Original Article

Cardiac Arrests in Patients Undergoing Gastrointestinal Endoscopy: A Retrospective Analysis of 73,029 Procedures

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ABSTRACT

Background/Aims: Airway difficulties leading to cardiac arrest are frequently encountered during propofol sedation in patients undergoing gastrointestinal (GI) endoscopy. With a noticeable increase in the use of propofol for endoscopic sedation, we decided to examine the incidence and outcome of cardiac arrests in patients undergoing gastrointestinal (GI) endoscopy with sedation. **Patients and Methods:** In this retrospective study, cardiac arrest data obtained from the clinical quality improvement and local registry over 5 years was analyzed. The information of patients who sustained cardiac arrest attributable to sedation was studied in detail. Analysis included comparison of cardiac arrests due to all causes until discharge (or death) versus the cardiac arrests and death occurring during the procedure and in the recovery area. **Results:** The incidence of cardiac arrest and death (all causes, until discharge) was 6.07 and 4.28 per 10,000 in patients sedated with propofol, compared with non–propofol-based sedation (0.67 and 0.44). The incidence of cardiac arrest during and immediately after the procedure (recovery area) for all endoscopies was 3.92 per 10,000; of which, 72% were airway management related. About 90.0% of all peri-procedural cardiac arrests occurred in patients who received propofol. **Conclusions:** The incidence of cardiac arrest and death is about 10 times higher in patients receiving propofol-based sedation compared with those receiving midazolam–fentanyl sedation. More than two thirds of these events occur during EGD and ERCP.

Key Words: Cardiac arrest, death, endoscopy, Endoscopc retrograde cholangiopancreatogrphy, Esophagoduodenoscopy, propofol

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Gastrointestinal (GI) endoscopies are commonly performed across the globe and these procedures are on the increase. Over the years, they have evolved from simple diagnostic to complex therapeutic procedures, with increased duration and patient discomfort. To a large extent, the success of these procedures is due to improved sedation techniques including extensive use of propofol. However, they are associated with increased direct costs (drugs, provider's payment, and so on) along with reported sedation-related complications such as cardiac arrest.[1] The incidence of cardiac arrests during outpatient GI endoscopy is likely to be higher than that reported under general anesthesia. Closed claim studies suggest that propofol sedation (PS) is likely to be associated with a higher incidence of cardiorespiratory complications than non–propofol-based sedation (NPBS) during GI endoscopy.[2] However, studies comparing cardiac arrests and their outcome between PS and NPBS are unavailable. In this single center retrospective study, we compared the incidence, causation, and outcome of cardiac arrests in patients who underwent GI endoscopy over a period of 5 years.

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PATIENTS AND METHODS

After obtaining the institutional review board's approval, patient and procedure data of GI endoscopic procedures

performed between 9-08-2008 and 5-31-2013 (our new endoscopy center opened on 9-08-2008) were analyzed. Data from the hospital Clinical Quality Improvement (CQI) and the local registry for the same period were scrutinized for documented cardiac arrests, regardless of their duration and outcome. All adverse events, especially major adverse events like death or cardiopulmonary arrests are entered in a register kept at the nurses' station. Additionally, the concerned physician documents in a hospital reporting system. Both are accessed by the physician presenting the data on a quarterly basis at the continuous quality improvement meetings. The data for the study was obtained from the records kept by both the physician presenting the register at the nurses' station. Patients who displayed asystole, ventricular fibrillation, or pulseless electrical activity requiring cardiopulmonary resuscitation of any duration were included in the definition of cardiac arrest. In effect, cardiac arrest was defined as an event with cessation of pumping action of the heart, requiring CPR, however brief it was. However, the duration of loss of pumping action was not standardized. Many cardiac arrests proceeded with respiratory arrest.

The statistical analysis was performed using SPSS Ver 21 (IBM Inc., Chicago, IL, USA) for Macintosh.

Parametric data was compared using *t*-test and frequency data was compared using the Chi-square test, considering *P* value of 0.05 as significant in comparisons. The denominator included 251 different procedures among a total of 73,029 procedures. This large group was simplified into 14 broad categories based on the type and complexity of the procedures (Tables 1 and 2 in Appendix). The patients who were not given any type of sedation were excluded from the analysis. At the Hospital of the University of Pennsylvania, Philadelphia, propofol sedation is used at either patients' request or referring physician's recommendation. Younger patients and patients who have failed non-propofol sedation are generally sedated with propofol. Some of the gastroenterologists use propofol sedation for all the procedures irrespective of patient- or procedure-related factors. Non–propofol-based sedation was provided using fentanyl, midazolam and occasionally diphenhydramine by the endoscopy nurse under the supervision of the endoscopist, whereas propofol was administered by a certified registered nurse anesthetist (CRNA) or a resident physician under the supervision of a physician anesthesiologist. Statistical comparisons were made between the cardiac arrest events recorded (all causes, irrespective of outcome) in either the propofol or nonpropofol sedation groups. Where available, data was analyzed to find relationships between the frequency of cardiac arrest and the American Society of Anesthesiology (ASA) physical status, Modified Mallampatti (MMP) airway classification, and Body Mass Index (BMI) of the patients.

RESULTS

From a total of 73,029 GI (36,092 males and 36,937 females) endoscopic procedures performed, 20 cardiac arrests were reported [Table 1]. These were the patients who sustained cardiac arrest (irrespective of the outcome) during or after the procedure, irrespective of the length after the procedure. About 28,008 (14,083 males and 13,925 females) procedures received propofol-based sedation, whereas 45,021 (22,009 males and 23,012 females) procedures received non–propofol-based sedation (typically with midazolam, fentanyl, and rarely diphenhydramine). Propofol-based sedation was administered by either a nurse anesthetist or a resident (physician training in anesthesia) under the supervision of an experienced anesthesiologist, whereas non–propofol-based sedation was administered by a registered nurse under the guidance of the endoscopist performing the procedure. Irrespective of the cause of cardiac arrest and death (sedation related, procedure complication related, or unrelated to either of these), patients who received propofol-based sedation had a higher risk of cardiac arrest and death. As displayed in Table 1, the overall incidence of cardiac arrest in patients undergoing GI procedures with PS (6.069 per 10000) was 9.11 times greater when compared with those undergoing GI procedures with NPBS (0.666 per 10000, Chi-square test 12.46, $P < 0.001$). The odds ratio of patient developing cardiac arrest in PS group was 9.109 (95% CI, 2.67–31.079). The incidence of death was even higher, at 11.25 times greater in PS (4.28 per 10000) compared with that of NPBS (0.444 per 10000) with a $P < 0.001$ using Chi-square test.

The incidence of peri-proceudural cardiac arrests in patients undergoing EGD and ERCP was 4.64 per 10,000 peri-procedural in patients receiving propofol sedation, whereas it was zero in patients who received nonpropofol sedation. Airway complications were responsible for 4.12 per 10,000 of these procedures.

Table 2 shows the incidence of cardiac arrests in patients undergoing different endoscopic procedures. Screening and diagnostic colonoscopies had the lowest risk of cardiac arrest. Surprisingly, of the 45,021 procedures performed under

Table 1: Relationship between cardiac arrest (all causes irrespective of duration) and type of sedation (the incidence of cardiac arrest is per 10,000 procedures)

Number of cardiac arrests	Propofol	Non-propofol based sedation (NPBS)
Total arrests	17	3
Deceased	12	2
Incidence cardiac arrest	6.07	0.67
Incidence death	4.28	0.44

nonpropofol sedation, only one patient experienced a brief asystole (possibly vasovagal) in the immediate postoperative period. He received brief cardiopulmonary resuscitation and admitted to emergency room; he was discharged to go home later. However, the therapeutic colonoscopy group had one intraprocedural aspiration that resulted in sepsis followed by death. The patient had received propofol sedation. ERCP had the highest incidence of mortality among all endoscopic procedures.

Where possible, an attempt was made to evaluate the relationship between the cardiac arrest and the ASA status, MMP airway class, and BMI [Tables 3–5]. The majority of cardiac arrests and deaths occurred in patients assigned to ASA status 3. Chi-square test showed a significant association of frequency of arrest to both ASA status ($P = 0.003$, highest being ASA III) and MMP class ($P = 0.03$, highest being in MMP II). Unfortunately, ASA status and MMP status of all 73,029 patients who underwent the procedures was not available; therefore, it was not possible to calculate the risk of cardiac arrest associated with both ASA status and MMP class.

Table 6 documents the details of the patients who sustained cardiac arrests attributable to sedation-related causes (directly or indirectly). These are the patients sustaining cardiac arrest either during the procedure or in the postprocedure recovery area. One patient developed a cerebrovascular stroke during the colonoscopy and died later. Hypoxemia, as a result of hypoventilation, was found to be the leading cause of intraoperative cardiac arrest and all such arrests occurred only during propofol-based sedation. Although successfully resuscitated and discharged home in the majority, 2 patients died in the postoperative period. In 9 patients, cardiac arrests not attributable to sedation resulted from the following: Procedure-related bleeding (3/9), guts perforation (1/9), pancreatitis (1/9), pulmonary embolism (1/9), and undiagnosed cause (3/9). Excluding surgical causes, the sedation-related cardiac arrest incidence was 0.357 per 10,000 in PS and 0.022 per 10,000 in NPBS.

The effectiveness of the following components (for their ability to predict cardiac arrest) was estimated using automatic linear modeling in SPSS: Age at the time of procedure, BMI, ASA status, gender, and type of sedation (propofol vs nonpropofol). The adjusted r^2 value using above modeling was 0.406, with 2 variables displaying possible predictive association with cardiac arrests. Automated predictor importance in SPSS reported a value of 0.96 for "Age at time of procedure" and 0.04 for "increasing ASA" status. However, none of the above factors showed any possible predictive efficacy using the data of patients who sustained cardiac arrest.

DISCUSSION

This is the first study to systematically analyze the frequency, mechanisms, management, and outcome of cardiac arrests during GI endoscopy. The reported incidence of cardiac arrest during general anesthesia and regional anesthesia, is 5.5 and 1.5 per 10,000, respectively.[3,4] Of 5.5 per 10,000 reported by Sprung *et al.*, approximately 50% were related to airway complications. In our analysis, although the total incidence of peri-procedure-related cardiac arrests in patients undergoing upper endoscopic procedures (EGD and ERCP) was 4.64 per 10,000, about 90% (4.12 per 10,000) of these cardiac arrests were related to airway management.

In a closed claim study, it was found that about 50% of all claims in the GI suite were related to propofol-based sedation.[2] Moreover, claims related to death or brain damage resulted predominantly from oversedation, which led to hypoxemia. Our findings are in agreement, with many of the cardiac arrests heralded by sedation-related hypoxemia. However, closed claim studies have two major drawbacks. Firstly, they do not have a denominator. As a result, calculating incidence is not possible. For the first time, we have provided such an incidence from a large sample of patients, sedated with both PS and NPBS. Secondly, closed claim studies often underestimate the actual incidences due to under-reporting of complications.

Table 2: Relationship between type of procedure and cardiac arrest (all causes)

Procedure	Total number of procedures (Propofol/NPBS)	Number of cardiac arrests (Propofol/NPBS)	Incidence of cardiac arrests per 10,000 (Propofol/NPBS)	Number of patients deceased (Propofol/NPBS)	Deceased Incidence per 10,000 (Propofol/NPBS)
Colonoscopy-Diagnostic, screening with or without biopsy	7006/16282	0/1	0/0.61	0/0	0/0
Colonoscopy-Therapeutic	1611/3192	1/0	6.21/0	1/0	6.21/0
EGD-Diagnostic with or without biopsy	7956/11599	5/0	6.28/0	2/0	2.51/0
ERCP-diagnostic and therapeutic	3694/1545	2/1	5.14/6.47	2/1	5.14/6.47
Liver biopsy (under sedation)	5/1811	0/1	0/5.52	0/1	0/5.52
EGD Therapeutic	4210/3509	9/0	21.38/0	7/0	16.62/0

Table 3: Relationship between ASA status and cardiac arrest

ASA status	Number of cardiac arrests	Deceased
1	0	0
2	4	2
3	12	9
4	1	1
Not available	3	2

ASA: American society of anesthesiology

Table 4: Relationship between Airway class and cardiac arrest

Mallampatti airway class	Number of cardiac arrests	Deceased
1	1/0	1/0
2	8/1	6/1
3	4/0	2/0
4	0/0	0/0
Not available	4/2	4/2

Numerator refers to propofol group and denominator non propofol sedation

Table 5: Relationship between body mass index and cardiac arrest

Body mass index	Cardiac arrest	Death
up to 30	9/3	8/2
30-40	3/0	1/0
40-50	0/0	0/0
over 50	0/0	0/0
Not available	4/0	3/0

Numerator refers to Propofol group and denominator non propofol sedation

Other large studies mainly involving endoscopist-directed propofol sedation are available. In a retrospective study (by Rex *et al.*) involving 646,080 patients, the number of patients with sedation-related hypoxemia requiring endotracheal intubation was 11.[5,6] Rex *et al.* did not report any neurological injuries and only 4 deaths. Moreover, among deceased were 2 patients with pancreatic cancer, a severely handicapped patient with mental retardation, and a patient with severe cardiomyopathy. In another prospective study involving 10,000 patients undergoing GI endoscopy with endoscopist-guided propofol, only 3 needed assisted ventilation.[7] No patient experienced laryngospasm or needed endotracheal intubation. There were no deaths or neurological injuries. Another study involving 446 patients undergoing advanced endoscopic procedures, including ASA III/IV patients, found a very low incidence of complications.[8] Apart from minor complications including a 7.9% incidence of <90% oxygen saturation, the safety record was outstanding. No patients required endotracheal intubation or sustained cardiac arrest. The readers are referred to other studies with similar outcomes.[9-12]

The only endoscopist-directed PS involving ERCP patients reported one case of hypoxemia requiring bag mask ventilation and another patient requiring endotracheal intubation.[13] However, a sample size of 156 is too small to make meaningful conclusions.

Data examining the incidence of cardiac arrest in patients undergoing GI endoscopy under propofol sedation administered by anesthesia providers is absent. In a prospective study involving 799 patients undergoing advanced endoscopic procedures,[14] the incidence of hypoxemia was about 13% and no patient required either bag mask ventilation or endotracheal intubation. There were no major complications such as cardiac arrest.

It might come as a surprise that the incidence of cardiac arrest in our study is higher than the only large study referenced above (Rex *et al.*). An explanation is that the endoscopists are likely to be more conservative than anesthesia providers, especially with regard to depth of sedation. With extensive experience in intravenous conscious sedation, they are more likely to provide mild-to-moderate sedation, even with propofol. This is in contrast to anesthesia providers, where the sedation is likely to be deeper. However, when anesthesia providers are utilized, gastroenterologists expect their patients to be sedated to the point of being unresponsive. Lastly, endoscopists might have used anesthesia providers to treat any severe hypoxemia episodes, thereby preventing further deterioration. Additionally, anesthesiologists seem to accept lower oxygen saturations (longer apnea times leading to desaturation) than endoscopists.

Our study has certain inadequacies. It is a retrospective study with its inevitable limitations. The documentation was done in patients chart with no plans to analyze at a later date. However, retrospective studies are more likely to underestimate the incidence of morbidity and mortality. The patient's data such as ASA status and BMI were not available for all the patients. Although hypoxemia was a factor in many cardiac arrests, the factor that triggered hypoxemia was not clear from the documentation. The patients' comorbidity might have played a significant role in the outcome of the resuscitation efforts. The mortality in ERCP group is higher in patients sedated without propofol and is unexpected. However, considering the total deaths (2 and 1) and smaller denominator, they are understandable and of questionable significance.

CONCLUSIONS

In this single-center large retrospective study, cardiac arrest and death are seemingly higher in patients provided with propofol sedation, when compared with non–propofol-based

Table 6: Details of the patients who sustained possible sedation related cardiac arrest during the procedure and in post procedure recovery area

Procedure	Age	ASA	MP	Co-morbidity	Ht/Wt/BMI	Sedation/ Anesthesia	Associated events	Management	Possible causative factor	outcome
EGD with ultrasound	76 F	3	3	IHD, RA, DM	57/143/31.69	Propofol	Hypoventilation, airway obstruction, laryngospasm, loss of IV (EJV)	Brief CPR Mask Ventilation intralingual succinylcholine, ER	Hypoventilation	discharged home
ERCP for bile stones	59M	2	1	Chronic AF/HT	79/287/32	Propofol	Hypoventilation/ Hypoxemia/ cardiac arrhythmia/ cardiac arrest	Nasal airway/O2 followed by turning supine and ETT CPR> 30 min Rhythm BP restored, transferred to ICU dies few hours later	Hypoventilation	died
EGD	41F	3	2	IHD/HT/AS/MR/ CRF-HD	60/120/23	Propofol/ FEN/KET	Hypoventilaion/ hypoxemia/ cardiac arrest	Nasal airway ETT Prolonged CPR	Hypoventilation	Anoxic brain injury/died after 9 days
EGD	68 M	3	2	Heart transplant/ kidney transplant	64/188/32	propofol	Asystole after endoscope withdrawal	No CPR, Epi, ER, ICU	Unknown	Discharged home
EGD	68 M	3	2	HT, CKD, Metastatic Prostate CA, Cardiomyopathy	70/183/26	Fentanyl, etomidate,vecuronimum,sevoflorane	Was not reversible from muscle relaxants in OR, transferred intubated to ICU	CPR, full code	Hypoventilation after extubation in ICU within 60 minutes after transfer	died
EGD dilation	70F	3	3	Bronchiectasis	64/85/14.94	Propofol, Fentanyl midazolam	Hypoventilation Hypoxemia	Brief. CPR, LMA, ER, ICU	Hypoventilation	Discharged home
EGD US	70 M	2	2	OSA,CPAP	68/198/30.83	Fentanyl, propofol	Hypoventilation Hypoxemia	Brief CPR, LMA, ER, Admission	Hypoventilation	Discharged home
EGD-dysphagia-stent occlusion	67M	3	2	Recurrent esophageal CA	69/139/20	MAC with Fentanyl-Propofol After 10 mins desaturation, intubated	Aspiration during the initial part of procedure ETT after 10 minutes	Post op arrest due to intra-op cause DNR	Hypoventilation	Died
Colonoscopy, recto-sigmoid baloon dilation	56 M	3	2	Esophageal ca, Esophagectomy, colonic metastasis	67/117/18.77	Propofol fentanyl	Aspiration during end of the procedure	Immediate post op Sepsis Syndrome Post op ETT, ICU	Hypoventilation	Died next day
colonoscopy	M		3	HT/CAD/MI-Post stent	70/168.5/25	propofol	Post procedure (immediate) stroke	ETT, DNR	stroke	Uncal herniation death
colonoscopy	67 M	2	2	HT,HL	72/194/26	Fentanyl, Midazolam	Unexplained immediate post-operative brief Asystole	brief CPR Vasopressor/ atropine	vasovagal	ER and Discharged home

Ht: Height; Wt: Weight; BMI: Body Mass Index; ASA: American Society of Anesthesiologists physical status; IHD: Ischemic heart disease; DM: Diabetes Mellitus; RA: Rheumatoid arthritis; OSA: Obstructive sleep apnea; CPAP: Continuous positive airway pressure; EGD: Esophagoduodenoscopy; ER: Emergency room; CPR: Cardio Pulmonary Resuscitation; EJV: External Jugular Vein; IV: Intravenous; AF: Atrial Fibrillation; HT: Hypertension; ERCP: Endoscopic Retrograde Cholangiopancreatography; O2: Oxygen; ETT: Endotracheal tube; ICU: Intensive Care Unit; AS: Aortic Stenosis; MR: Mitral Regurgitation; CRF: Chronic Renal Failure; HD: Hemodialysis; HL: Hyperlipedemia; MI: Myocardial Infarction; CA: Carcinoma; FEN: Fentanyl; KET: Ketamine; Epi: Epinephrine; Intraop: Intraoperative; LMA: Laryngeal Mask Airway; CKD: Chronic Renal Disease; DNR: Do Not Resuscitate

intravenous conscious sedation. Although sedation-related hypoxemia was one of the associated factors during intraprocedural cardiac arrests, a cause and effect relationship could not be consistently established. Case selection might have contributed, although it could not be demonstrated in our analysis. A multicentric prospective study might address the contribution of sedation, especially propofol-mediated deep sedation to cardiac arrests.

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APPENDIX

Appendix Table 1: Master chart displaying the procedures performed over about 5 years

Procedure name	Category
Colon ca scrn not hi rsk ind	1
Colonoscopy w/biopsy	1
Colonoscopy, diagnostic	1
Colonoscpy, flexibl, proximl to splenic flexure; with biopsy, single or multiple	1
Colonscpy flex; intramural/transmural fna/bxs	1
Colonscpy, flexib, proximl-splenc flexur; dx, w, w/o collctn-specimn-brush/wash	1
Colorectal cancer screening; colonoscopy on individual at high risk	1
Colorectal scrn; hi risk ind	1
Colorectl cancer screening; colonscpy on indivdl not meeting criteria-high risk	1
Colonoscpy thru stoma; with biopsy, single or multiple	2
Colonoscope dilate stricture	2
Colonoscopy w/snare	2
Colonoscopy with clip placement	2
Colonoscopy, flexible, proximal to splenic flexure; w/ transendoscopic stent place (w/ predilation)	2
Colonoscopy, ablate lesion	2
Colonoscopy, control bleeding	2
Colonoscopy, flex, proximl to splenic flexure; with removal of foreign body	2
Colonoscopy, remv foreign body	2
Colonoscopy, remv lesn, snare	2
Colonscpy, flex, proximl-splenc flexr; w/contrl-bleedng (e.g., INJC, bipolr CAUT, etc)	2
Colonscpy, flex, proximl-splenc flexur; w/trnsendscpc stent plcmnt	2
Colonscpy, flex, proximl-splenc flexur; remvl-tumrs, polyps by hot biopsy forceps	2
Colonscpy, flex, proximl-splenc flexur; w/ablatn-tumrs, polyps not removl-hot bx	2
Colonscpy, flex, proximl-splenc flexur; w/removl-tumors, polyps by snare technq	2
Colonscpy, flex, proximl-splenc flexure; w/directd submucosl injectn (s), any subst	2
Colorectal cancer screening; flexible sigmoidoscopy	3
Pr hemorrhoidectomy internal rubber band ligations	3
Pr rx certified ehr	3
Proctosigmoidoscopy, rigid; w/ transendoscopic stent place (w/ predilation)	3
Proctosigmoidoscopy, rigid; with biopsy, single or multiple	3
Proctosigmoidoscopy, biopsy	3
Proctosigmoidoscopy, ctrl bleed	3
Proctosigmoidoscopy, decompr volvul	3
Proctosigmoidoscopy, remv, lesn, snare	3
Proctosigmoidoscopy, rigid, diagnos	3
Proctosigmoidoscopy, rigid; with dilation (eg, balloon, guide wire, bougie)	3
Proctosigmoidoscopy, rigid+dilatn	3
Proctosigmoidoscopy; rigid, diagnstc, w, w/o collectn-specimen, brush/wash	3
Proctosigmoidoscpy, rigid; w/remvl-single tumor, polyp, othr lesn-snare tech	3
Proctosigmoidoscpy, rigid; with removl-foreign body	3
Proctosigmoidoscpy, rigid; w/ablatn-tumors/polyps, othr lesns not amenabl-rem hot	3
Proctosigmoidoscpy, rigid; w/contrl-bleedng (eg, INJCTN, bipolt CAUT, etc.)	3
Proctosigmoidoscpy, rigid; w/removl-mult tumors, polyps, othr lesns-hot bx forcps	3
Proctosigmoidoscpy, rigid; w/trnsendoscpc stent placemnt (includes predilatn)	3
Sig w/balloon dilation	3
Sigmoidoscope w/submuc inj	3
Sigmoidoscopy, flexible; w/ endoscopic ultrasound exam	3
Sigmoidoscopy, flexible; w/ transendoscopic stent place (w/ predilation)	3
Sigmoidoscopy, flexible; w/ transendoscopic ultrasound guided intra-/transmural fine needle aspir/bx	3

Contd...

Appendix Table 1: Contd...

Procedure name	Category
Sigmoidoscopy, flexible; with directed submucosal injection(s), any substance	3
Sigmoidoscopy, ablate lesn	3
Sigmoidoscopy, biopsy	3
Sigmoidoscopy, ctrl bleeding	3
Sigmoidoscopy, decompress volvulus	3
Sigmoidoscopy, diagnostic	3
Sigmoidoscopy, flexible; w/endoscopic ultrasound examination	3
Sigmoidoscopy, flexible; with biopsy, single or multiple	3
Sigmoidoscopy, flexible; with removal of foreign body	3
Sigmoidoscopy, remv lesn, snare	3
Sigmoidoscopy, remvl F.B.	3
Sigmoidoscpy, flex; w/removl-tumor (s), polyp (s), othr lesion (s) by snare tech	3
Sigmoidoscpy, flex; w/trnsendoscpc stnet placemnt (incl predilatn)	3
Sigmoidoscpy, flex; w/trnsendscpc ultrasnd guided intramurl/trnsmurl fine needle	3
Sigmoidoscpy, flex'w/removl-tumors, polyps, othr lesns-hot bpsy forcps/biplr caut	3
Sigmoidoscpy, flexble; dx, w, w/o collectn-specimn by brushng/washng (sep proc)	3
Sigmoidoscpy, flexible; w/control-bleeding (eg, injctn, bipolr cautry, etc)	3
Sigmoidoscpy, flexible; with decompression - volvulus, any method	3
Sigmoidsc flexible w/abalatn- tumors polyps or other lesions not amend	3
Unlisted procedure, rectum	3
Anoscopy and biopsy	4
Anoscopy and dilation	4
Anoscopy, control bleeding	4
Anoscopy; with biopsy, single or multiple	4
Anoscopy; diagnostc, w, w/o collectn-specimen (s)-brushng/washng (sep proc)	4
Anoscopy; w/removl single tumr, polyps, othr lesn by snare technique	4
Anoscopy; with dilation (eg, balloon, guide wire, bougie)	4
EDG transoral biopsy single/multiple	4
EGD w/duodenum capsule placement	4
Esophagogastroduodenoscopy transoral diagnostic	4
Esophagoscopy flexible transoral with biopsy	4
Esophagoscopy intra/transmural needle aspirat/bx	4
Uppr gastrointestnl endoscpy incl esophags, stomch; dx, w, w/o collctn-specims	4
Uppr gastrointestnl endoscpy incl esophagus, stomach; w/biopsy, single/multiple	4
Double balloon enteroscopy, diagnostic	5
Double balloon enteroscopy, w/biopsy	5
Double balloon enterscopy, w/avm abalation	5
Double balloon enterscopy, w/biopsy and spot injection	5
Double balloon enterscopy, w/bleeding control	5
Double balloon enterscopy, w/snare polypectomy	5
Double balloon enterscopy, w/spot injection	5
Retrograde double balloon enteroscopy, diagnostic	5
Retrograde double balloon enterscopy, w/biopsy and spot injection	5
Retrograde double balloon with snare polypectomy	5
Retrograde single balloon enteroscopy, diagnostic	5
Retrogradedouble balloon enteroscopy, w/biopsy	5
Retrogradedouble balloon enterscopy, w/avm abalation	5
Retrogradedouble balloon enterscopy, w/bleeding control	5
Retrogradesingle balloon enteroscopy, w/biopsy	5
Singel balloon enterscopy, w/spot injection	5
Single balloon enterscopy, w/spot injection	5
Single balloon enteroscopy, diagnostic	5
Single balloon enteroscopy, w/biopsy	5
Single balloon enterscopy, w/avm abalation	5

Contd...

Appendix Table 1: Contd...

Procedure name	Category
Single balloon enterscopy, w/biopsy and spot injection	5
Single balloon enterscopy, w/bleeding control	5
Single balloon enterscopy, w/snare polypectomy	5
SM intest endoscpy, enteroscpy beynd 2nd prtn-duodnm; w/biopsy, singl/mult	5
SM intest endoscpy, enterscpy beynd 2nd prtn-duodnm; w/removl tumor	5
SM intest endscpy, enterscpy beynd sec prtn-duod; w/cntrl-bleedng (eg, injctn)	5
SM intestinal endo/enteroscopy >2nd portion duodenum, not w/ ileum; w/ transendo stent placement	5
Unlisted procedure, intestine	5
Endoscopc retrograde cholangiopancreatogrphy (ERCP); dx, w, w/o collectn-spec	6
Endoscp retrogr cholangiopancreatgrphy-ercp; w/ablatn-tumrs, polyps, othr lesns	6
Endoscopc retrograde cholangiopancreatgrphy (ercp); w/sphinctertmy/papp	6
Endoscopc retrograde cholangiopancreatogrphy (ercp); w/biopsy, single/multiple	6
Endoscopic catheterizatn-biliary ductal systm, radiologcl supervisn and interprtn	6
Endoscopic catheterizatn-pancreatc ductal systm, radiologcl supervsn and interp	6
Endoscopic papilla cannulation bile/pancreatic	6
Endoscp retrogr cholangiopancreatgrp-ecrp; w/endscpc retrogr balloon dilatn	6
Endoscp retrogr cholangiopancreatgrph- ercp; w/endscpc retrgr insertn-tube	6
Endoscp retrogr cholangiopancreatgrph-ercp; w/endscp retrgd remvl-foreign	6
Endoscpc retrogr cholangiopancreatgrph -ercp; w/endscp retrgrd insrtn-stnt	6
Endoscpc retrogr cholangiopancreatgrph-ercp; w/endscpc retrg destrctn	6
Endoscpc retrogr cholangiopancreatgrphy-ercp; w/endscpc retrogr removl-calculus	6
ERCP destruction/lithotripsy calculi any method	6
ERCP dx collection specimen brushing/washing	6
ERCP remove calculi/debris biliary/pancreas duct	6
ERCP, ablation tumor	6
ERCP, balloon dil ducts	6
ERCP, biopsy	6
ERCP, insert stent, biliary/panc	6
ERCP, rmv F.B./Change stent	6
ERCP, sphincterotomy	6
Esoph funct tst ger nasl cath elec plcmt; prolng	6
Unlisted procedure, biliary tract	6
Diagnostic anoscopy	7
Unlisted procedure, anus	7
Biopsy of liver, needle; percutaneous	8
PR biopsy liver needle percutaneous	8
Hemorrhoidectomy, by simple ligature (eg, rubber band)	9
Replace duod/jej tube perc	9
Replace duodenostomy/jejunostomy tube perq	9
Replace G/C tube perc	9
Replace gastrostomy/cecostomy tube percutaneous	9
Ultrasonic guidance-needle placemnt (eg, bx, aspiratn, etc), imaging-supervsn/interp	9
Sm intest endoscpy, enterscpy beynd 2nd portn-duod; w/remvl tumor-snare	10
Uppr gi endo-esoph/stmch; w/band ligatn-esophagl/gastrc varices	10
Uppr gi endo-esoph/stmch; w/removl-tumors, polyps, othr lesns-snare techng	10
Uppr gi endo-esoph/stmch; w/trnsendscpc stent placemnt (incl predilatn)	10
Change gastrostomy tube	10
Change of gastrostomy tube	10
Dilate esoph, balln, >30 mm achalasia	10
Dilation of esophagus, by balloon or dilator, retrograde	10
Dilation of esophagus, over guide wire	10
Edg balloon dilation esophagus <30 mm diam	10
EDG band ligation esophgeal/gastric varices	10

Contd...

Appendix Table 1: Contd...

Procedure name	Category
EDG dilation gastric/duodenal stricture	10
EDG flexible foreign body removal	10
EDG insert guide wire dilator passage esophagus	10
EDG intraluminal tube/catheter insertion	10
EDG intrmural needle aspir/biop altered anatomy	10
EDG intrmural us needle aspirate/biopsy esophags	10
EDG percutaneous placement gastrostomy tube	10
EDG removal tumor polyp/other lesion snare tech	10
EDG transoral control bleeding any method	10
EDG transoral transmural drainage pseudocyst	10
Endoscopy, bowel pouch, biopsy	10
Esophagogastroduodenoscopy (egd) with clip placement for closure	10
Esophagogastroduodenoscopy submucosal injection	10
Esophagogastroduodenoscopy us scope w/adj strxrs	10
Esophagoscopy flex balloon dilat <30 mm diam	10
Esophagoscopy flexib lesion removal tumor snare	10
Esophagoscopy flexible guide wire dilation	10
Esophagoscopy flexible removal foreign body	10
Esophagoscopy flexible transoral diagnostic	10
Esophagoscopy, rigid or flexible; with insertion of plastic tube or stent	10
Esophagoscopy, rigid or flexible; with removal of foreign body	10
Esophagoscopy, rigid or flexible; w/band ligation of esophageal varices	10
Esophagoscopy, ablation tumor	10
Esophagoscopy, insert tube/stent	10
Esophagoscopy, rigid/flexible; w/injection sclerosis of esophageal varices	10
Esophagoscopy, rigid/flexible; w/insertn-guide wire followed by dilatn	10
Esophagoscpy, rigid/flex; diagn, w, w/o collectn-specimem (s)-brush/wash (sep proc)	10
Esophagoscpy, rigid/flex; w/ablatn-tumors, polyps, othr lesns, not hot bx, caut	10
Esophagoscpy, rigid/flex; w/control-bleed (eg, injctn, bi/unipolr cautery, lasr)	10
Esophagoscpy, rigid/flex; w/reoml-tumors, polyps, or othr lesns by snare	10
Esophagoscpy, rigid/flex/w/direct submursosal ant sub	10
Esophagoscpy, rigid/flexible; with biopsy, single or multiple	10
Esophagscpy, rigid or flexble; with baloon dilation (less thn 30 mm diameter)	10
Intestine surg procedure unlisted	10
Intraluminal stricture dilation, radiological supervision and interpretation	10
Mucosal banding	10
SB endoscopy, rmvl lesn, snare	10
SB scope, place percut jejun tube	10
SB scope, to ileum, ctrl bleed	10
Small bowel endoscopy, ablate lesn	10
Small bowel endoscopy, biopsy	10
Small bowel endoscopy, ctrl bleed	10
Small bowel endoscopy, past 2nd duod	10
Small bowel endoscopy, remvl F.B.	10
Small intest endoscpy, enteroscpy beynd 2nd prtn-duodnm; w/removl-foreign body	10
Small intest endoscpy, enteroscpy beynd 2nd portn-duodnm/ileum; diagnostic	10
Small intestine endoscopy with balloon dilation	10
Small intestnl endosc, enteroscp beynd 2nd prtn-duodnm; w/trnsendscpc stent place	10
Small intestnl endoscpy, enteroscpy beynd 2nd prtn-duodenm; w/ablatn-tumor, polyp	10
Small intestnl endoscpy, enterscpy beynd secnd portn-duodenm, not incl ileum; dx	10
Unlisted procedure, stomach	10
Up gi endo-esoph/stmch; w/ablatn-tumrs, polyps, othr lesns not amenabl-hot bx	10
Upper gastrointestinl endoscpy inc esophagus, stomach, eithr duodenum/jejunum	10
Upper GI endoscopy, tumor ablatn	10

Contd...

Appendix Table 1: Contd...

Procedure name	Category
Upper GI endoscopy; w/ transendoscopic stent placement (w/ predilation)	10
Upper GI endoscpy inclesoghags, stomch; w/trnsendosc intralumnl tube/cath placmnt	10
Upper GI endoscpy-esoph/stomch; w/removl-foreign body	10
Uppr gastroinestnl endoscpyw/dir submucosal	10
Uppr gastrointestnl endoscopy, simple primary examinatn (sep proc)	10
Uppr gastrointstnl endoscpy incl esoghags, stomch; w/trnsmurl drain-pseudocyst	10
Uppr GI endo-esoph/stmch; w/dilatn-gastr outlt-obstrctn (eg, balloon)	10
Uppr GI endo-esoph/stmch; w/injectn-sclerosis-esophagl/gastrc varices	10
Uppr GI endo-esoph/stmch; w/balloon dilatn-esoph (less thn 30mm)	10
Uppr GI endo-esoph/stmch; w/control-bleeding, any methd	10
Uppr GI endo-esoph/stmch; w/directd placemnt-percutns gastrstmy tube	10
Uppr GI endo-esoph/stmch; w/insertn-guide wire followd-dilatn	10
Uppr GI endo-esoph/stmch; w/removl=tumor (s), polyp (s), othr lesn (s)-hot bx	10
Uppr gstrntstnl endscpy incldng esphgs, stmch, ethr the ddnm	10
Endoscopy of bowel pouch	11
Endoscpc eval-sm intestn (abdm/pelv)pouch:dx, w, w/o collctn-specimn-brush/wash	11
Lleoscopy thru stoma, biopsy	11
Lleoscopy thru stoma, diagnostic	11
Lleoscpy, thru stoma; diagnostc, w, w/o collectn-specimns-brushng/washng	11
Lleoscpy, thru stoma; with biopsy, single or multiple	11
Lntest endosc, enteroscp beynd 2nd prtn-duod; w/convrsn-percut gastrstmy tube	11
Lntest endosc, enteroscp beynd 2nd prtn-duodnm; w/placemnt-percut jejunstmy	11
Retrograde double ballon enteroscopy with spot injection	11
Endoscpc eval-sm intest (abdmn/pelvc)pouch; w/biopsy, singl/mult	11
Uppr GI endo-esoph/stmch; w/trnsendscpc ultrasnd-guide intra/trnsmurl fine ndl	12
EDG US exam surgical alter stom duodenum/jejunum	12
Endoscopic with ultrasnd fna/biopsy	12
Esophagoscopy flexible transoral ultrasound exam	12
Esophagoscpy, rigid/flex; w/endoscopic ultrasound examination	12
Esophagoscpy, rigid/flex; w/endoscpc ultrasnd examinatn	12
Colonoscopy, flexible, proximal to splenic flexure; w/endoscopic us exam	13
Colonscpy flex prox splenic flxure; w/endo us ex	13
Colonoscope, submucous inj	14
Colonoscopy through stoma w/biopsy	14
Colonoscopy through stoma, diagnostic	14
Colonoscopy through stoma; w\removal of foreign body	14
Colonoscopy thru colotomy	14
Colonoscopy thru stoma; w/control-bleeding (eg, injctn, bi/unipolar cautry, lasr)	14
Colonoscpy thru stoma; diagnostc, w, w/o collectn-specimns-brush/wash (sep proc)	14
Colonoscpy thru stoma; w/remvl-tumr, polyp, othr lesn by hot bx forcep/bipolr caut	14
Colonoscpy, flexibl, proximl to splenic flexure; w/dilatn by baloon, 1 or more str	14

Appendix Table 2: Simplified procedure list

Procedure code	Propofol sedation	Conscious sedation	Total
1	7006	16282	23288
2	1611	3192	4803
3	824	2421	3245
4	7956	11599	19555
5	324	163	487
6	3694	1545	5239
7	3	7	10
8	5	1811	1816
9	5	1215	1220
10	4210	3509	7719
11	125	165	290
12	1919	1471	3390
13	7	6	13
14	319	1635	1954
Total	28008	45021	73029

Explanation of the procedure codes