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Abbreviation:
DRG = diagnosis-related group

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Cost Analysis of Adjunct Hypnosis with Sedation during Outpatient Interventional Radiologic Procedures¹

PURPOSE: To compare the cost of standard intravenous conscious sedation with that of sedation with adjunct self-hypnotic relaxation during outpatient interventional radiologic procedures.

MATERIALS AND METHODS: Data were reviewed from a prospective randomized study in which patients undergoing vascular and renal interventional procedures underwent either standard sedation ($n = 79$) or sedation with adjunct hypnosis ($n = 82$). These data were used to construct a decision analysis model to compare the cost of standard sedation with the cost of sedation with adjunct hypnosis. Multiple sensitivity analyses were performed to assess the applicability of these results to other institutions with different cost structures with respect to the following variables: cost of the hypnosis provider, cost of room time for interventional radiologic procedure, hours of observation after the procedure, and frequency and cost of complications associated with over- or undersedation.

RESULTS: According to data from this experience, the cost associated with standard sedation during a procedure was \$638, compared with \$300 for sedation with adjunct hypnosis, which resulted in a savings of \$338 per case with hypnosis. Although hypnosis was known to reduce room time, hypnosis remained more cost-effective even if it added an additional 58.2 minutes to the room time.

CONCLUSION: Use of adjunct hypnosis with sedation reduces cost during interventional radiologic procedures.

Hypnotic and behavioral interventions have been shown to be effective in reducing pain and anxiety associated with invasive medical procedures (1–8). Although authors of several reports (5,9,10) allude to the cost-effectiveness of these interventions, it is difficult to find supportive numeric data that would favor generalized introduction into clinical practice. Results of a recent prospective randomized study (6) showed that adjunct self-hypnotic relaxation provided to patients during interventional radiologic procedures was associated with greater patient comfort, fewer adverse side effects, and shorter room times than when patients underwent only intravenous conscious sedation. The purpose of our study was to compare the cost of standard intravenous conscious sedation with that of sedation with adjunct self-hypnotic relaxation during outpatient interventional radiologic procedures.

MATERIALS AND METHODS

Patients

Input data originated from a prospective randomized study (6) in which the authors assessed the effect of adjunct self-hypnotic relaxation on patient comfort during percutaneous vascular and renal procedures. The patient pool included consecutive consenting patients referred to the Section of Vascular and Interventional Radiology at the University

of Iowa Hospital and Clinics, Iowa City, in 1997 and 1998. The study was approved by the investigational review board for human use and the hospital's nursing committee, and all patients signed an informed consent form prior to enrollment.

Patients were enrolled in the study if they had been referred for any of the following interventional radiologic procedures: diagnostic arteriography, diagnostic venography, thrombolysis, angioplasty, vascular stent placement, placement of vena cava filters, transjugular hepatic biopsy, nephrostomy or nephroureterostomy. Exclusion criteria were severe chronic obstructive pulmonary disease, psychosis, intolerance of midazolam or fentanyl, pregnancy, or inability to hear or understand English. Patients underwent screening with the Mini-Mental State Examination (11). If they passed with a score of at least 24 of a maximum of 30 points, they were randomly assigned to one of three groups. Levels of anxiety or hypnotizability were neither inclusion nor exclusion criteria.

Seventy-nine patients (36 men, 43 women; age range, 18–92 years; median age, 57 years) were randomly assigned to a group undergoing standard intravenous conscious sedation; 82 patients (38 men, 44 women; age range, 19–82 years; median age, 54 years) were randomly assigned to a hypnosis group having additional self-hypnotic relaxation. The physical status classification, according to the American Society of Anesthesiologists, of the patients ranged from 1 to 4, with a mean of 2.23, defined as follows: 1, healthy patient; 2, mild systemic disease; 3, severe systemic disease; 4, acute life-threatening condition. There were no significant differences in group composition with regard to age, weight, sex, disease category, type and complexity of procedure, number of prior procedures, and baseline pain and anxiety levels.

Standard Intravenous Conscious Sedation

All patients were attended by a special procedures nurse and had access to patient-controlled anesthesia with delivery of 0.5 mg of midazolam and 25 µg of fentanyl per request for as many as four requests, with lockout times (when the patient could not access medication) of 5 minutes, followed by a lockout time of 15 minutes. Patients indicated the desire for medication with activation of a bell that signaled the attending nurse to deliver the drugs. Medication was withheld when

the systolic pressure was less than 89 mm Hg, oxygen saturation was less than 89%, or patients developed slurred speech or became difficult to arouse.

The patient-controlled analgesia model was chosen to reduce the possibility of unblinded experimenter bias toward using more drugs in control patients and to ensure that all patients had the same access to drugs. Patient-controlled anesthesia is well suited for acute pain management during and after medical procedures and is thought to enhance comfort while providing patients with a means of control (12,13). In a pilot trial (Lang EV, unpublished observation, 1995) prior to this study, use of a patient-controlled anesthesia pump was tested but was found to be potentially hazardous. Since drug-induced cardiorespiratory emergencies are treated differently from those induced by other causes, rapid knowledge of the drug history becomes important, and entering the recording mechanism of a patient-controlled anesthesia pump could cause undue delay. Therefore, patients were given a reusable attention bell (cost, \$3.50 at office supply stores) that signaled the attending nurse, rather than a machine, to deliver drugs through an indwelling intravenous access route.

To ensure that patients who would hesitate to use the bell would not undergo undue distress, rules for overriding patient-determined analgesia were defined and agreed on by the study and procedure personnel prior to the study. Overriding criteria included *de novo* increase in systolic blood pressure beyond 180 mm Hg, spontaneous complaints, verbal request for drugs, or significant perceived distress. In addition, all patients received 1% lidocaine for local anesthesia for all access sites—typically 10 mL for vascular access and 30–40 mL for percutaneous renal access.

Self-hypnotic Relaxation

The self-hypnotic relaxation intervention was structured in the procedure room by one of four providers (one nurse, one psychology graduate student, two medical students) and has been described in detail previously (14). It included the following standardized behaviors: matching the patient's verbal and nonverbal communication pattern (ie, preference for modes of expression, sitting next to rather than towering over a supine patient); attentive listening; provision of control; swift response to patient requests; encouragement; use of emotionally neutral descriptors (“What

are you experiencing?”); avoidance of negative descriptors (“How bad is your pain?”); and reading of a hypnotic induction script, with a provision for management of anxiety and pain, if needed. In summary, patients were instructed to roll their eyes upward, close their eyes, breathe deeply, concentrate on a sensation of floating, and immerse themselves in a safe and comfortable place (for full text, see reference 14).

The completion time of the hypnotic induction script was 5–10 minutes, and hypnosis was performed while the patient was prepared for the procedure. Since all hypnotic inductions were performed in the procedure suite, the time involved was included in the overall procedure time and, thus, in the cost analysis. All patient-provider interactions were videotaped, and 60 (25%) of 240 were randomly selected to check for adherence to the protocol. Fidelity of treatment administration was invariably high among the providers, and thus not significantly different.

Analysis of variance showed that there was no difference among providers with respect to room time; analysis was performed by using the logarithmic transformation of the procedure times because of skewness of distribution of the raw time data. To assess for theoretic differences among future providers, the reader can refer to two sensitivity analyses (described later) that would reflect the skill of the provider structuring the hypnosis: a sensitivity analysis performed for the effect of room time with hypnosis and another sensitivity analysis for the effect of undersedation with hypnosis.

Decision Analysis Model

The cost of the hypnosis treatment, compared with that of standard treatment, was assessed with a decision analysis model (Fig 1, Table 1) by using commercial software (DATA; TreeAge, Williamstown, Mass). For both treatments, with the decision analysis model the following possible outcomes were used for outpatient interventional radiologic procedures: (a) uncomplicated sedation, (b) oversedation, or (c) undersedation.

Uncomplicated sedation was assumed to be associated with no additional cost. Oversedation or undersedation could result in (a) no additional cost, (b) cost associated with additional intense observation, (c) cost associated with sustained observation, or (d) cost associated with hospital admission. Probabilities of occurrence and associated cost for each of

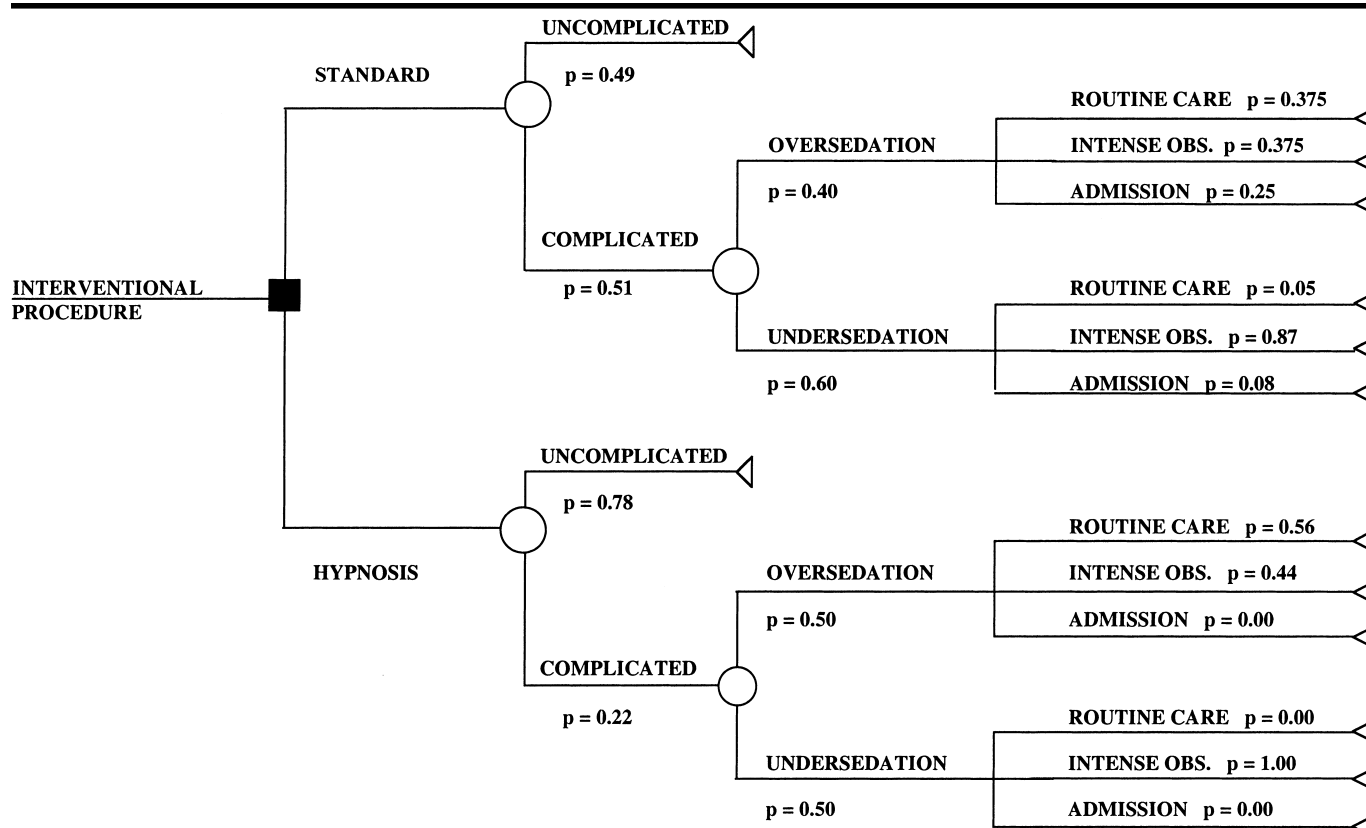


Figure 1. Basic decision tree used to build the model and perform sensitivity analyses. The *P* values are probabilities of the event at the decision branch used in this decision model. OBS. = observation.

these scenarios were derived from our prior experience with the 161 patients. Costs of materials administered during treatment of oversedation or undersedation were omitted because of their negligible contribution—for example, costs for oxygen tubing, emesis basins, and drugs such as nifedipine or atropine were all less than \$1. The analysis was conducted from the perspective of the hospital.

Basic Decision Tree

Since the goal of this study was to provide a generalizable cost assessment for outpatient interventional radiologic procedures, input data for cost were derived from year 2000 costs at Beth Israel Deaconess Medical Center, Boston, Mass, and are listed in Table 1; sensitivity analyses were included to allow for extrapolation to cost structures at other institutions. For the basic decision analysis tree, the assumption was made that all patients would leave the hospital after a 4-hour recovery period unless extended observation or admission were required.

Room time encompassed the period from the patients' entry into the procedure

suite until their transfer to the recovery unit. Average procedure time was 78 minutes in the standard group and 61 minutes in the hypnosis group. Costs for room time included equipment amortization and personnel cost based on local salaries and fringe benefits for one physician, one nurse, one technologist, and one optional additional provider structuring the hypnotic intervention (Table 1).

The basic decision tree assumptions were that the nurse already present structured the hypnosis intervention and, thus, the cost for an optional additional hypnosis provider would be \$0. To allow for the possibility of an additional hypnosis provider in a subsequent sensitivity analysis (Materials and Methods, last section), the cost of one additional health care provider, a psychologist, was included in the room time. In either event, the cost of nursing time was included for the duration of the entire procedure.

Recovery cost included four possible components (Fig 2): (a) immediate postprocedure time (eg, sheath removal, groin compression); (b) basic recovery time (eg, monitoring vital signs); (c) additional intense recovery time, when re-

quired; and (d) sustained observation time, when required. We assumed that one physician and one nurse were required for the immediate postprocedure care and that one nurse was able to monitor up to four patients during the basic recovery time. All patients required immediate postprocedure time and basic recovery time.

If over- or undersedation occurred, we assumed that patients would require additional intense recovery time and that this would have to be monitored by a nurse and physician. The following times were assumed for additional intense recovery time for complications of sedation with hypnosis: oversedation leading to sustained observation or admission, 15 or 30 minutes, respectively; undersedation leading to sustained observation or admission, 30 or 60 minutes, respectively. The following times were assumed for additional intense recovery time for complications of sedation with standard care: oversedation leading to sustained observation or admission, 30 or 60 minutes, respectively; undersedation leading to sustained observation or admission, 45 or 60 minutes, respectively.

TABLE 1
Data Used to Build the Cost Analysis Model

Clinical Factors and Cost	Standard Intravenous Conscious Sedation Group	Sedation with Adjunct Hypnosis Group	Comments*
Basic cost			
Procedure room time	78 min	61 min	NA
Procedure room cost			
Equipment	\$1.60/min	\$1.60/min	\$200,000/y, 52 wk/y, 40 h/wk
Physician	\$1.88/min	\$1.88/min	\$125,000/y, 30% benefits, 45 wk/y, 32 h/wk
Nurse	\$0.56/min	\$0.56/min	\$50,000/y, 30% benefits, 48 wk/y, 40 h/wk
Technologist	\$0.45/min	\$0.45/min	\$40,000/y, 30% benefits, 48 wk/y, 40 h/wk
Optional additional provider	\$0/min	\$47.39/h	\$70,000/y, 30% benefits, 48 wk/y, 40 h/wk
Sum of equipment and personnel	\$4.49/min	\$4.49/min	NA
Basic intravenous setup	\$6.96	\$6.96	NA
Average cost of sedative†	\$4.97	\$2.82	NA
Additional cost for complication of sedation			
Recovery cost for sustained observation‡			
Additional space and nurse for monitoring complications of over- or undersedation	\$100/h	\$100/h	Assumes one nurse and 150 additional square feet of recovery room
Time required to monitor patient for complications of oversedation	1 h	1 h	NA
Time required to monitor patient for complications of undersedation	30 min	30 min	NA
Admission cost			
Blended rate	\$4,273	\$4,273	Medical reimbursement to hospital per 1.00 DRG weight
Admission for oversedation	\$2,540	\$2,540	Average DRG weight of 0.5944
Admission for undersedation	\$3,310	\$3,310	Average DRG weight of 0.7747

Note.—Input data for cost were derived from year 2000 costs at the authors' current institution. Probabilities of occurrence were derived from reference 6.

* NA = not applicable.

† Drug costs were \$0.21 for each 0–200 µg of fentanyl administered and \$4.35 for each 0.5–2.0 mL of midazolam administered. Drug cost averaged \$4.97 per patient in the standard intravenous conscious sedation group, with 14 patients receiving no drugs, 50 patients receiving drugs at a cost of \$4.56 each, and 15 patients receiving drugs at a cost greater than \$9.91 each. Drug cost in the sedation with adjunct hypnosis group averaged \$2.82, with 38 patients receiving no drugs, 38 patients receiving drugs at a cost of \$4.56 each, and six patients receiving drugs at a cost greater than \$9.91 each.

‡ When patients received intravenous sedatives and narcotics within the last 30 minutes of the procedure, 15 minutes of one-on-one nursing time was added to the recovery period to reflect standard intravenous conscious sedation policies. This pertained to 38 (48%) of 79 patients in the standard intravenous conscious sedation group and 27 (33%) of 82 patients in the sedation with adjunct hypnosis group.

If after the intense recovery time the patients still exhibited the effects of over- or undersedation, we allowed for an additional 30–60 minutes of sustained observation time monitored by a nurse. After the time in the interventional radiologic recovery area, all patients either were sent to the day care unit for an additional 4 hours of “outpatient” observation or, if complications necessitated, were admitted to the hospital.

To calculate admission cost for undersedation, we used the average cost weights of diagnosis-related group (DRG) 130, peripheral vascular disorders with complications (cost weight, 0.9427) and DRG 131, peripheral vascular disorders without complications (cost weight, 0.6067). The average cost weight for undersedation was 0.7747. To calculate admission cost caused by oversedation, we used the average cost weight of DRG 99, respiratory signs and symptoms with com-

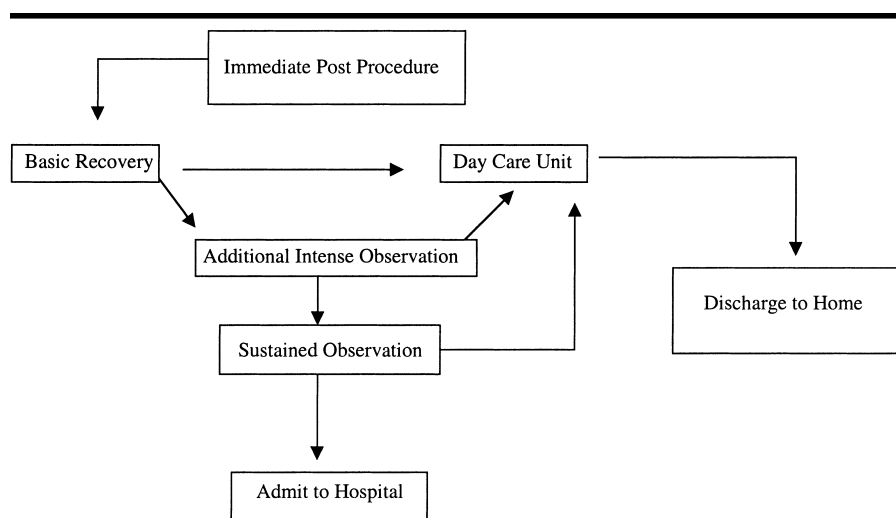


Figure 2. Diagram of patient flow after an outpatient interventional radiologic procedure.

plications (cost weight, 0.6738) and DRG 100, respiratory signs and symptoms with-

out complications (cost weight, 0.5150). The average cost weight for oversedation

TABLE 2
Sensitivity Analyses for Several Variables Used in the Cost Analysis Model

Variables	Base Factor	Factor Range	Cost at Lower Boundary of Range Tested (\$)			Cost at Upper Boundary of Range Tested (\$)		
			Sedation with Adjunct Hypnosis	Standard Intravenous Conscious Sedation	Savings*	Sedation with Adjunct Hypnosis	Standard Intravenous Conscious Sedation	Savings*
Additional hypnosis provider	\$0.78/min	\$0–\$10/min	300	638	338	910	638	–272
Procedure room time with hypnosis	61 min	25–200 min	138	638	500	925	638	–287
Procedure room cost	\$4.50/min	\$2.50–\$10/min	178	482	304	636	1,067	431
Additional observation after procedure for complication of oversedation	1 h	0–5 h	295	631	336	320	669	349
Additional observation after procedure for complication of undersedation	0.5 h	0–5 h	295	625	330	350	758	408
Probability of undersedation with hypnosis treatment	.11	.00–.50	286	638	352	348	638	290
Probability of oversedation with standard treatment	.20	.00–.50	300	489	189	300	858	558
Cost weight for admission because of undersedation	0.7747	0.6067–0.9427	300	620	320	300	657	357
Cost weight for admission because of oversedation	0.5944	0.5150–0.6738	300	621	321	300	656	356
Blended rate	\$4,273	\$2,500–\$10,000	300	550	250	300	923	623

Note.—Input data for base cost were derived from year 2000 costs at the authors' current institution. Probabilities of occurrence were derived from reference 6.

* Savings are the cost of standard therapy minus the cost of hypnosis.

was 0.5944. In both instances, the Medicare blended rate paid to Beth Israel Deaconess Medical Center, Boston, in 1999 (\$4,273) was assumed. The blended rate included technical but not professional fees.

The cost weight is the severity factor assigned to each DRG by the Health Care Financing Administration, or HCFA. It is multiplied by the blended rate—the standardized rate that each hospital is paid—to calculate the exact reimbursement for a specific DRG. For example, if a DRG has a cost weight of 2 and a blended rate of \$5,000, the hospital would be paid \$10,000 for that DRG. An average of two cost weights was used in the basic decision tree to account for institutional variations in DRG coding. Subsequently (Materials and Methods, last section), sensitivity analyses were performed to assess the effect that specific DRG coding of complications may have on our conclusions. The two cost weights for each complication defined the range of the sensitivity analyses.

Oversedation

Oversedation included all events associated with depression of cardiorespiratory or mental status. Oxygen desaturation was included only when a decrease to less than 89% persisted longer than 2 minutes and required placement of a nasal oxygen cannula.

Standard group.—Sixteen (20%) of 79 patients showed signs of oversedation. Six patients with oxygen desaturation incurred no additional cost, except for the nasal oxygen cannula, which was considered a no-cost item. Six patients required intense observation because of prolonged hypoxemia with or without associated cardiovascular depression ($n = 5$) and slow resolution of slurred speech ($n = 1$). Four patients qualified for admission—three because of drowsiness and/or unresponsiveness and one because of continued bradycardia, hypotension, and recurrent bleeding from the puncture site.

Hypnosis group.—Oversedation affected nine (11%) of 82 patients and required no treatment in five patients, except for a nasal cannula. Four patients needed intense observation—one for prolonged hypoxemia with distracting behavior during the procedure, one for transient hypoxemia in recovery, one for being poorly arousable in recovery, and one for bradycardia.

Undersedation

Undersedation included all events associated with incidents requiring staff attention, such as discomfort in recovery, persistent new hypertension, and distracting, attention-seeking patient behavior.

Standard group.—Undersedation was

observed in 24 (30%) of 79 patients. One patient did not need further treatment for transient tachycardia. Twenty-one patients required intense observation for distracting behavior ($n = 10$), discomfort ($n = 6$), hypertension ($n = 3$), or recurrent bleeding from the puncture site ($n = 2$). Two patients qualified for admission because of recurrent bleeding.

Hypnosis group.—Undersedation was encountered in eight (10%) of 82 patients because of discomfort ($n = 4$), hypertension ($n = 1$), and distracting behavior ($n = 3$). All incidents required intense observation.

Sensitivity Analyses

Sensitivity analyses were performed to address how changes in individual input parameters would affect overall outcome and to extrapolate the applicability of these results to those of other institutions with different cost structures. Outcome was considered not sensitive to a parameter if change in the value of this parameter over a given range did not affect overall cost superiority of a treatment (ie, standard or hypnosis treatment). If outcome was sensitive to a parameter, a threshold analysis was performed to determine at what value one strategy became preferable to the other.

Sensitivity analyses were performed for the following parameters (Table 2): (a) cost of an additional hypnosis provider

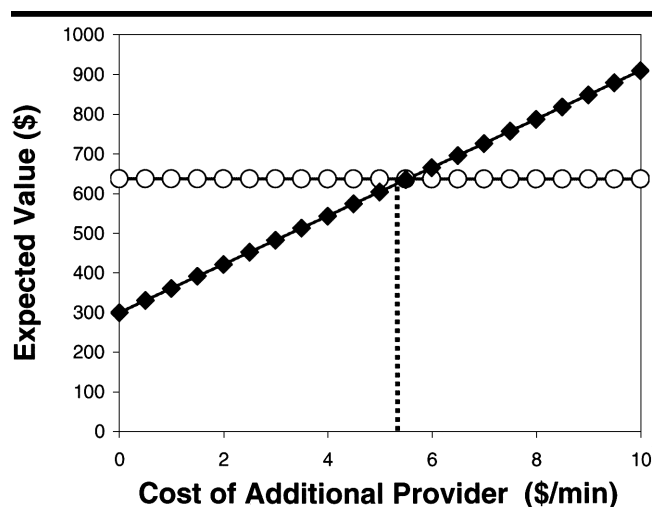


Figure 3. Graph shows the effect of adding a health care provider structuring hypnosis during the procedure. Savings with adjunct hypnosis decrease with increasing reimbursement, in dollars per minute, to this additional provider up to a threshold of \$5.50/min, or \$330/h (dashed line), beyond which it is more costly to provide adjunct hypnosis. The expected value is the cost in dollars for standard therapy (○) versus that for hypnosis (◆).

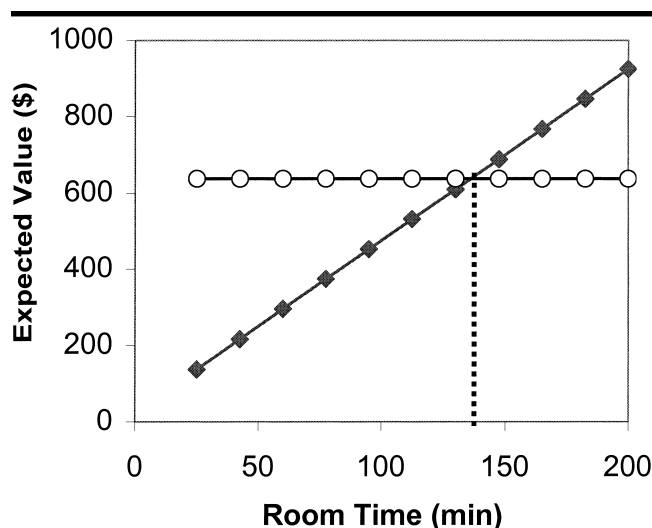


Figure 4. Graph shows the effect of room time in minutes required for an interventional radiologic procedure by using hypnosis divided by the expected value, which is the cost in dollars for standard therapy (○) versus that for hypnosis (◆). The cost of standard therapy is constant at an average procedure duration of 78 minutes. According to conditions of the basic decision tree, a procedure with hypnosis lasts, on average, 61 minutes. The threshold value (dashed line) is the room time at which the cost of hypnosis is equal to the cost of standard therapy. As long as interventional radiologic procedures performed with hypnosis require fewer than 136.2 minutes, it is more cost-effective to perform hypnosis than to perform standard therapy.

of \$0–\$10/min; (b) room time for use of hypnosis of 25–200 minutes; (c) hours of additional observation after the procedure for complications related to over- or undersedation of 0–5 hours; (d) probability of oversedation with standard treatment with *P* values between .00 and .50; (e) probability of undersedation with hypnosis treatment with *P* values between .00 and .50; (f) cost for admission caused by undersedation of \$0–\$10,000; (g) cost weight for admission caused by undersedation of 0.6067–0.9427; (h) cost for admission due to oversedation of \$0–\$10,000; (i) cost weight for admission due to oversedation of 0.5150–0.6738; (j) a blended rate of \$2,500–\$10,000; and (k) hourly cost of the procedure room of \$2.50–\$10/min.

RESULTS

Basic Decision Tree

Figure 1 illustrates the decision analysis tree with the associated probabilities of each outcome (derived from reference 6). Average sedation cost for standard treatment was \$638 and for hypnosis treatment was \$300, which resulted in an average savings of \$338 per case with hypnosis.

Sensitivity Analyses

Data used in the sensitivity analyses are presented in Table 2. The sensitivity analysis allowed us to calculate the effect

that changing one variable would have on the total costs associated with hypnosis or standard therapy. The lower and upper boundaries correspond to the lowest and highest values assumed for each variable tested. These boundaries were chosen to reflect a reasonable range of variation that may be encountered in different clinical practices. In most cases, the range was chosen so that the baseline value was near the center of the range.

Effect of an additional hypnosis provider.—When an additional provider is included to structure the hypnosis treatment, savings realized by using hypnosis decrease to a threshold of a salary of \$5.50/min; when the salary is greater than this amount, standard treatment is more cost-effective (Fig 3). The threshold of \$5.50/min corresponds to \$330/h, or \$633,600/y plus 30% fringe benefits. When the basic decision tree is recalculated for a scenario that includes a staff psychologist at an annual salary of \$70,000 plus fringe benefits, the sedation cost with hypnosis is \$348. This still leaves a cost superiority of \$290 (\$638 minus \$348) per case.

Effect of room time and postprocedure observation time.—When sensitivity analysis was performed with room time of 25–200 minutes while keeping all other variables constant, a threshold value of 136.2 min-

utes resulted for adjunct hypnosis (Fig 4). Thus, as long as average room time with hypnosis does not exceed 136.2 minutes, for a case that would take 78 minutes with standard conditions, hypnosis remains less costly on average. Hypnosis was always more cost-effective over a range of postprocedure observation times of 0–5 hours because of complications of over- or undersedation.

Effect of the probability of oversedation during standard treatment.—Standard treatment was always more expensive than hypnosis treatment over a range of probability between 0% and 50% of oversedation from standard therapy. When the probability of oversedation from standard therapy is 0%, standard therapy costs \$189 more than hypnosis. When the probability of oversedation from standard therapy is 50%, the cost of standard therapy is \$558 more than the cost of hypnosis.

Effect of the probability of undersedation with hypnosis treatment.—Standard treatment was always more expensive than hypnosis treatment over a range of probability of 0%–50% of undersedation from hypnosis therapy. When the probability of undersedation from hypnosis therapy is 0%, standard therapy costs \$352 more than hypnosis. When the probability of undersedation from hypnosis therapy is

50%, the cost of standard therapy is \$290 more than the cost of hypnosis.

Effect of blended rates and cost weights.—The savings with hypnosis increase with an increase in the blended rate, ranging from \$250 (\$550 for standard therapy minus \$300 for hypnosis) at a blended rate of \$2,500 and reaching \$623 (\$923 minus \$300) at a blended rate of \$10,000. We then tested whether the use of the specific DRG used to estimate the cost of complications associated with oversedation or undersedation had an effect on our results. If the cost weight for the DRG used for complications from oversedation increases from 0.5150 (DRG 100) to 0.6738 (DRG 99), the savings from the use of hypnosis increase from \$321 to \$356. If the cost weight for the DRG used for complications associated with undersedation increases from 0.6067 (DRG 131) to 0.9427 (DRG 130), the savings from the use of hypnosis increase from \$320 to \$357. Thus, as the costs of complications increase, the net savings associated with the use of hypnosis, compared with those associated with standard therapy, increase.

Effect of the hourly procedure room cost.—Our base case assumption was that each minute in the procedure room cost \$4.50. As the cost of procedure room time varied between \$2.50 and \$10 per minute, the savings realized by using hypnosis increased from \$304 per case to \$431 per case.

DISCUSSION

With use of adjunct hypnosis, the savings, on average, was \$338 per case in conditions of the basic decision tree. The savings depended strongly on the Medicare blended rate of the institution, which ranged from \$250 per case at a blended rate of \$2,500 to \$623 per case at a blended rate of \$10,000. Thus, high-cost academic centers with high Medicare blended rates are expected to gain most from use of the hypnotic intervention.

The basic decision tree assumption was that hypnosis was provided by an interventional team member, such as a specially trained nurse or technologist. Members of surgical teams can be highly effective in structuring hypnosis during invasive medical procedures (3,15–18) and may be superior to outside personnel (5). If an additional person were to be added to structure hypnosis, cost savings would be less, but still remain substantial at \$290 per case. This latter number was derived from a decision tree by using the

equivalent of a staff psychologist's salary of \$70,000/y plus 30% fringe benefits. Sensitivity analysis showed that adjunct hypnosis is less costly than standard sedation unless the additional person were to demand more than \$330/h. This rate of reimbursement surpasses by far that of most nonphysician specialists and interventionalists, making even their participation in hypnosis worth their time.

If procedure personnel structure hypnosis, the cost of training and continued support should be accounted for. Typically, 24 hours of classroom instruction, supervised clinical instruction, and a second 8-hour workshop suffice for medical personnel to achieve sufficient skills in the methods (6,18). Continued supervision through a psychologist or a physician experienced in hypnosis on a bi-weekly basis is highly desirable.

Whether using procedure personnel is more resource-sensitive than adding a psychologist, who does not need additional training and supervision, depends on personnel turnover and recurrent training cost. The up-front costs of establishing a procedure team–based hypnosis program depend on the level of participation rate of the personnel desired. The cheapest alternative may be to have individual procedure personnel trained at a hypnosis course administered by one of the hypnosis societies (eg, Society for Clinical and Experimental Hypnosis, American Society of Clinical Hypnosis, New England Society of Hypnosis) or other accredited continuing medical education programs. Training an entire team for the procedure has the advantage of creating a supportive climate and providing team members enhanced communication skills that can also be used in nonpatient interactions.

On the basis of which model is chosen and how many persons are selected for training or whether outside trainers are invited, up-front costs are an estimated \$3,000–\$15,000 (estimated on the basis of the prior training cost incurred). From a hospital perspective, these costs are recuperated after using self-hypnotic relaxation in 10–50 patients.

When offered hypnosis training, personnel commonly voice concerns that inducing and maintaining hypnosis in the procedure suite is performed may prolong room time. In the case of adjunct hypnosis, as was used in this study, room time actually decreased from 78 to 61 minutes despite the fact that hypnosis was induced in the procedure suite (6). However, even if hypnosis were to add time to the procedure, it would still be

less costly than standard sedation. Specifically, hypnosis could add up to an additional 58.2 minutes to the procedure time and still have a cost superiority, compared with the cost of standard treatment (Fig 4). These results should dispel concerns that introduction of the self-hypnotic intervention would reduce efficiency or be too costly.

Costs of standard conscious sedation are heavily influenced by the probability of oversedation with intravenously administered sedatives and narcotics. The average amount of sedatives and narcotics administered in standard sedation in patients in this study (1.9 drug units; with one drug unit equaling 1 mg of midazolam or 50 µg of fentanyl) is well within the range of doses commonly used for similar procedures (19) and within the customary range of drugs used in the institution of this study for these types of procedures. Higher doses risk higher probabilities of oversedation; lower doses may result in a less cooperative patient. Hypnotic adjuncts are clinically helpful in that they can provide comfort with less need for intravenous drugs (0.9 units in this study) and thus less risk of oversedation. On the other hand, individuals who are not responsive to the hypnotic intervention may either demand more drugs, and thus be exposed to the risk of oversedation, or remain undersedated. Undersedation with hypnosis also affects cost. Sensitivity analysis shows that even if the probability of undersedation were to reach 80%, hypnosis would still be less costly than standard therapy, with a savings of \$86.

One potential limitation is the use of DRGs to estimate the cost of complications related to over- and undersedation. Although the DRG may not directly correspond to the actual cost of care provided by the hospital, we believe that it is a reasonable proxy. In addition, the use of DRGs incorporates the blended rate paid to each hospital. The blended rate takes into account the hospital's patient population and regional variations in cost. Thus, by varying the severity of the blended rate, our analysis can be easily generalized to other institutions.

The superior clinical effect of hypnosis has already been described in the original article (6) from which the cost data of this study are derived. Thus, this current analysis does not aim at demonstrating the effect of hypnosis on clinical well-being (ie, its effectiveness) but merely on the effect of hypnosis on cost. Several of these events labeled as oversedation or undersedation do not qualify as compli-

cations in the sense of morbidity reporting but rather represent a highly self-critical reporting of any event in deviation of an ideal equilibrium among comfort level, dose of medication, and side effects of medication.

A second limitation is that the cost of room time for the procedure varies among institutions. However, the sensitivity analysis performed on the cost of the procedure room demonstrates that the cost superiority of hypnosis persisted at all values tested from \$2.50 to \$10 per minute (base case, \$4.50/min).

We have previously shown that adjunct hypnosis with intravenous conscious sedation during interventional radiologic procedures is effective in reducing pain, anxiety, and procedure time. Findings of this cost analysis show substantial cost savings when adjunct hypnosis is used. Therefore, the choice between greater patient comfort and lower cost need not be made. Medical benefits of hypnosis for the patient notwithstanding, adjunct hypnosis during procedures is a clinically feasible and cost-saving practice.

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