RESEARCH ARTICLE

Culture Pus, Not Blood: Decreasing Routine Laboratory Testing in Patients With Uncomplicated Skin and Soft Tissue Infections

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ABSTRACT

BACKGROUND: Blood cultures and complete blood cell counts (CBCs) are commonly used in evaluating patients with skin and soft tissue infections (SSTIs). Published data have shown that these tests may not aid in patient management. The objective of this study was to decrease the collection of blood test specimens in children with uncomplicated SSTIs.

METHODS: We designed a longitudinal preintervention/postintervention study that used modifications of well-known propaganda posters. These were displayed in work stations to discourage staff from ordering routine blood cultures in children being evaluated for uncomplicated SSTIs. We studied a total of 230 otherwise healthy patients with SSTIs admitted to a freestanding children's hospital between September 1, 2013, and August 31, 2014. Data were collected in 3 groups: a 4-month baseline period, a 4-month poster display period, and a 4-month follow-up period to determine practice change persistence. Data collected included baseline clinical characteristics, the number of laboratory studies obtained, and outcomes (including length of stay).

RESULTS: Patients in the 3 groups were similar in terms of clinical characteristics. Compared with baseline, posters were associated with decreased blood cultures (47%–17%; $P < .001$) and CBCs (53%–36%; $P = .04$). This effect partially persisted for results of blood cultures (27%; $P = .01$) and CBCs (42%, $P = .17$). There was no change in median length of stay. Seven-day emergency department returns increased in the poster group (0–7%; $P = .02$) with no clear relation to laboratory testing, but not in the follow-up group (3%; $P = .15$).

CONCLUSIONS: A simple and creative poster campaign improved staff laboratory testing practices.

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Skin and soft tissue infections (SSTIs) are common diagnoses within the pediatric population. In the last 2 decades, there has been a significant upsurge in these infections. During this time, the rate of emergency department (ED) visits for SSTIs has more than doubled.[1] Blood cultures continue to be used in an attempt to isolate an organism, despite many studies illustrating that they tend to be low yield.[2–4] Retrospective studies show that although <5% of blood culture specimens in patients with SSTIs yield bacteremia, as many as 70% of these patients have blood cultures drawn. In addition, up to one-half of patients who undergo wound or tissue culture also have blood cultures drawn.[4] These blood cultures can be contaminated, leading to increased length of stay (LOS), unnecessary antibiotic treatment, and higher medical costs. According to practice guidelines from the Infectious Diseases Society of America, blood cultures from patients with uncomplicated cellulitis are not recommended.[5]

In our ED, we noted the frequent collection of blood culture specimens and other tests for patients being admitted with routine SSTIs, despite published data showing no added benefit from these studies.

We engaged in a novel educational project in an attempt to decrease the ordering of unnecessary routine blood tests in these patients.

METHODS

This project was an initiative to decrease the routine ordering of laboratory testing in otherwise healthy patients with uncomplicated SSTIs. Approval and support were received from our institutional review board and from the collective staffs of the ED, General Pediatric Division, and Infectious Disease Service. Data were collected from a total of 230 patients who were admitted to Nemours/A.I. duPont Hospital for Children during the 12-month study period.

Study Design

This longitudinal preintervention and postintervention study aimed to decrease routine laboratory testing in patients with otherwise uncomplicated SSTIs. The study was divided into three 4-month periods: a baseline period, a poster period, and a follow-up period after posters were removed. Baseline data were collected during the initial 4-month baseline period, from September 1, 2013, to December 31, 2013. A poster period was then implemented from January 1, 2014, to April 30, 2014, when posters encouraging ED staff to refrain from routine blood testing were displayed. These posters were placed in highly visible, nonpatient care areas of the ED and resident work areas. Posters were modifications of famous propaganda posters with the superimposed likenesses of hospital staff, including hospitalists, ED attending physicians, and residents (Fig 1). Posters were created by using Adobe Photoshop to insert digital photographs of staff (along with text) into historic propaganda posters. The posters were intended as a temporary intervention and were removed May 1, 2014, because the ED was moving into a new physical space. In addition, we wanted to determine if any change in laboratory ordering practices persisted after poster removal. The follow-up period occurred from May 1, 2014, to August 31, 2014.

Data Analysis

A retrospective chart review of data derived from the electronic medical records was subsequently performed. Data were collected for each of the 4-month periods and were analyzed by using SAS version 9.4 (SAS Institute, Inc, Cary, NC). The continuous variables, age and LOS, were analyzed with the UNIVARIATE procedure because they

FIGURE 1 Sample modifications of historic propaganda posters.

have a skewed distribution and are reported as descriptive statistics with the median and interquartile range. The Wilcoxon rank sum test was used to calculate statistical significance. Categorical data were analyzed by using a χ^2 test.

Study Population and Setting

Using the electronic medical records, data were collected on all patients aged 2 months to 21 years admitted to the Alfred I. duPont Hospital for Children during the study period who received an *International Classification of Diseases, Ninth Revision, Clinical Modification*, diagnosis code of 682 for cellulitis and/or abscess. Uncomplicated SSTIs were defined as those occurring in patients who met all of the following criteria: age >2 months but <21 years, no indwelling hardware or foreign body, immunocompetent, and with no malignancy, surgical site infections, bite wounds, osteomyelitis, or an SSTI requiring surgical intervention beyond a simple incision and drainage. Patients were excluded if they had any of these conditions. This approach ultimately resulted in a study population of 230 patients: 78 patients in the baseline study period, 75 patients in the poster intervention study period, and 77 patients in the follow-up study period.

Measures

Data obtained from the electronic medical records included patient demographic characteristics, date of admission, length of inpatient stay, ED revisit status (return to the ED within 7 days of initial hospitalization), bodily location of the infection, history of fever ≥100.4°F, systemic antibiotic usage within 7 days, and any underlying skin conditions such as eczema, varicella, or scabies. Information was also collected on laboratory testing performed, imaging obtained, and whether incision and drainage was performed.

RESULTS

Patient characteristics, as shown in Table 1, were similar for all 3 study periods (the baseline period, the poster period, and the follow-up period [after poster removal]). There was no statistical difference between the 3 study groups for median patient age, sex distribution, history of fever ≥100.4°F, or antibiotic use. Fewer patients had underlying skin conditions in the poster study group compared with the baseline group ($P = .006$) and the follow-up group ($P = .06$). There were more groin infections in the poster group and fewer leg infections compared with the baseline or follow-up groups.

Unnecessary blood culture and CBC testing in patients with uncomplicated SSTIs decreased after poster introduction (Table 2). The number of blood cultures decreased from 47% to 17% ($P < .001$) from the baseline to poster study period. This decrease in blood cultures persisted in the follow-up study period, with 27% of patients having blood cultures drawn ($P = .01$). Importantly, none of the blood culture results obtained in any of the study groups was positive. The number of CBCs decreased from 53% during the baseline period to 36% ($P = .04$). Although a smaller percentage of patients had CBCs drawn in the follow-up study period (42%) compared with baseline, this finding was not statistically significant ($P = .17$).

The number of nares swabs for methicillin-resistant *Staphylococcus aureus* screening was not statistically different between the poster and follow-up groups compared with baseline, but it was significantly lower for the follow-up group (3%) compared with the poster group (13%) ($P = .01$). The number of additional laboratory tests obtained (eg electrolytes, sedimentation rate, C-reactive protein) in the poster group decreased from 45% to 27% ($P = .02$) compared with baseline. This reduction persisted in the follow-up group compared with baseline, with 29% of patients having additional laboratory testing ($P = .04$).

Imaging studies were increasingly obtained during the course of the study. Although the increase in imaging studies obtained between the baseline (38%) and poster (49%) groups was not statistically significant ($P = .18$), the further increase seen in the follow-up study period to 56% was statistically significant compared with baseline ($P = .03$). The change in imaging studies was not correlated with any change in the number of draining infections as the abscess culture rate was unchanged across all study groups.

There was no difference in LOS between any of the groups, and LOS was also unrelated

TABLE 1 Patient Characteristics for Baseline, Poster Intervention, and Follow-up Groups

Characteristic	Baseline ($n = 78$)	Poster ($n = 75$)	Follow-up ($n = 77$)	*P* (Poster–Baseline)	*P* (Follow-up–Baseline)	*P* (Follow-up–Poster)
Age, median (IQR), y	4.7 (1.5–11.7)	4.8 (1.7–11.6)	3.9 (1.5–8.7)	.84	.32	.4
Male sex	39 (50%)	47 (63%)	42 (55%)	.11	.57	.31
Fever	26 (33%)	27 (36%)	28 (36%)	.73	.69	.96
Recent antibiotic	31 (40%)	40 (53%)	30 (39%)	.09	.92	.08
Skin condition	19 (24%)	6 (8%)	14 (18%)	.006	.35	.06
SSTI location				.03	.89	.05
Head	13 (17%)	21 (28%)	16 (21%)			
Trunk	4 (5%)	3 (4%)	5 (6%)			
Arm	11 (14%)	12 (16%)	13 (17%)			
Groin	15 (19%)	23 (31%)	12 (16%)			
Leg	35 (45%)	16 (21%)	31 (40%)			

IQR, interquartile range.

TABLE 2 Clinical Outcomes Comparing Baseline, Poster Intervention, and Follow-up Groups

	Baseline ($n = 8$)	Poster ($n = 75$)	Follow-up ($n = 77$)	P (Poster–Baseline)	P (Follow-up–Baseline)	P (Follow-up–Poster)
Blood culture	37 (47%)	13 (17%)	21 (27%)	<.001	.01	.14
CBC	41 (53%)	27 (36%)	32 (42%)	.04	.17	.48
Abscess culture	41 (53%)	48 (64%)	40 (52%)	.15	.94	.13
MRSA swab	5 (6%)	10 (13%)	2 (3%)	.15	.25	.01
Other laboratory tests	35 (45%)	20 (27%)	22 (29%)	.02	.04	.79
Imaging	30 (38%)	37 (49%)	43 (56%)	.18	.03	.42
Incision and drainage	19 (24%)	32 (43%)	18 (23%)	.02	.89	.01
LOS, median (IQR), h	29 (20–40)	28 (20–42)	24 (18–40)	.75	.36	.19
7 d ED return	0	5 (7%)	2 (3%)	.02	.15	.23

IQR, interquartile range; MRSA, methicillin-resistant *Staphylococcus aureus*.

to whether blood cultures or CBCs were obtained. In addition, although no patients in the baseline group returned to the ED within 7 days, 5 patients in the poster group ($P = .02$) and 2 patients in the follow-up group ($P = .15$ versus baseline) returned to the ED. We reviewed each of these patients to determine the cause of the return to the ED. Two of the patients returned to have their wound packing removed, and 2 patients had re-accumulation of pus requiring repeat drainage. Finally, 3 patients returned with concerns that their infection was not improving. Two of these patients had no change in therapy, and the other patient had an antibiotic change when it was determined that the causative organism from the wound culture specimen was not sensitive to the initial antibiotic.

DISCUSSION

American health care is the most expensive in the world, and costs continue to grow at a high rate.[6] Although this problem is multifactorial, excessive and unnecessary medical tests are contributing factors. An editorial by Berwick and Hackbarth[7] estimated that at least 20% of the US health care budget is wasted. Physicians have a significant influence on health care costs through the ordering of tests and treatments, many of which are unnecessary but the use of which persists. In some cases, these tests do not enhance care and may adversely affect patients through false-positive results leading to anxiety, further testing, unneeded treatment, and higher medical costs.

While the overuse of unnecessary medical tests by physicians persists despite clear data illustrating their lack of utility, changing physician practice patterns is difficult. A systematic review of methods to implement clinical guidelines found that active forms of medical education and multifaceted interventions were most effective in improving physician performance.[8] Creative and effective methods are needed to lead to physician practice change.

Given our observation of the frequency of laboratory testing performed on otherwise healthy children with uncomplicated SSTIs within our own hospital, we implemented a novel educational initiative to decrease ordering of these routine tests. We used simple and inexpensive modifications of famous historical propaganda posters to promote these recommendations. Ordering of routine and unnecessary blood cultures decreased after display of our posters. This decrease in blood culture testing persisted even after removal of the posters, suggesting that practice pattern changes can become ingrained. Although the message conveyed by our posters focused on not ordering routine blood cultures, there was a concomitant decrease in the ordering of other blood tests (CBCs, electrolytes, and inflammatory markers) associated with the poster campaign. Of note, none of the blood culture specimens obtained for any of the patient groups grew any pathogens, which is concordant with previously identified low rates of bacteremia in the uncomplicated SSTI population.

Implementation of this reduced testing strategy did not coincide with any adverse patient consequences such as longer LOS or ED return rates. Although 5 patients in the poster group and 2 patients in the follow-up group returned to the ED, we believe that the return of these patients to the ED was not due lack of testing during their initial evaluation. We did find an increase in the number of imaging studies obtained after introduction of the poster campaign. This increase in imaging studies may have been due to a number of factors. Our follow-up study period encompassed a new academic year. These novice physicians may not have been as confident in their physical examination skills at detecting drainable abscesses and therefore relied on ultrasound imaging. Alternatively, it is possible that without results of laboratory blood tests, clinicians sought some reassurance in their management decisions from imaging studies. The increase in imaging studies obtained after the poster campaign does not seem to be related to an actual increase in the number of drainable abscesses. The unintended effect of more imaging studies increased medical costs but would have been unlikely to result in negative consequences to the patient such as additional testing or treatment resulting from false-positive blood culture results.

Our study has a number of limitations. First, we were unable to determine if the decrease in routine laboratory testing resulted from less frequent ordering by ED residents and attending staff or a change in the practice of ED nurses either discouraging this testing or no longer asking if laboratory specimens should be drawn while a peripheral intravenous

catheter is placed. Our ED is a training location for many residents from outside institutions doing a pediatric rotation. We were therefore also unable to determine if there was a difference in testing frequency between our own staff and the rotating staff who likely would have had less exposure to the displayed posters and would not necessarily have known the identities of the individuals in the modified posters exhorting less testing. It is possible that the change in testing frequency was unrelated to the presence of the posters, but we believe that the uniqueness and humor of the posters were effective in changing laboratory ordering practices.

CONCLUSIONS

The most important finding of our study is that a simple, inexpensive, and creative marketing technique can be used as an effective tool to change physician laboratory ordering behaviors. Changing the messages displayed in the posters or the individuals depicted will be important for other campaigns to influence specific physician practice patterns. Future efforts should focus on the development of other similarly effective and inexpensive means of positively influencing physicians' behaviors. The increase in imaging studies seen in our poster campaign illustrates the need to monitor and guard against unintended consequences.

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REFERENCES

1. Pallin DJ, Egan DJ, Pelletier AJ, Espinola JA, Hooper DC, Camargo CA Jr. Increased US emergency department visits for skin and soft tissue infections, and changes in antibiotic choices, during the emergence of community-associated methicillin-resistant Staphylococcus aureus. *Ann Emerg Med*. 2008;51(3):291–298
2. Malone JR, Durica SR, Thompson DM, Bogie A, Naifeh M. Blood cultures in the evaluation of uncomplicated skin and soft tissue infections. *Pediatrics*. 2013;132(3):454–459
3. Trenchs V, Hernandez-Bou S, Bianchi C, Arnan M, Gene A, Luaces C. Blood cultures are not useful in the evaluation of children with uncomplicated superficial skin and soft tissue infections. *Pediatr Infect Dis J*. 2015;34(9):924–927
4. Wathen D, Halloran DR. Blood culture associations in children with a diagnosis of cellulitis in the era of methicillin-resistant Staphylococcus aureus. *Hosp Pediatr*. 2013;3(2):103–107
5. Stevens DL, Bisno AL, Chambers HF, et al. Practice guidelines for the diagnosis and management of skin and soft tissue infections: 2014 update by the Infectious Diseases Society of America. *Clin Infect Dis*. 2014;59(2):47–159
6. Reinhardt UE, Hussey PS, Anderson GF. US health care spending in an international context. *Health Aff (Millwood)*. 2004;23(3):10–25
7. Berwick DM, Hackbarth AD. Eliminating waste in US health care. *JAMA*. 2012;307(14):1513–1516
8. Mostofian F, Ruban C, Simunovic N, Bhandari M. Changing physician behavior: what works? *Am J Manag Care*. 2015;21(1):75–84

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