Impact of Sedation and Resident Teaching on Complications of Colonoscopy

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Key Words
Conscious sedations
Colonoscopy
Complications
Physician training complications

Abstract
There is controversy regarding the frequency of sedation-related complications of colonoscopies and whether these procedures are safely performed by physicians-in-training. We retrospectively reviewed the safety of 1,004 consecutive outpatient colonoscopies. No perforations occurred. No patients were hospitalized for sedation-related complications. Seventeen percent of patients had significant changes in vital signs that lasted less than 5 min. These changes were less common in patients receiving $\leq 3$ mg midazolam intravenously without meperidine ($p < 0.005$). Complications were slightly more frequent in procedures performed by trainees (23%) than by gastroenterologists (12%) and by surgeons (18%) ($p = 0.01$). These data support the safety of colonoscopy under intravenous sedation, even when performed by trainees.

Introduction
Endoscopy is one of the most frequent outpatient procedures performed. Training in endoscopy is an important part of both general surgery residency and gastroenterology fellowship in the United States. Upper endoscopy and colonoscopy are performed using light intravenous sedation also referred to as 'conscious sedation'. Conscious sedation is a depressed level of consciousness that retains the patient’s ability to maintain a patent airway and respond appropriately to physical stimulation and/or verbal commands [1]. This type of sedation is used to elevate the patient’s pain threshold and to provide some degree of amnesia.

Our four affiliated teaching hospitals offer an unusual milieu in which to evaluate practice parameters among physicians-in-training, full-time medical school faculty, and physicians in private practice. We undertook this study to evaluate the safety of colonoscopy when performed by physicians-in-training and to determine the frequency of sedation-related complications.

Patients and Methods
Hospital records of all patients who underwent outpatient colonoscopy at our four affiliated teaching hospitals during a 6-month period (January 1 to June 30, 1994) were reviewed. Patients were continuously monitored during the procedure with pulse oximetry and electrocardiography. Blood pressure was recorded at 5-min intervals.

Records were retrospectively reviewed to determine the indications for colonoscopy, type of physician performing the procedure, and whether diagnostic or therapeutic colonoscopy was performed. Pre-existing cardiac and/or pulmonary disease was noted, as was information on the type of sedation, duration of the procedure, and whether colonoscopy was completed to the cecum.

Procedure-related complications were categorized as technical or sedation related. Technical complications included colonic perfora-
tion and bleeding requiring surgery, repeat colonoscopy, or hospital admission for observation and/or transfusion. Sedation-related complications that lasted less than 5 min and did not require intervention other than supplemental oxygen, intravenous fluids, or reversal of sedation, were classified as mild. Severe sedation-related complications were those that required procedure cessation, administration of drugs other than atropine or narcotic/sedative antagonists, and/or hospital admission.

The occurrence of hypotension (<85 mm Hg systolic), hypertension (>180 mm Hg systolic), decrease in oxygen saturation [SaO₂] below 90%, cardiac arrhythmia (pulse <50, >120, ectopy, or irregular rhythm), cardiac arrest, aspiration and oversedation (patient’s inability to respond to verbal or painful stimuli), and subsequent hospital admission were documented.

Results

Patient Demographics

One thousand and four patients underwent colonoscopy at our affiliated teaching hospitals during this 6-month period. The patients ranged in age from 11 to 89 years (x ± SD; 54 ± 15). Forty-six percent of patients had at least one pre-existing medical condition, the most common being hypertension (30%), or cardiac (12%), pulmonary (7%), hepatic (4%), and renal disease (4%).

Indications for Colonoscopy

The most frequent indications for colonoscopy were rectal bleeding (25%), history of colonic polyps (25%), personal history of colorectal cancer (14%), diarrhea (12%), abdominal pain (12%), and occult fecal blood (8%). Other indications for colonoscopy included abnormal findings on barium enema and family history of colorectal carcinoma among others.

Physicians Performing Colonoscopy

Physicians in private practice performed 560 of the colonoscopies (56%); 216 by gastroenterologists and 344 by surgeons. Full-time medical school faculty performed 21% of the colonoscopies and 23% were performed by physicians-in-training. Diagnostic colonoscopy (with or without biopsy) accounted for 87% of procedures, and colonoscopy with polypectomy for the remaining 13%. Gastroenterologists performed colonoscopy with biopsy or polypectomy more frequently than general surgeons (p < 0.001). The mean duration of diagnostic colonoscopy (x ± SD) was 21 ± 13 min, 30 ± 16 min for colonoscopy with biopsy, and 42 ± 25 min for colonoscopy with polypectomy. The rate of colonoscopy to the cecum was similar for both gastroenterologists and surgeons (94%) and physicians-in-training (93%).

Table 1. Complications in 1,004 colonoscopies

<table>
<thead>
<tr>
<th>Complications</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical</td>
<td></td>
</tr>
<tr>
<td>Bleeding</td>
<td>2</td>
</tr>
<tr>
<td>Anesthetic related</td>
<td></td>
</tr>
<tr>
<td>BP systolic &gt;180 mm Hg</td>
<td>64</td>
</tr>
<tr>
<td>BP systolic &lt;80 mm Hg</td>
<td>36</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>58</td>
</tr>
<tr>
<td>SaO₂ &lt;90%</td>
<td>69</td>
</tr>
<tr>
<td>Unresponsiveness</td>
<td>2</td>
</tr>
</tbody>
</table>

Intravenous Sedation

All patients received intravenous sedation, and all but one received midazolam intravenously (x dose ± SD; 3.8 ± 2 mg). Eighty-four percent of patients received intravenous meperidine (x dose ± SD; 62 ± 29 mg).

Complications

There were no technical or serious sedation-related complications. Given the extremely low incidence of technical complications reported in many large series, however, the number of cases in the present report is too small to permit any conclusions regarding this. Minor sedation-related complications occurred in 174 patients (17%) (table 1). In 13 patients, more than one minor complication occurred. All patients with minor complications responded to conservative treatment such as reversal of sedation, supplemental oxygen, intravenous atropine, or intravenous fluids.

The frequency of minor, sedation-related complications by type of physician performing the colonoscopy is shown in table 2. Minor complications occurred more frequently when colonoscopies were performed by gastroenterologists and surgeons in private practice compared to university faculty (p < 0.05) and when surgical residents or gastroenterology fellows (23%) performed the procedure compared to surgeons and gastroenterologists (16%) (p = 0.012).

Minor, sedation-related complications did not occur more frequently in patients with one or more preexisting condition(s) (p = 0.4). There was no difference in the frequency of minor complications following diagnostic colonoscopy, or colonoscopy with biopsy or polypectomy (18 and 17%, respectively). Minor sedation-related complications occurred less frequently in patients receiving
Table 2. Procedures performed and complications by physician status

<table>
<thead>
<tr>
<th>Physicians</th>
<th>Total patients</th>
<th>Patients with complications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Total gastroenterologists</td>
<td>338</td>
<td>42</td>
</tr>
<tr>
<td>University</td>
<td>122</td>
<td>13</td>
</tr>
<tr>
<td>Private practice</td>
<td>216</td>
<td>29</td>
</tr>
<tr>
<td>Surgeons total</td>
<td>433</td>
<td>78</td>
</tr>
<tr>
<td>University</td>
<td>89</td>
<td>9</td>
</tr>
<tr>
<td>Private practice</td>
<td>344</td>
<td>69</td>
</tr>
<tr>
<td>Physicians-in-training</td>
<td>231</td>
<td>53</td>
</tr>
<tr>
<td>Surgical residents</td>
<td>161</td>
<td>39</td>
</tr>
<tr>
<td>Gastroenterology fellows</td>
<td>70</td>
<td>14</td>
</tr>
</tbody>
</table>

≤ 3 mg midazolam without concomitant meperidine (p < 0.005). Naloxone and flumazenil were administered with the same frequency to patients with complications (22%) and to those without complications (24%). Patients with complications (39%) were not administered supplemental oxygen more frequently compared to those without complications (32%) (p = 0.14).

Three patients (0.3%) were admitted to the hospital following colonoscopy. One patient had inadequate bowel preparation and was admitted for repeat colonoscopy the following day. In another patient, a rectal cancer was identified at colonoscopy, and the patient was admitted to the hospital for anterior rectal resection. The third patient who underwent biopsy polypectomy was admitted for observation of bleeding and discharged the following day.

Discussion

Colonoscopy under conscious sedation has come under the increased surveillance of the Joint Commission for Accreditation of Health Organizations (JCAHO). JCAHO was created in 1918 by the American College of Surgeons in order to ensure the maintenance of standards of hospital care [2]. This body is now a respected, independent review organization. There are no separate JCAHO standards for endoscopy, and the same standards are applied for this as for operations performed under general anesthesia [3]. Under current JCAHO pressures, our university-affiliated hospitals now require detailed, lengthy documentation prior to performing an outpatient endoscopic procedure under conscious sedation.

Mistrust of conscious sedation is based in part on adverse outcomes (including deaths) reported with the use of midazolam, soon after its release [4]. Just as with laparoscopic cholecystectomy, lack of experience and training of physicians in the use of midazolam, led to serious complications a decade ago. The frequency of related complications has decreased and held steady, partly due to the education of physicians and the development of an effective midazolam antagonist, flumazenil.

With standard patient monitoring during endoscopy, using electrocardiography, pulse oximetry and a dynamometer, potential sedation-related complications (such as hypertension, hypotension, and/or cardiac dysrhythmia) can be promptly identified and treated before they become serious. A drop in arterial SaO2 below 90% can also be detected and promptly corrected.

Technical and sedation-related complication rates following colonoscopy are extremely low. The rate of technical complications is only 0.1% with diagnostic and 2% with therapeutic colonoscopy [5]. In sedated patients, cardiopulmonary complications account for most of the morbidity associated with endoscopy. Myocardial ischemia and cardiac arrhythmia [6] are significant cardiorespiratory complications arising secondary to hypoxia. The use of midazolam combined with opiates such as meperidine has been associated with an increased risk of hypoxia, compared to the use of midazolam alone [6]. Our data are in agreement with this. A previous prospective study of concurrent medical conditions did not reveal any factors predictive of hypoxia. Patient age, procedure duration, type and dose of sedative, baseline SaO2, and change in breathing pattern were all not predictive of hypoxia [5]. Importantly, the clinical relevance of SaO2 less than 90% is controversial, since the SaO2 in randomly selected passengers on commercial airlines was less than 90% in 43% of passengers [7].

One anesthesiologist’s report on conscious sedation stated that informed consent for endoscopy should include a warning of possible stroke, nerve damage, and death [8]. The patient on hearing this would immediately choose to have an anesthesiologist administer the sedation. This would dramatically and exponentially increase the already significant costs of endoscopy.

The most certain method of reducing sedation-related complications is to establish formal training requirements for physicians performing these procedures rather than increasing unnecessary and redundant documentation requirements. The American Society for Gastrointestinal
Endoscopy’s (ASGE) guidelines for training in gastrointestinal endoscopy state that the minimum number of supervised colonoscopies to obtain hospital privileges is 100 [9]. This document further states that endoscopic privileges should not be granted on the basis of short, didactic, weekend courses that have been popular in the United States as the principal training experience. The Society of American Gastrointestinal Endoscopy Surgeons (SAGES) has also formulated a similar document [10]. With the encouragement of these organizations, establishment of guidelines for clinical competency and credentials will do more to reduce sedation-related morbidity and mortality than administrative guidelines, which further increase medical costs.

While sedation-related complications are undoubtedly related to both the experience of the investigator and the doses of analgesic or sedative administered, colonoscopy performed under conscious sedation, with current monitoring, is still a safe procedure associated with minimal morbidity when performed by credentialed physicians or supervised physicians-in-training.

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