—76.8
Yes	1164	29.8	23.2—37.3

* Quartiles are based on quartiles of median income of ZIP-code from all ZIP-codes in the 2000 U.S. Census. Estimates of median income of ZIP-code are also from 2000 U.S. Census for all years.

** MSA=Metropolitan Statistical Area. Non-MSA= non-metropolitan statistical area.

*** Estimate not reliable due to relative standard error>30%

Table II

Ten most frequent primary diagnoses among children aged 2 to 24 months presenting in a US Emergency Department with fever without source, 2001–2009 (National Hospital Ambulatory Medical Care Survey-Emergency Department).

Diagnosis	ICD-9-CM code(s)	Unweighted percentage of sample	Weighted percentage of sample (SE)
Fever	780.6	27.3	26.9 (1.5)
Upper respiratory infection	460, 465.8, 465.9	21.8	21.2 (1.2)
Viral (not otherwise specified)	079.99	14.9	13.8 (0.8)
Acute pharyngitis	462	3.1	3.6 (0.4)
Gastroenteritis	008.61, 008.8, 009.0, 558.9	2.9	2.5 (0.3)
Febrile seizure	780.31	2.4	2.3 (0.4)
Vomiting	787.01, 787.03	1.9	2.4 (0.4)
Asthma	493	1.8	1.8 (0.3)
Urinary tract infection and pyelonephritis	590, 599.0	1.7	1.5 (0.3)
Influenza	487.1	1.5	1.5 (0.3)

Table III

Percentage of visits receiving any CBC, any UA, or neither test among all children 2–24 months, girls 2–24 months, boys 2–24 months, and all children 2–11 months presenting to the emergency department with fever without source by year (National Hospital Ambulatory Care Survey—Emergency Departments, 2001–2009).

	Percent Any CBC (SE)	Percent Any UA (SE)	Percent No CBC or UA (SE)	Percent Any Blood Culture (SE)
All 2–24 months	22.3 (1.2)	18.2 (0.9)	70.9 (1.2)	10.6 (1.1)
2001	21.3 (3.0)	16.5 (2.9)	72.4 (3.5)	12.0 (3.2)
2002	25.4 (3.4)	17.5 (2.8)	70.4 (3.5)	11.6 (2.1)
2003	24.0 (3.5)	14.4 (3.5)	70.9 (3.7)	12.6 (2.2)
2004	28.5 (3.3)	19.5 (2.6)	64.3 (3.5)	14.7 (3.2)
2005	24.2 (3.2)	20.1 (2.4)	69.3 (3.0)	**
2006	21.6 (2.8)	23.5 (2.9)	68.6 (3.2)	**
2007	22.5 (3.5)	18.6 (2.9)	70.0 (4.4)	10.6 (2.8)
2008	19.1 (2.3)	17.8 (2.3)	73.4 (2.8)	8.8 (1.9)
2009	15.9 (2.7)	16.1 (2.5)	76.8 (3.1)	5.9 (1.5)
Girls 2–24 months	23.5 (1.6)	24.2 (1.4)	66.0 (1.6)	*
2001	23.0 (4.7)	22.5 (5.0)	67.3 (5.3)	*
2002	26.3 (5.3)	23.6 (4.7)	66.5 (5.2)	*
2003	20.5 (3.9)	14.2 (3.4) *	71.3 (4.3)	*
2004	28.7 (4.2)	24.7 (4.4)	61.9 (4.5)	*
2005	17.0 (3.8)	21.7 (3.8)	73.7 (4.0)	**
2006	23.5 (3.9)	33.8 (4.3)	59.4 (4.3)	**
2007	31.4 (5.3)	28.7 (4.6)	56.5 (6.0)	*
2008	22.7 (3.5)	24.5 (3.7)	66.1 (3.8)	*
2009	20.3 (4.7)	23.9 (4.3)	69.0 (5.2)	*
Boys 2–24 months	21.2 (1.5)	13.1 (1.1)	75.0 (1.5)	*
2001	19.8 (3.5)	11.2 (3.1) *	76.9 (3.9)	*
2002	24.3 (4.8)	10.9 (2.7)	74.6 (4.9)	*
2003	26.8 (4.7)	14.5 (5.8) *	70.6 (5.6)	*
2004	28.3 (4.5)	15.4 (3.3)	66.2 (4.8)	*
2005	30.4 (4.1)	18.7 (3.2)	65.6 (4.2)	**
2006	19.7 (4.2)	13.4 (3.5)	77.5 (4.3)	**
2007	15.7 (3.9) *	11.1 (3.0) *	80.2 (4.3)	*
2008	15.9 (4.0) *	11.7 (3.1) *	79.9 (4.4)	*
2009	13.1 (3.3)	11.2 (2.7)	81.6 (3.7)	*
All children 2–11 months	25.1 (1.6)	21.1 (1.3)	68.0 (1.6)	*
2001	21.4 (3.6)	16.6 (3.5) *	75.1 (3.8)	*
2002	29.6 (4.9)	22.5 (5.2)	65.6 (4.9)	*

	Percent Any CBC (SE)	Percent Any UA (SE)	Percent No CBC or UA (SE)	Percent Any Blood Culture (SE)
2003	23.6 (4.6)	13.4 (3.7) *	72.7 (4.9)	*
2004	33.4 (4.6)	25.0 (4.5)	58.3 (4.6)	*
2005	28.5 (4.6)	22.9 (3.8)	66.7 (4.9)	**
2006	26.7 (4.3)	25.9 (4.2)	64.0 (4.5)	**
2007	26.5 (4.9)	23.0 (4.3)	65.8 (6.0)	*
2008	18.1 (2.6)	18.3 (3.5)	73.2 (3.7)	*
2009	20.1 (3.4)	20.8 (3.7)	70.7 (3.8)	*

* Not reliable due to cell size <30.

** Data on blood cultures were not collected in NHAMCS-ED in 2005 and 2006.

Table IV

Multivariate results: Unadjusted and Adjusted* odds ratios (per year) and p-values of year from models to predict CBC use, UA use, and combinations of CBC and UA among visits of children aged 2–24 months, girls 2–24 months, boys 2–24 months, and children 2–11 months presenting in a US Emergency Department with fever without source, 2001–2009.** (National Hospital Ambulatory Medical Care Survey-Emergency Department).

	CBC		UA		No CBC or UA	
	CBC any, 2001–2004	CBC any, 2004–2009	UA any, 2001–2006	UA any, 2006–2009	No CBC or UA, 2001–2004	No CBC or UA, 2004–2009
All 2–24 months						
Unadjusted Odds ratio and CI	1.11 (0.96–1.28)	0.88 ^{††} (0.81–0.95)	1.10 (1.00–1.21)	0.86 (0.74–1.00)	0.89 (0.78–1.03)	1.11 ^{††} (1.03–1.20)
Adjusted Odds ratio and CI	1.15 (0.97–1.37)	0.88 ^{††} (0.81–0.96)	1.10 (0.99–1.22)	0.91 (0.77–1.07)	0.87 (0.74–1.03)	1.10 [†] (1.02–1.20)
Girls						
Unadjusted Odds ratio and CI	1.05 (0.85–1.31)	0.98 (0.87–1.10)	1.11 (0.97–1.26)	0.84 (0.70–1.02)	0.95 (0.78–1.16)	1.01 (0.92–1.11)
Adjusted Odds ratio and CI	1.19 (0.91–1.55)	0.95 (0.84–1.07)	1.13 (0.98–1.30)	0.82 [†] (0.67–1.00)	0.88 (0.71–1.10)	1.05 (0.95–1.15)
Boys						
Unadjusted Odds ratio and CI	1.16 (0.95–1.41)	0.80 ^{††} (0.71–0.90)	1.09 (0.96–1.24)	0.95 (0.73–1.24)	0.83 (0.69–1.01)	1.21 ^{††} 1.08–1.35)
Adjusted Odds ratio and CI	1.15 (0.92–1.44)	0.83 ^{††} (0.73–0.95)	1.08 (0.93–1.26)	1.00 (0.75–1.33)	0.84 (0.67–1.05)	1.16 [†] (1.03–1.30)
All 2–11 months						
Unadjusted Odds ratio and CI	1.16 (0.97–1.40)	0.86 ^{††} (0.78–0.95)	1.11 (0.99–1.25)	0.90 (0.73–1.09)	0.82 [†] (0.69–0.97)	1.11 [†] (1.01–1.21)
Adjusted Odds ratio and CI	1.28 [†] (1.04–1.57)	0.88 [†] (0.79–0.98)	1.07 (0.93–1.23)	0.94 (0.77–1.15)	0.75 ^{††} (0.62–0.92)	1.09 (0.98–1.21)

[†] p<0.05

^{††} p<0.01

* Adjusted models are adjusted for age category, temperature in ED, race/ethnicity, sex, expected source of payment, U.S. census region, ED volume, and median income of ZIP-code.

** Odds ratio is per year over 2001–2009 with year considered as a continuous variable