

# Successful Implementation of a Radiology Sedation Service Staffed Exclusively by Pediatric Emergency Physicians

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## ABSTRACT

**OBJECTIVE.** As the number of diagnostic imaging studies performed has increased, the demand for sedation in support of these radiologic tests has also increased. Our objectives were to (1) assess the safety and efficacy of a radiology sedation service that is staffed exclusively by pediatric emergency medicine (PEM) physicians, (2) determine the frequency and the type of commonly performed pediatric imaging studies that require procedural sedation, and (3) assess the average duration of procedural sedation for commonly performed radiologic studies.

**METHODS.** We conducted a retrospective observational study of patient encounters in 2004 involving procedural sedation to facilitate diagnostic imaging. We are a university-affiliated group of PEM physicians that provide a radiology sedation service during weekdays at a freestanding urban children's hospital.

**RESULTS.** The sedation service participated in 1285 patient encounters during the study period. Deep sedation was provided to 1027 patients. Moderate sedation was administered to 258 patients. Procedural sedation times for the most frequently performed imaging studies ranged from 5 to 183 minutes. Agents that were used to provide deep sedation were pentobarbital (with midazolam, fentanyl, or both) in 65% of cases, propofol in 31%, and ketamine (with or without midazolam) in 4%. Moderate sedation was achieved with chloral hydrate in 86% and oral diazepam in 14% of the cases. A total of 99.1% of the imaging studies were completed successfully. Six imaging studies were aborted because of failed sedation or occurrence of adverse event. Five patients who were deemed high risk on their presedation evaluation were referred electively for general anesthesia.

**CONCLUSIONS.** Our data suggest that a dedicated sedation team in support of diagnostic imaging services, staffed exclusively by PEM physicians, can be a successful clinical enterprise. The service consumes significant resources and physician time.

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### Key Words

emergency physicians, radiology, sedation

### Abbreviations

PEM—pediatric emergency medicine

RSS—radiology sedation service

ASA—American Society of Anesthesiologists

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**P**ROCEDURAL SEDATION IN radiology departments historically has been performed under supervision by pediatric radiologists or anesthesiologists.<sup>1-17</sup> With an increase in the frequency of imaging studies in pediatrics, there has been a corresponding increase in demand for procedural sedation to facilitate these radiologic tests. Moreover, regulatory changes from Joint Commission on Accreditation of Health Care Organizations have required hospitals to develop guidelines for safe delivery of sedation and analgesia.<sup>18</sup> Limited resources within departments of anesthesiology and an overall increase in procedural sedation outside the traditional operating room setting have led to the provision of this service by nonanesthesiologists.<sup>19,20</sup> More recently, pediatric emergency medicine (PEM) physicians have begun to provide sedation for imaging studies to meet this increasing demand.<sup>21</sup>

Compared with adults, children have greater risks associated with deep sedation.<sup>22,23</sup> In addition, the resources that are consumed during deep sedation are greater for children than for adults.<sup>22,23</sup>

Deep sedation (or monitored anesthesia care) involves monitoring that is sufficient to anticipate the potential need to administer general anesthesia during procedures. It requires careful and continuous evaluation of various physiologic functions and recognition and treatment of adverse events. The Center for Medicare and Medicaid Services (CMS) recognizes this type of service as payable, if medically necessary. The national Correct Coding Initiative of the Center for Medicare and Medicaid Services recommends the use of anesthesia codes for deep sedation when administered by another physician or anesthesiologist in support of a radiologic procedure.<sup>24</sup>

The objectives of our study were to (1) assess the safety and efficacy of a radiology sedation service (RSS) that is staffed exclusively by PEM physicians, (2) determine the frequency and the type of commonly performed pediatric imaging studies that require procedural sedation, and (3) assess the average duration of procedural sedation for commonly performed radiologic studies.

## **METHODS**

This retrospective observational study analyzed our experience providing a RSS. We are a university-affiliated group of 12 academic PEM physicians who provide sedation between 7 AM and 5 PM, Monday through Friday, in support of radiologic procedures at an urban tertiary-level children's hospital. The group is also responsible for staffing the emergency department, whose annual census is 70 000 patient visits.

Our RSS, staffed exclusively by board-certified or -eligible PEM physicians, was established in September 2003. The hospital administration had initially approached our division about this service opportunity.

We provide coverage from 7 AM to 5 PM on weekdays. A dedicated PEM provider was solely responsible for staffing the service. This physician does not have any additional patient care responsibilities in the emergency department. All of the PEM physicians in our group provide rotating coverage for the sedation service.

This was a consecutive sample of patients who received procedural sedation in the department of radiology. We obtained patient encounter data from billing records of patients who received care from our RSS during 2004. All cases were captured and had a bill submitted by our billing company. This was independent of whether the bill was eventually written off. No cases were excluded.

Our standard record for a patient encounter involves 4 pieces of documentation. First is a consultation report rendered by the PEM physician, at the request of the radiologist. This includes a standardized presedation risk assessment. Second, it includes documentation by the sedation nurses of their presedation screening and monitoring during the procedure. Third is generation of a billing encounter form. Fourth is an entry of key identifiers into a sedation log. The log includes the patient name, medical record number, type of drugs administered, and documentation of any adverse events or sedation failure. Our sedationists complete these 3 forms contemporaneously. We have included a blank template of the consultation report, sedation record, and encounter form as Figs 1, 2, and 3, respectively.

Cases that involved an adverse event or a sedation failure were identified from the sedation log, and the complete sedation record then was reviewed retrospectively for additional details. An adverse event was deemed significant when it resulted in interruption of the scan or precluded completion of the radiologic study. A sedation failure was defined as noncompletion of a radiologic study because of inability to achieve an optimal sedation level despite maximum doses of sedative medications. The latter was based on our institution's preapproved medication protocols (Table 1) and clinical judgment of the sedationist.

Usually, the sedationist monitors 1 patient at any given time. However, 1 patient may be induced while the other is being recovered after the scan is completed. Nil per os criteria were in accordance with the institution's guidelines (Table 2). They are based on the American Society of Anesthesiologists' (ASA's) procedural sedation fasting guidelines.<sup>25</sup> Details of adverse events encountered were obtained by review of the logbook by one of the authors (J.P.). The medical record then was retrieved to obtain additional clinical details and outcome.

Our medical billing company, Med-A.R.M., Inc, which has been in operations since 1986, employed the chart abstractors. Their mission is to provide excellence in accounts receivable management. Two abstractors



**REPORT OF CONSULTATION**

Pt. Name \_\_\_\_\_ Med. Rec. # \_\_\_\_\_

Dr. \_\_\_\_\_  
Name of Consultant

**CONSULTANT'S REPORT**  
(Examination of Patient & Record; Opinion & Recommendations)

**Request:** "Consult received by Dr. \_\_\_\_\_ to evaluate the need for sedation / analgesia to perform \_\_\_\_\_"

**Age:** \_\_\_\_\_ **Reason ( i.e.dx ) for procedure** \_\_\_\_\_

**HPI ( brief ):** \_\_\_\_\_

**PMHx:** \_\_\_\_\_

**PSH Procedure Hx.** \_\_\_\_\_ **WITHOUT Complications** \_\_\_\_\_ **Time of last meal:** \_\_\_\_\_  
\_\_\_\_\_ **WITH Complications** \_\_\_\_\_

**Allergies: ( Drug and foods particularly peanuts and eggs )** \_\_\_\_\_

**Medications** \_\_\_\_\_

**PE:** **Wt.** \_\_\_\_\_ **kg** \_\_\_\_\_ **HR** \_\_\_\_\_ **BP** \_\_\_\_\_ **RR** \_\_\_\_\_ **Temp** \_\_\_\_\_  
**SpO2** \_\_\_\_\_

**Airway:** **Mal.** \_\_\_\_\_ **I** \_\_\_\_\_ **II** \_\_\_\_\_ **III** \_\_\_\_\_ **IV** \_\_\_\_\_ **Oral Aperture:** \_\_\_\_\_ **Nim** \_\_\_\_\_ **Decreased** \_\_\_\_\_

**Neck Extension:** \_\_\_\_\_ **Nim** \_\_\_\_\_ **Decreased** \_\_\_\_\_ **Teeth:** **Present** \_\_\_\_\_ **Y** \_\_\_\_\_ **N** \_\_\_\_\_

**HEENT** \_\_\_\_\_ **Pulm** \_\_\_\_\_ **Loose** \_\_\_\_\_ **Y** \_\_\_\_\_ **N** \_\_\_\_\_

**CVS** \_\_\_\_\_ **Neuro** \_\_\_\_\_

**Procedure / Sedation Note:** \_\_\_\_\_

**ASA Class:** **I** \_\_\_\_\_ **II** \_\_\_\_\_ **III** \_\_\_\_\_ **IV** \_\_\_\_\_

**Start Time:** \_\_\_\_\_ **End Time:** \_\_\_\_\_ **Total Time:** \_\_\_\_\_

**Agents Used and Amounts** \_\_\_\_\_

**Adverse Reactions and Interventions** \_\_\_\_\_

\*Patient was provided continuous monitoring throughout the procedure and was recovered according to sedation protocol.

Date of Consultation: \_\_\_\_\_ Signature of Consultant \_\_\_\_\_ M.D.

PS001222.0304

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REPORT OF CONSULTATION

FIGURE 1  
Sedation consultation report.

were assigned to recording data from our sedation encounter forms (Fig 3) The abstracted data points included the ASA physical status modifier, start time, end time, and type of sedation. A systems analyst, who has a bachelor's degree in computer science and is employed by Med-A.R.M., conducted the data analysis. The chart abstraction process by the billing company did not involve subjective interpretation of the encounter but rather transfer of data from the encounter form to a

spreadsheet. The level of sedation, as noted on the billing encounter form, was based on whether the patient had received oral or parenteral medications.

At our institution, board-certified PEM physicians, critical care physicians, and anesthesiologists are approved for procedural sedation (moderate and deep) on the basis of their advanced training and core hospital privileges. Pediatricians and PEM fellows must obtain moderate sedation privileges through the medical staff



## Pediatric Sedation Specialists, P.C.

**Date of Service:** \_\_\_\_\_  
Mo. Day Yr.

**Patient Name:** \_\_\_\_\_ **DOB:** \_\_\_\_\_

**Account#** \_\_\_\_\_ **FIN#** \_\_\_\_\_

Diagnosis:	Physical Status Modifier	MedArm Office Use Only
Procedure: (CPT) _____	<input type="checkbox"/> P1 (Healthy) 99101	CPT: _____
Base Units: _____	<input type="checkbox"/> P2 (Mild systemic dis.) 99102	CPT: _____
MAC Start Time: _____	<input type="checkbox"/> P3 (Severe systemic dis.) 99103	CPT: _____
MAC Stop Time: _____	<input type="checkbox"/> P4 (Severe dis. threat to life) 99104	Stop Time _____
	<input type="checkbox"/> P5 (Moribund) 99105	Start Time _____
	<input type="checkbox"/> < 1 YR. 99100	Total Time _____
	<input type="checkbox"/> Emergency 99140	
Radiologist/Clinician: _____	Location: CT   MRI   US   ED	

FIGURE 3  
Sedation billing encounter form.

### SEDATIONIST

- Forsythe    Godambe    Herman    Knepper    O'Donnell    Pollack  
 Gilmore    Hanna    Hertz    O'Connor    Pershad    Sweeney

### MEDICAL DIRECTION

- MAC, Personally Administered Medications  
 MAC, Medical Direction, Nurse Administered Medication  
 Moderate Sedation  
 Mild Sedation (Anxiolysis)

### CONSULTATION

- 99241   Limited   (15 min)  
 99242   Expanded   (30 min)  
 99243   Detailed   (45 min)  
 99244   Comprehensive   (60 min)  
 99245   Complex   (>60 min)

**TABLE 1 Medication Dosing Protocols**

Agent	Dose	Maximum	Adjuvant Agents
Pentobarbital	IV: 1–3 mg/kg	100 mg	Midazolam, Fentanyl
Propofol	Loading: 1–2 mg/kg Infusion: 3–9 mg/kg per h Additional: 0.5–1 mg/kg	Titrated to effect	None
Ketamine	Initial dose: 1–2 mg/kg Additional: 0.5–1 mg/kg	Titrated to effect	Midazolam
Fentanyl	IV: 1–2 µg/kg	50 µg per dose	Midazolam
Midazolam	Oral: 0.5 mg/kg IV: 0.1–0.4 mg/kg	12 mg, 8 mg	None
Chloral hydrate (oral)	Initial: 50 mg/kg Additional: 25 mg/kg	1 g	None

IV indicates intravenous.

**TABLE 2 Nil per Os Criteria**

Ingested Material	ASA Criteria, h	Institutional Criteria, h
Clear liquids	2	2
Breast milk	4	4
Infant formula	6	6
Nonhuman milk	6	6
Light meal	6	6

credentialing process. Their training requires completion of a 4-hour didactic sedation course, obtaining a passing score on the posttest, demonstration of airway competency skills, a current Pediatric Advanced Life Support certification, and advanced airway training in rescue bag–valve–mask and intubation techniques. They are also required to perform 5 procedural sedations under

the supervision of a PEM physician with privileges in provision of moderate and deep sedation (Fig 4).

**RESULTS**

Total visits to the radiology department during this period were 49 804. There were 2473 MRI, 7494 computerized tomography, and 688 nuclear medicine imaging studies performed. The RSS recorded 1285 patient encounters that required varying degrees of sedation to facilitate diagnostic imaging. A total of 1027 patients received deep sedation, generating 11 135.6 anesthesia work units. Anesthesia units refer to time units of 15-minute duration. They represent the time when the patient was monitored continuously by the sedationist. A total of 258 patients were administered moderate sedation, 10 of whom were inpatients. Consultation Cur-

FIGURE 4  
Departmental sedation privileges.

DEPARTMENTAL SEDATION PRIVILEGES			
<b>Name</b>			
<b>Hospital Privileges Category</b>	<b>I</b>	<b>II</b>	<b>III</b>
<b>Hospital Sedation Privileges</b>	<b>Yes</b>	<b>No</b>	<b>NA</b>
<b>PALS</b>	<b>Yes</b>	<b>No</b>	<b>NA</b>
<b>Advanced Airway Training</b>	<b>Yes</b>	<b>No</b>	<b>NA</b>
<b>Supervision of Clinical Application</b>	<b>Yes</b>	<b>No</b>	<b>NA</b>
<b>Date Signed Off</b>	<b>Month</b>	<b>Day</b>	<b>Year</b>
<b>* Attach MR#s , Dates, Agents Used</b>			
<b>Signature</b>			<b>M.D.</b>

rent Procedural Terminology codes (99241–99245 for outpatients; 99251–99253 for inpatients) were submitted for these encounters, generating 535.68 relative value units.<sup>26,27</sup>

Table 3 lists the frequency, median duration, and range for procedural sedation times for the most commonly performed diagnostic imaging studies. Table 4 shows the ASA risk-class distribution for patients who received deep sedation.<sup>25,28</sup> Sixty-five patients experienced multiple sedations on different days totaling 209 repeat encounters. A breakdown of repeat sedations in individual patients is shown in Table 5. Agents that were used to provide deep sedation were pentobarbital (with midazolam, fentanyl, or both) in 65% of cases, propofol in 31%, and ketamine (with or without midazolam) in 4%. Moderate sedation was achieved by using chloral hydrate (in infants who were younger than 1 year) in 86% of cases and oral diazepam in 14% of the cases. In cases in which painful procedures such as renal biopsy were to be performed, ketamine (with or without midazolam) or propofol (with fentanyl) were also administered.

Three imaging studies were aborted because of failure to sedate despite maximal doses of medications. Three children experienced adverse events. In 2 of these patients, the adverse events precluded completion of their diagnostic imaging. One infant was sedated successfully for a cranial MRI but woke up just before initiation of his neck MRI. The remainder of the studies were accomplished successfully (Table 6).

Five patients were referred electively for general anesthesia because they were deemed high risk on their pre-sedation evaluation. Three of these patients belonged to ASA class IV, and 2 were assessed to have a potentially difficult airway. One patient's intravenous access had infiltrated and precluded additional administration of sedatives. Another patient's imaging study was cancelled when we discovered that the patient had not met our institution's nil per os criteria.

## DISCUSSION

We are aware of 1 previous study that described a propofol-based protocol for sedation to facilitate brief outpa-

**TABLE 3 Sedation Time per Encounter of the Most Frequently Performed Imaging Studies**

Procedure	Count	Median, min	Range, min
MRI brain and brain stem without contrast	429	39	5–183
MRI brain and stem with and without contrast	77	56	18–126
MRI lumbar spine without contrast	50	53.5	25–90
MRI thoracic spine without contrast	51	56	30–113
CT head and brain without contrast	55	19.5	5–102
MRI cervical spine without contrast	15	47	21–83
MRI lower extremity and joint with and without contrast	12	74	26–110

**TABLE 4 ASA Risk Class Distribution**

ASA Class	Frequency
P1	280
P2	678
P3	64
P4	0
P5	0
E2 (emergency)	3
Age <1 y	2
Total	1027

**TABLE 5 Breakdown of Repeat Sedations in Individual Children**

Frequency of Patients	No. of Repeat Sedation Encounters
28	2
24	3
4	4
1	5
2	6
1	7
2	9
1	10
1	13

tient painful procedures in a pediatric emergency department–affiliated short-stay unit.<sup>29</sup> Patients in this study received sedation by a team led by the on-call pediatric emergency attending or fellow. The majority of the procedures were lumbar punctures and bone marrow aspirations. Their data set did not include sedations to facilitate diagnostic imaging. In contrast to the study by Guenther et al,<sup>29</sup> this study involved a range of brief and prolonged outpatient radiologic procedures that were performed by a PEM physician who was solely responsible for procedural sedation in the radiology suite.

Our study demonstrates that although a dedicated RSS is a time- and resource-intensive commitment, PEM physicians can meet the service demands of the radiology department at a high-volume tertiary-level pediatric facility. There was a low incidence of significant adverse events and elective referrals for general anesthesia. This is consistent with preliminary data from an RSS staffed conjointly by PEMs and intensivists.<sup>21</sup>

This study had several limitations. As a retrospective analysis, it was subject to reporting bias. Furthermore, because it represents the experience of 1 center, the data cannot be extrapolated to other settings. In addition, multiple agents, based on the preference of the PEM provider, were administered to facilitate sedation. The lack of a standardized protocol limits comparison across patient groups.

Because we did not include assessment of the depth of sedation as part of our usual protocol for monitoring patients during the study period, the definition of deep and moderate sedation was based on the anticipated level of sedation. When patients received chloral hydrate

**TABLE 6 Sedation Failures and Adverse Events**

Patient	Age, y	Wt, kg	Reason for Study	Study	Comorbidity	Medication History	Medication Received	Reason for Failure or Adverse Event
1	10	80	Precocious puberty, strabismus	Cranial MRI	Seizure disorder, developmental delay, phenobarbital allergy	Topiramate, Keppra, carbamazepine	F (50 $\mu$ g) M (6 mg)	Could not sedate
2	1	8.2	Cerebellar lesion	Cranial MRI	Hydrocephalus, ventriculoperitoneal shunt	None	F (20 $\mu$ g) M (2 mg) P (32 mg)	Could not sedate
3	0.5	7.5	Torticollis, staring spells	Cranial and neck MRI	None	None	CH (575 mg)	Awake after cranial MRI; could not perform neck MRI
4	2	12.2	Left knee infection	MRI leg	Knee cellulitis with prepatellar bursitis	None	M (2.5 mg) P (36 mg) F (24 $\mu$ g)	Could not sedate
5	6	14	Seizure	Cranial MRI	History of 1 seizure	None	M (2 mg) P (42 mg) F (14 $\mu$ g)	Experienced respiratory depression and hypoxia ( $O_2$ saturation 85%); required <5 min of assisted ventilation and 1 dose of naloxone; discharged by inpatient service within 24 h without event
6	2	11.3	Follow-up scan	Cranial MRI	Left midbrain lesion; likely astrocytoma	None	Propofol bolus 21 mg; Maximum infusion: 100 mg/h	Experienced hypotension (BP 60/28) during propofol infusion; infusion rate was decreased, and a 30-mL crystalloid bolus was administered with resolution of hypotension; MRI was completed successfully
7	2.5	12.9	Sinus tract	MRI spine	Lumbosacral pti; gluteal cellulitis, seizures, diabetes insipidus, microcephaly	Zonisamide, valproic acid, DDAVP, Clarithin, clindamycin	M (1 mg) F (10 $\mu$ g)	$O_2$ saturations decreased to 90%, with respiratory distress; MRI was rescheduled the following day and completed successfully without event

F indicates fentanyl; M, midazolam; P, pentobarbital; CH, chloral hydrate; BP, blood pressure.

or oral diazepam, it was considered “moderate” sedation. Parenteral administration of sedatives such as ketamine, pentobarbital, and propofol was considered “deep” sedation. We recognize that several of our patients who were administered propofol- or pentobarbital-based regimens or ketamine may have been assessed under the category of general anesthesia at some time during their procedural sedation. This is a limitation of the study. We have since then incorporated depth of sedation and end-tidal carbon dioxide monitoring to our protocols.

Another limitation of the study was that minor adverse events that did not interfere with the imaging study were not reported. These events included pain on injection, transient hypoxia that resolved with supplemental oxygen, and airway repositioning or emergence reactions that were not systematically assessed. The study also did not compare the frequency of failed sedations, number of patients who were referred for general anesthesia, adverse events and throughput times, and pre- and postintroduction of the RSS. Hence, we cannot assess the impact of implementation of the RSS on the aforementioned patient care-related metrics.

## CONCLUSIONS

Our data suggest that a PEM physician-driven radiology sedation service can be a safe and effective clinical enterprise with a low incidence of significant adverse events and elective referrals for general anesthesia. Sedations for imaging studies consume significant hospital resources and physician time. This information may be helpful to hospital administrators and emergency physician groups that plan to implement a pediatric radiology sedation service.

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Jay Pershad and Barry Gilmore

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