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Variation in the Use of Procedural Sedation for Incision and Drainage of Skin and Soft Tissue Infection in Pediatric Emergency Departments

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Abstract

Objectives—Little is known about procedural sedation use for anxiety and pain associated with skin and soft tissue infections (SSTIs) requiring incision and drainage (I&D). Our objectives were therefore (1) to characterize the use of procedural sedation use for SSTI I&D procedures in pediatric emergency departments (EDs), (2) to compare the frequency of procedural sedation for I&D across hospitals, and (3) to determine factors associated with use of procedural sedation for I&D.

Methods—We performed a retrospective cohort study of pediatric EDs contributing to the Pediatric Health Information Systems database in 2010. Cases were identified by primary *International Classification of Diseases, 9th revision, Clinical Modification* procedure codes for I&D. We used descriptive statistics to describe procedural sedation use across hospitals and logistic generalized linear mixed models to identify factors associated with use of procedural sedation.

Results—There were 6322 I&D procedures, and procedural sedation was used in 24% of cases. Hospital-level use of procedural sedation varied widely, with a range of 2% to 94% (median 17%). Procedural sedation use was positively associated with sensitive body site, female gender, and employer-based insurance, and negatively associated with African American race and increasing age. Estimates of hospital-level use of procedural sedation for a referent case eliminating demographic differences exhibit similar variability with a range of 5% to 97% (median 34%).

Conclusions—Use of procedural sedation for SSTI I&D varies widely across pediatric EDs, and the majority of variation is independent of demographic differences. Additional work is needed to understand decision-making and to standardize delivery of procedural sedation in children requiring I&D.

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Keywords

procedural sedation; incision and drainage; variation in care

Emergency department (ED) visits for skin and soft tissue infections (SSTIs) are rapidly increasing, from 1.2 million visits in the United States in 1993 to 3.4 million visits in 2005. Children and young adults accounted for one-fifth of these visits.¹ Abscessed SSTIs are optimally treated with incision and drainage (I&D).²

Inadequate pain control in children during procedures such as I&D is common.^{3,4} Procedural pain also has adverse consequences that can occur after the procedure, including a heightened pain experience during subsequent procedures.^{5,6} In an effort to achieve adequate pain control, procedural sedation is often used during I&D of abscessed SSTIs in pediatric EDs.^{7,8} Procedural sedation provides a high level of analgesia and potential amnesia for the procedure and also improves patient cooperation. However, procedural sedation puts the patient at risk for respiratory complications and requires additional health care resources that may be challenging to implement in a busy ED.

On the basis of our personal experience in several pediatric EDs, we have observed variation in hospital-level use of procedural sedation for I&Ds of abscessed SSTIs. To date, no studies have examined the use of procedural sedation for SSTI I&D procedures in children across US hospitals. The objectives of this study were therefore to (1) characterize the use of procedural sedation for SSTI I&D procedures in pediatric EDs, (2) compare the frequency of procedural sedation for SSTI I&D procedures across pediatric hospitals, and (3) determine factors associated with use of procedural sedation for SSTI I&D procedures.

Methods

Study Design and Data Source

We conducted a retrospective, observational study using the Pediatric Health Information System (PHIS) database. PHIS contains administrative data about inpatient, ED, ambulatory surgery, and observation stays at 47 not-for-profit, tertiary-care pediatric hospitals in the United States (as of September 2014). Participating hospitals are affiliated with the Children's Hospital Association (Overland Park, KS). Hospitals submit deidentified encounter data, including demographics, diagnoses, procedures, and resource utilization (eg, pharmacy, radiology, and laboratory use) into PHIS. Data quality and reliability are assured through a joint effort between the Children's Hospital Association and participating hospitals. In the calendar year 2010, a subset of 38 PHIS hospitals contributed ED data.

This study received approval from the institutional review board at the study institution and from the Children's Hospital Association.

Study Population

Our study population included children aged 6 months to 18 years who were discharged from the ED after being treated for a SSTI with an I&D procedure. We identified patients with a primary *International Classification of Diseases, Ninth Revision, Clinical*

Modification (ICD-9-CM) procedure code for an “other incision with drainage of skin and subcutaneous tissue” (86.04). We then excluded patients whose primary *ICD-9-CM* discharge diagnosis codes indicated skin conditions that were not bacterial SSTIs, including contusions (923.3, 924.3), injuries (915.x, 916.x, 917. x, 927.3, 959.x), open wounds (883.x, 892.x, 893.x), fractures (826.x), fungal infections (110.x), viral infections (078.xx), complications from procedures (998.x), and congenital anomalies (744.x). We also excluded patients with SSTIs who were likely to be anesthetized with a digital block rather than procedural sedation (eg, paronychia [681.x, 703.0], herpetic whitlow [054.6]). Patients who had an operating room charge flag indicating a procedure performed in this setting and those who had a complex chronic condition flag in PHIS, collectively <2% of cases were also excluded. Finally, we excluded 19 hospitals, including 11 that did not report procedure codes for the ED and 6 in which >10% of race/ethnicity or payer data were missing or where other significant data-quality issues were present according to the PHIS data-quality reports. We also excluded 2 hospitals after an examination of ED pharmacy data quality using a gold standard diagnosis (asthma, *ICD-9-CM* diagnosis codes 493.01 and 493.02) for which a specific medication would be expected to be given in a majority of cases (albuterol) revealed much lower rates of medication coding than at other hospitals. Review of the primary *ICD-9-CM* diagnosis codes that occurred in 3 cases in the study population demonstrated that >96% of visits had a primary diagnosis code consistent with a SSTI (*ICD-9-CM* diagnosis codes 680.2, 680.5, 680.6, 682.0-9, 685.0, 686.9, 729.81, 782.2).

Our case identification strategy using *ICD-9-CM* procedure codes was designed to be highly specific for I&D procedures. This strategy, however, may be less sensitive than use of *ICD-9-CM* diagnosis codes.⁹ Additionally, our stringent hospital data accuracy requirements excluded a number of centers. To ensure our method of case identification and restrictions on the study population did not bias our results, we performed a sensitivity analyses using a population with cases identified either by *ICD-9-CM* procedure code 86.04 or by a primary *ICD-9-CM* discharge code indicating an SSTI along with a laboratory code consistent with a wound culture (Supplemental Appendix Table 4) from all 36 PHIS hospitals contributing ED and pharmacy data in 2010.

Primary Outcome

The primary outcome of interest was use of procedural sedation. Procedural sedation was defined as the receipt of any 1 of the following medication(s) within the pharmacy data: ketamine, propofol, nitrous oxide, chloral hydrate, etomidate, fentanyl with midazolam, or pentobarbital.¹⁰ Therefore, procedural sedation included the use of combinations of medications such as benzodiazepine/ketamine and ketamine/propofol but not the use of benzodiazepines alone.

Primary Predictor

The primary predictor of interest was hospital. In accordance with Children's Hospital Association policies, study hospitals are not identified.

Covariates

Although patients were identified for study inclusion based on *ICD-9-CM* procedure code, a primary abscess diagnosis was considered a covariate. This covariate permitted stratification of cases by data quality and allowed us to assess the impact of potentially questionable cases on our regression without excluding them. Patients were considered to have a primary abscess diagnosis if the primary *ICD-9-CM* discharge code was for a diagnosis frequently used for patients with a skin abscess (carbuncle and furuncle [680.x], other abscess [682.x], pilonidal cyst [685.x], other local infection of skin and subcutaneous tissue [686.x], swelling of limb [729.81], localized superficial swelling, mass or lump [782.2]). *ICD-9-CM* diagnosis codes consistent with skin infection but not abscess, such as for cellulitis, were not included in the covariate. An abscess was considered to be at a sensitive body site if the patient had a primary *ICD-9-CM* diagnosis code consistent with oral (054.2, 528.x), auricular (380.x, 382.x), perianal (566.x), peri-neal (607.x, 616), or mamillary infection (611.x). Demographic covariates we considered in the analysis included age; gender; race/ethnicity, divided into 4 mutually exclusive categories: white non-Latino, African-American, Latino, and other; and payer, divided into employer (eg, commercial) and nonemployer (government or other/unknown or self-pay).

Data Analysis

Descriptive statistics were calculated for study population demographics, use of procedural sedation, sedation medication selection, and use of procedural sedation across hospitals. To identify the association of each covariate with use of procedural sedation, we performed a logistic generalized linear mixed model with a single fixed covariate and hospital as a random intercept. To identify the association of each covariate with procedural sedation while accounting for other plausible explanatory variables, a multivariable logistic generalized linear mixed model was fit, which included all covariates of interest and hospital as a random intercept. Covariates were deemed significant at the $P = .05$ level. We report unadjusted and adjusted odds ratios (ORs) with 95% confidence intervals (CIs). Finally, we generated hospital-level estimates of procedural sedation use based on the multivariable generalized linear mixed model for a referent demographic group. The referent group was created using the demographic groups most frequently sedated. Statistical analysis was implemented in R 3.1.0 (Foundation for Statistical Computing, Vienna, Austria).

Results

The study population included 6322 visits, and 93% had a primary abscess diagnosis (Fig 1). The median age was 3.9 years (interquartile range [IQR] 1.8–12.1 years). Among visits, 55% were for female children, 50% were for African American children, and 70% had government insurance (Table 1).

Overall use of procedural sedation for SSTI I&Ds was 24% ($n = 1495/6322$) (Table 2). Ketamine was the primary agent used for procedural sedation, with 69% ($n = 1030$) of sedated patients receiving this medication as their sole sedative agent. Other medications used for procedural sedation were propofol and ketamine (25%, $n = 368$), propofol alone (4%, $n = 62$), and fentanyl and midazolam (2%, $n = 34$). Use of procedural sedation for

SSTI I&D procedures varied widely across hospitals, with a median hospital procedural sedation rate of 17% (IQR 4%–30%, range 2%–94%; Fig 2).

Use of procedural sedation for SSTI I&D procedures was associated with abscess characteristics, age, gender, race/ethnicity, and payer in both the univariate and multivariable models (Table 3). Adjusting for other covariates, those with a sensitive affected body site (adjusted OR 3.4, 95% CI: 1.7–6.8) were more likely to receive procedural sedation, whereas older children, male children (adjusted OR 0.7, 95% CI 0.6–0.8), African Americans compared with whites (adjusted OR 0.7, 95% CI: 0.6–0.9), and children not on employer-based insurance (adjusted OR 0.7, 95% CI: 0.6–0.8) were less likely to receive procedural sedation.

On the basis of this model, estimates of hospital-level use of procedural sedation rates for a referent demographic group (white girls aged 1–5 on employer insurance), eliminating demographic differences, exhibit a degree of variability similar to that of the overall observed rates, with a median of 34% (IQR 11%–62%, range 5%–97%; Fig 3). Whereas some variation in use of procedural sedation between hospitals is associated with the demographic factors listed here, the majority of variation in use of procedural sedation between hospitals is independent of demographic differences.

A total of 15 487 patients were included in the sensitivity analysis. The overall sedation rate for this population was 20%. In multivariable analysis, differences in use of sedation based on gender, age, race/ethnicity, and payer type persisted, albeit with somewhat attenuated magnitudes (Supplemental Appendix).

Discussion

In this study, procedural sedation was used in approximately one-quarter of SSTI I&D procedures. Wide variation exists in the use of procedural sedation for I&D procedures across pediatric EDs. Significant differences in use of procedural sedation are associated with affected body site, age, gender, race/ethnicity, and insurance type. However, the majority of variation in use of procedural sedation between hospitals is independent of hospital-level differences in these patient characteristics.

In our study, ketamine was overwhelmingly the preferred sedative agent, either alone or in combination with propofol. This reflects its desirable properties as an anesthetic, analgesic, and amnestic for this painful procedure.¹¹ Propofol in combination with ketamine may result in a shorter period of sedation while maintaining ketamine's analgesic effects.^{12,13}

To our knowledge, this is the first multicenter study that has demonstrated differences in use of procedural sedation for SSTI I&D procedures across tertiary-care pediatric EDs. Variation in care in pediatric EDs have been described in a number of studies.^{14–17} However, the degree of difference between hospitals in their use of procedural sedation for I&D procedures exceeds typically observed variation. Establishing the presence of variation of care is important because unintended variation has been associated with patient harm^{18,19} and may be driven by physician opinion rather than patient preference.^{19,20} Variation in care

based on hospital of presentation and demographic factors may be a sign of suboptimal care of patients undergoing I&D procedures.

Part of the observed variation may be because procedural sedation is not indicated for all patients requiring I&D procedures. Although I&D is clearly a painful procedure, there is no current standard for the use of procedural sedation for this procedure. For many smaller, superficial abscesses, local anesthesia or systemic analgesia alone may adequately control pain. Therefore, the decision to use procedural sedation for I&D procedure is likely driven in part by abscess characteristics. The PHIS database does not capture specific clinical findings; we are therefore unable to measure these differing characteristics. However, differences in abscess characteristics at the patient-level are unlikely to explain the wide observed variation between EDs in the use of procedural sedation. Alternatively, resource availability may limit the feasibility of using procedural sedation in I&Ds. Procedural sedation requires significant resource utilization including provider time and sedation medications, and although there is minimal risk associated with procedural sedation in the ED,²¹ there still exists both the real and perceived potential for complications. Unmeasured factors at the hospital level, such as hospital culture, patient volume, and nursing and other resource staffing may better explain the wide variation in use of procedural sedation for SSTI I&Ds across pediatric hospitals.

Our study was only designed to examine the use of sedation for I&D procedures performed in the ED. Certain centers may either routinely admit patients for I&D procedures in the operating room or discharge patients to obtain an outpatient I&D procedure in an ambulatory surgery center. Although these strategies potentially allow for procedural sedation use while not straining ED resources, they also potentially represent increased burdens of cost to the medical system and time to patients and their families. Use of these strategies therefore also represents significant variation in care across centers.

Significant differences seen in the use of procedural sedation by demographic characteristics are potentially concerning. In a large study of EDs, less use of parenteral analgesia or sedation for orthopedic fractures was demonstrated among children with African American race/ethnicity and Medicaid insurance.²² Other studies have failed to find similar disparities for sedation or analgesia in forearm fracture reduction,²³ laceration repair,²⁴ long-bone fractures,²⁵ and burns.²⁶

However, these studies examined single centers or smaller populations and may have not been powered to detect the differences in treatment that our study was; in fact, we observed significant differences between demographic groups in a minority of the 19 hospitals when analyzed on a single-center basis. Other factors, such as parent or patient preferences and cultural differences in how pain is regarded in groups, may also contribute to differences between demographic groups. Efforts are needed to mitigate variation in care of patients undergoing I&D procedures based on demographic factors. Clinical practice guidelines have been shown to result in more effective pain management²⁷ and timely care^{28,29} in pediatric EDs and could be used to guide the decision for procedural sedation for I&D for SSTIs.

This study is subject to several limitations. To maximize the specificity of our population, we used *ICD-9-CM* procedure codes to identify patients undergoing an I&D procedure. Although the sensitivity of *ICD-9-CM* procedure codes can be variable, they tend to be more sensitive for invasive procedures such as I&D and have been shown to have a high positive predictive value for a wide range of procedures.⁹ Additionally, data-quality issues limited the number of hospitals included in our analysis, potentially resulting in bias based on hospital selection. However, in the sensitivity analysis on all hospitals submitting ED data and based on a broader case definition, the results were similar, albeit attenuated toward the null, as is expected when there is a true effect and lower-quality data are added. Variation exists in coding practices between hospitals but is not adequate to account for the large interhospital variation in sedation practice observed in our study.

Our retrospective study design does not permit us to determine the etiology of disparities in the use of procedural sedation based on patient demographics and hospital of presentation. Differing ED utilization patterns and disparities in access to care might lead to differing case-mix patterns across socioeconomic groups. For example, individuals with poor access to care might preferentially go to the ED for the care of less significant abscesses, which might not require sedation. Unfortunately, the data are also not adequate to delve into questions of patient and hospital-level factors associated with decisions to sedate, nor are we able to determine the outcomes of use or nonuse of procedural sedation. Our study is also limited to use of procedural sedation in the ED. It is not designed to capture use of sedation for I&D procedures in other care settings. Although this may depress our observed rate of sedation, it also highlights the variation in abscess care across centers.

Given their low numbers, cases in the sensitive body site covariate do not capture the majority of abscesses located at sensitive sites. However, the increased sedation rate in the cases that were captured further validates our regression model. Finally, certain sedation agents, such as nitrous oxide, did not appear in query results. The limitations of using a large database study prevent us from quantifying the extent to which this or other agents were undercoded.

Despite these limitations, this study demonstrates wide variation in the use of procedural sedation for SSTI I&D procedures in pediatric EDs both by hospital of presentation and also based on the demographic characteristics. A better understanding of the drivers of decision-making for procedural sedation is needed to understand the wide variation in its use for SSTI I&Ds. Optimizing resource availability for procedural sedation and reducing the subjectivity of the decision to use procedural sedation through standardization of care may mitigate unjustified variation in its use.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

CI	confidence interval
ED	emergency department
I&D	incision and drainage
ICD-9-CM	<i>International Classification of Diseases, Ninth revision, Clinical Modification</i>
IQR	interquartile range
OR	odds ratio
PHIS	Pediatric Health Information System
SSTI	skin and soft tissue infection

Figure 1.
Enrollment Diagram. CCC, complex chronic care; OR, operating room.

Figure 2. Variation in use of procedural sedation for SSTI I&D procedures by hospital. The gray line indicates overall use of procedural sedation for the study population (24%).

Figure 3. Estimated use of procedural sedation for I&D procedures by hospital for a specific referent demographic group, white girls aged 1 to 5 years with employer insurance, based on multivariable modeling. Error bars represent the upper 95% confidence limit of the estimates. The gray line indicates overall observed sedation rate for the study population (24%).

Table 1**Study Population (*n* = 6322)**

Primary abscess diagnosis,	
<i>n</i> (%)	
Present	5873 (93)
Absent	449 (7)
Body site, <i>n</i> (%)	
Nonsensitive site	6231 (99)
Sensitive site	91 (1)
Age, median in y, <i>n</i> (IQR)	3.9 (1.8–12.1)
Gender, <i>n</i> (%)	
Female	3461 (55)
Male	2861 (45)
Race/ethnicity, <i>n</i> (%)	
African American	3178 (50)
White	1868 (30)
Latino	910 (14)
Other/unknown	366 (6)
Payer type, <i>n</i> (%)	
Government	4422 (70)
Employer	1426 (23)
Other/unknown/self-pay	474 (8)

Table 2**Use of Procedural Sedation**

Covariate	<i>n</i>	Sedated, <i>n</i> (%)
Overall	6322	1495 (24)
Primary abscess		
diagnosis		
Present	5873	1426 (24)
Absent	449	69 (15)
Body site		
Nonsensitive site	6231	1467 (24)
Sensitive site	91	28 (31)
Age		
6 mo–1 y	414	111 (27)
1–5 y	3230	995 (31)
6–11 y	1089	217 (20)
12–18 y	1589	172 (11)
Gender		
Female	3461	886 (26)
Male	2861	609 (21)
Race/ethnicity		
African American	3178	637 (20)
White	1868	540 (29)
Latino	910	217 (24)
Other	366	101 (28)
Payer type		
Government	4422	953 (22)
Employer	1426	447 (31)
Other/unknown/self-pay	474	95 (20)

Table 3
Association Between Covariates and Use of Procedural Sedation for SSTI I&D Procedures

Covariate	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Primary diagnosis not abscess	0.6 (0.4–0.8) ^a	0.4 (0.3–0.6) ^a
Sensitive body site	1.6 (0.9–2.7)	3.4 (1.7–6.8) ^a
Age		
6 mo–1 y	0.8 (0.6–1.0)	0.8 (0.6–1.0)
1–5 y	Referent	Referent
6–11 y	0.4 (0.3–0.5) ^a	0.4 (0.3–0.5) ^a
12–18 y	0.2 (0.2–0.2) ^a	0.2 (0.1–0.2) ^a
Male (vs female)	0.7 (0.6–0.9) ^a	0.7 (0.6–0.8) ^a
White	Referent	Referent
African American	0.6 (0.5–0.8) ^a	0.7 (0.6–0.9) ^a
Latino	0.8 (0.8–1.0)	0.9 (0.7–1.2)
Other	0.8 (0.6–1.1)	0.8 (0.6–1.1)
Government/other payer (vs employer)	0.8 (0.7–1.0) ^a	0.7 (0.6–0.8) ^a

Results from a logistic generalized linear mixed model, with a random intercept for hospital. All covariates listed were included in the model.

^a Significant values.