Safety of non-anesthesia provider administered propofol sedation in non-advanced gastrointestinal endoscopic procedures: A meta-analysis

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Abstract

Background/Aims: The aim of the study was to evaluate the safety of non-anesthesia provider (NAPP) administered propofol sedation in patients undergoing non-advanced gastrointestinal (GI) endoscopic procedures.

Materials and Methods: PubMed, Embase, Cochrane central register of controlled trials, Scopus, and Web of Science databases were searched for prospective observational trials involving non-advanced endoscopic procedures. From a total of 608 publications, 25 [colonoscopy (9), upper GI endoscopy (5), and combined procedures (11)] were identified to meet inclusion criteria and were analyzed. Data was analyzed for hypoxia rates, airway intervention rates, and airway complication rates.

Results: A total of 137,087 patients were involved. A total of 2931 hypoxia episodes (defined as an oxygen saturation below 90%) were reported with a pooled hypoxia rate of 0.014 (95% CI being 0.008–0.023). Similarly, pooled airway intervention rates and pooled airway complication rates were 0.002 (95% CI being 0.006–0.001) and 0.001 (95% CI being 0.000–0.001), respectively.

Conclusions: The rates of adverse events in patients undergoing non-advanced GI endoscopic procedures with NAPP sedation are extremely small. Similar data for anesthesia providers is not available. It is prudent for anesthesia providers to demonstrate their superiority in prospective randomized controlled trials, if they like to retain exclusive ownership over propofol sedation in patients undergoing GI endoscopy.

Keywords: Airway complication, airway intervention, colonoscopy, endoscopy, esophagogastroduodenoscopy, hypoxia, non-advanced endoscopic procedures, propofol, sedation

INTRODUCTION

Propofol is the sine qua non of sedation during gastrointestinal (GI) endoscopy. In spite of its many shortcomings such as increased incidence of desaturation, aspiration, cardiac arrests, hypotension, colonic perforation, and bleeding, its role in the field of endoscopy sedation is unchallenged.¹⁻⁴ The primary reason appears to be a very high patient and endoscopist satisfaction.⁵⁻¹⁴ However, at least in the USA, the added costs involved with providing propofol sedation are a significant constraint. With shrinking health care budgets and escalating costs of treatment, it is...
essential to find cost-effective ways of providing propofol sedation. Payment to anesthesia providers involved in the administration of propofol is a case in point.[13] Although the fears associated with the use of propofol by non-anesthesia providers are based on sound theoretical principles, they are not borne out of scientific studies.

In view of this, it is important to conduct a meta-analysis of all the scientific publications that have studied the safety of non-anesthesia provider administered propofol in patients presenting for endoscopic procedures. The safety of such practice in patients undergoing advanced endoscopic procedures has been studied previously.[16] Publications studying the safety of non-advanced endoscopic procedures wherein propofol was administered by anesthesia providers (anesthesia administered propofol – AAP) are not available. As a result, the current pooled analysis deals with non-advanced endoscopic procedures where propofol was administered by the non-anesthesia providers (non-anesthesia administered propofol-NAAP). The studies that involve propofol administration by non-anesthesia providers presenting for advanced endoscopic procedures are not included in the current study.

The aim of the current meta-analysis is to study the safety of propofol sedation in patients undergoing non-advanced endoscopic procedures when administered by non-anesthesia providers. For the purpose of the study, advanced procedures included endoscopic retrograde cholangiopancreatography (ERCP), endoscopic ultrasound, balloon-assisted deep enteroscopy, peroral endoscopic myotomy (POEM), endoscopic mucosal resection (EMR), and HALO radiofrequency ablation (RFA).

**MATERIALS AND METHODS**

Literature search was conducted for terms “propofol sedation endoscopy,” “propofol sedation colonoscopy,” and nurse administered propofol sedation. The following databases were searched PubMed, EMBASE, Cochrane Central Register of Controlled Trials, Scopus, and Web of Science. Articles published until April 2015 (both in English and non-English languages) were included in the present pooled analysis. Article screening was done independently by two authors and final inclusion after meeting the PICOS framework [Figure 1] was included after the consensus of a third author. After removing the duplicates using the computer program “Endnote” (Thomson Reuters Inc, USA), we narrowed down the list of publications meeting the search criteria to 608. Efforts were made to contact the corresponding author if the study information was incomplete or conflicting. The final selection included 25 studies (prospective observational and randomized controlled trials combined; Table 1) on which the pooled analysis was conducted.

We included both prospective and retrospective studies in the analysis, provided they reported at least one of the desired variables. In all the trials included, sedation was administered by a registered nurse under the supervision of a gastroenterologist. The following parameters were included in the pooled analysis.

a. Hypoxia rates – Number of patients developing pulse oximeter measured saturation of 90% or below
b. Airway related interventions during the procedures – The interventions included in the analysis were jaw thrust, patients needing bag mask ventilation, oral/nasopharyngeal airway, and airway-related procedure interruption and intubation
c. Airway related complications – this group included the following events: Laryngospasm, unexpected hospital admissions, and unplanned conversion to general anesthesia

**Data extraction**

A standardized format was prepared for data extraction for the analysis. The following data was extracted from

![PRISMA 2009 Flow Diagram](image)

Figure 1: PRISMA flow diagram. Based upon the “Preferred Reporting Items for Systematic Reviews and Meta-Analyses” showing the number of studies screened, included, and excluded in the final analysis.
Table 1: Master table representing the characteristics of all the studies included in the pooled meta-analysis

| Lead Author | Sub-Group | Provider | Study Design | Year of Publication | Country of Population Studied | Total Number of Patients | Males | Females | Mean Age |
|-------------|-----------|----------|--------------|---------------------|-------------------------------|--------------------------|-------|---------|----------|
| Heuss,[17]  | Age 70-85 | RN       | Prospective observational | 2003 | Switzerland | 1167 | 318 |       |          |
| Heuss,[17]  | Age >85   | RN       | Prospective observational | 2003 | Switzerland | 4,527 | 5,473 | 51.8 |          |
| Friedrich,[18] | Age 70-85 | RN       | Prospective observational | 2012 | Germany | 10,000 | 6,111 | 4551 | 56.9 |         |
| Friedrich,[18] | Age >85   | RN       | Prospective observational | 2009 | Japan | 10,000 | 437 | 563 | 57 |          |
| Lucendo,[20] | Age 70-85 | RN       | Prospective observational | 2012 | Spain | 10,000 | 10,917 | 4,755.8 | 3,144.2 | 45.2±7.3 | 48.7±9.2 |
| Lucendo,[20] | Age >85   | RN       | Prospective observational | 2005 | Japan | 27,500 | 10,917 | 4,755.8 | 3,144.2 | 45.2±7.3 | 48.7±9.2 |
| Tohda,[21]  | Age 70-85 | RN       | Prospective observational | 2007 | Germany | 3,641 | 30 | 30 | 31 | 30 | 46.647±12.317 |
| Tohda,[21]  | Age >85   | RN       | Prospective observational | 2007 | Germany | 3,641 | 30 | 30 | 31 | 30 | 46.647±12.317 |
| Ayazoglu,[23] | Age 70-85 | RN       | Prospective observational | 2009 | Japan | 10,662 | 611 | 4,551 | 56.9 |          |
| Ayazoglu,[23] | Age >85   | RN       | Prospective observational | 2012 | Japan | 2101 | 1149 | 952 | 66 | (20-94) |
| Ayazoglu,[23] | Age >85   | RN       | Prospective observational | 2012 | Japan | 2101 | 1149 | 952 | 66 | (20-94) |
| Sieg,[24]   | Age 70-85 | RN       | Prospective observational | 2003 | Switzerland | 1284 | 688 | 596 | 63.65 |          |
| Sieg,[24]   | Age >85   | RN       | Prospective observational | 2003 | Switzerland | 1284 | 688 | 596 | 63.65 |          |
| Horiuchi,[19] | Age 70-85 | RN       | Prospective observational | 2009 | Japan | 10,662 | 611 | 4,551 | 56.9 |          |
| Horiuchi,[19] | Age >85   | RN       | Prospective observational | 2009 | Japan | 10,662 | 611 | 4,551 | 56.9 |          |
| Horiuchi,[24] | Age 70-85 | RN       | Prospective observational | 2009 | Japan | 10,662 | 611 | 4,551 | 56.9 |          |
| Horiuchi,[24] | Age >85   | RN       | Prospective observational | 2012 | Japan | 2101 | 1149 | 952 | 66 | (20-94) |
| Horiuchi,[26] | Age 70-85 | RN       | Prospective observational | 2009 | Japan | 10,662 | 611 | 4,551 | 56.9 |          |
| Horiuchi,[26] | Age >85   | RN       | Prospective observational | 2012 | Japan | 2101 | 1149 | 952 | 66 | (20-94) |
| Sieg,[27]   | Age 70-85 | RN       | Prospective observational | 2007 | Germany | 24,441 | 6092 | 7,701 | 50.12 | (10.51) |
| Sieg,[27]   | Age >85   | RN       | Prospective observational | 2007 | Germany | 24,441 | 6092 | 7,701 | 50.12 | (10.51) |
| Dollas,[28]  | Age 70-85 | RN       | Prospective observational | 2011 | Brazil | 100 | 64 | 36 | 54.12 | (10.51) |
| Dollas,[28]  | Age >85   | RN       | Prospective observational | 2011 | Brazil | 100 | 64 | 36 | 54.12 | (10.51) |
| Dolmas,[29]  | Age 70-85 | RN       | Prospective observational | 2003 | Switzerland | 300 | 116 | 184 | 53 |          |
| Dolmas,[29]  | Age >85   | RN       | Prospective observational | 2003 | Switzerland | 300 | 116 | 184 | 53 |          |
| Dolmas,[30]  | Age 70-85 | RN       | Prospective observational | 2003 | Switzerland | 300 | 116 | 184 | 53 |          |
| Dolmas,[30]  | Age >85   | RN       | Prospective observational | 2003 | Switzerland | 300 | 116 | 184 | 53 |          |
| Dolmas,[30]  | Age 70-85 | RN       | Prospective observational | 2003 | Switzerland | 300 | 116 | 184 | 53 |          |
| Dolmas,[30]  | Age >85   | RN       | Prospective observational | 2003 | Switzerland | 300 | 116 | 184 | 53 |          |
| Koshy,[31]  | Age 70-85 | RN       | Prospective observational | 2000 | USA | 14,856 | 12,205 | 36 | 54.12 | (10.51) |
| Koshy,[31]  | Age >85   | RN       | Prospective observational | 2000 | USA | 14,856 | 12,205 | 36 | 54.12 | (10.51) |
| Ho,[32]     | Age 70-85 | RN       | Prospective observational | 2012 | Taiwan | 129 | 66 | 63 | 53.4 |          |
| Ho,[32]     | Age >85   | RN       | Prospective observational | 2012 | Taiwan | 129 | 66 | 63 | 53.4 |          |
| Walker,[33] | Age 70-85 | RN       | Prospective observational | 2003 | USA | 131 | 67 | 64 | 52.34 |          |
| Walker,[33] | Age >85   | RN       | Prospective observational | 2003 | USA | 131 | 67 | 64 | 52.34 |          |
| Friedrich,[18] | Age 70-85 | RN       | Prospective observational | 2009 | Japan | 10,000 | 6111 | 4551 | 56.9 |          |
| Friedrich,[18] | Age >85   | RN       | Prospective observational | 2012 | Germany | 10,000 | 437 | 563 | 57 |          |
| Lucendo,[20] | Age 70-85 | RN       | Prospective observational | 2012 | Spain | 10,000 | 10,917 | 4,755.8 | 3,144.2 | 45.2±7.3 | 48.7±9.2 |
| Lucendo,[20] | Age >85   | RN       | Prospective observational | 2005 | Japan | 27,500 | 10,917 | 4,755.8 | 3,144.2 | 45.2±7.3 | 48.7±9.2 |
| Infante,[34] | Age 70-85 | RN       | Prospective observational | 2003 | Spain | 58 | 28 | 30 | 55 |          |
| Infante,[34] | Age >85   | RN       | Prospective observational | 2003 | Spain | 58 | 28 | 30 | 55 |          |
| Painclou,x,[35] Repici,[34] | Age 70-85 | RN       | Prospective observational | 2011 | France | 45 | 28 | 17 | 56.2 |          |
| Painclou,x,[35] Repici,[34] | Age >85   | RN       | Prospective observational | 2011 | Italy | 45 | 28 | 17 | 56.2 |          |
| Sieg,[31]   | Age 70-85 | RN       | Prospective observational | 2013 | Germany | 13,793 | 6092 | 7,701 | 59.9 |          |
| Sieg,[31]   | Age >85   | RN       | Prospective observational | 2013 | Germany | 13,793 | 6092 | 7,701 | 59.9 |          |

Contd...
Table 1: Contd...

| Lead Author | Mean Wt | Adjuvants       | Patients with oxygen saturation <90 | ASA 1-2 | ASA3-4 | Airway interventions | Airway Complications | Need to Intubate |
|-------------|---------|-----------------|------------------------------------|---------|--------|---------------------|----------------------|-------------------|
| Heuss, [19] | none    | none            | 37                                 | 446     | 721    | 1                   | Zero                 | Zero              |
| Friedrich, [18] | none    | none            | 15                                 | 63      | 255    | 1                   | Zero                 | Zero              |
| Lucendo, [20] | none    | none            | 24                                 | 1000    |        | 1                   | NA                   | NA                |
| Tohda, [21]  | none    | none            | 1842                               | 21445   | 3641   | 1705                | Zero                 | NA                |
| Sieg, [22]   | none    | none            | 51                                 | 5       |        |                      | Zero                 | NA                |
| Douglas, [13] | none    | 34              | 11                                 | 642     | 642    | 6                   | NA                   | NA                |
| Ayazoglu, [23] | 78.632±9.423 kg | none  | 28                                 | 10662   | 0      | 0                   | Zero                 | Zero              |
| Horiuchi, [19] | 53.7   | none            | 24                                 | 1000    |        | 1                   | NA                   | NA                |
| Horiuchi, [24] | 56.7 (32-98) kg | none  | 5                                  | 0       | 0      | 0                   | Zero                 | Zero              |
| Sieg, [27]   | none    | none            | 93                                 | 2       | 4      | (3-transient apnea, 1 laryngospasm) | Zero | 3 patients transient bag/mask ventilation |
| Correia, [28] | 71.00 (60.25-84.75) | fentanyl | 2                                 | 67      | 33     | 0                   | 0                    | 0                 |
| Kulling, [29] | Ketanest | Meperidine      | 11                                 | 284     | 16     | 0                   | Zero                 | Zero              |
| Kulling, [30] | Ketanest | Meperidine      | 623                                | 25979   | 6      | 2                   | Zero                 | Zero              |
| Koshy, [31]  | none    | none            | 16                                 | 114     | 36     | 0                   | Zero                 | NA                |
| Ho, [32]     | 62.57 (11.03) | none  | 4                                  | 121     | 4      |                      | NA                   | NA                |
| Walker, [33] | Fentanyl-Midzolam | none | 3                                 | 122     | 3      | 3                   | None                 | Zero              |
| Friedrich, [18] | none    | none            | 39                                 | 3       |        |                      |                      | NA                |
| Lucendo, [20] | none    | none            | 25                                 | 1000    | 1      |                      | NA                   | NA                |
| Infante, [34] | none    | Midazolam       | 50                                 | 8       | 0      |                      | Zero                 | NA                |
| Poincloux, [26] | none    | 45              | 0                                  | 11 patients in control, 20 in intervention-hypotension | 0 | 0 | 0 | Zero |
| Repici, [34] | Midazolam | none | 57                                 | 0       | 0      | 0                   | 0                    | 0                 |
| Sieg, [27]   | NA      | NA              | 15                                 | 3       | 1      |                      | NA                   | NA                |
| NA          | NA      | NA              | 21                                 | 1       |        |                      | NA                   | NA                |

the relevant trials: first author of the study, characteristics of population studied, nature of procedures performed, frequency of patients’ desaturation below 90%, need for intervention to maintain airway, type of intervention, total propofol dose used, complications during the procedure, any mortality, or any immediate cardiopulmonary complications. Specific, individual study related findings were also documented and are represented in Table 1.
Statistical analysis
The data for individual study was collected using a template spreadsheet in Microsoft Excel (Version 2013, Microsoft Inc, USA). Meta-analysis was performed using Comprehensive Meta-analysis version 2 (Biostat Inc, USA). Pooling for outcome rates was done initially using fixed-effects modeling and eventually with random-effects methods (after assessment of heterogeneity with fixed modeling). The extent of heterogeneity between the trials was quantified using the I^2 statistic. Values of I^2 <40% were considered unimportant, 40–50% were considered to represent moderate heterogeneity, and 50–90% represented high heterogeneity. Pooled values of results with associated alpha error of less than 5% were deemed statistically significant. Results of end points (hypoxia, airway intervention rate, and complication rate) were expressed as event rate (per patient) with 95% CI. Funnel plot was used for evaluation of any potential publication bias. To account for the high heterogeneity in our analysis, different methods were used. A sensitivity analysis, by removing a single study at a time, was performed. Further evaluation of heterogeneity was done by creating possible subgroups based upon upper and lower gastroenterological procedures. All values reported for analysis with I^2 more than 40% are from random-effects modeling only.

RESULTS
None of the studies reported the need for endotracheal intubation, and the conversion rate to general anesthesia was zero in the included trials [Table 1]. The following is an analysis of the pooled results of various variables mentioned above.

Hypoxia rates
Studies reporting pulse oximeter derived saturation of 90% or lower were included in this group. None of the studies documented the duration of such desaturation or the effects of interventions; thus, time-based analysis was not possible. We analyzed the documented hypoxia variables to derive pooled hypoxia rates. Variables from 24 trials/subgroups were included in this estimate. A total of 137,087 patients were involved in these trials and 2931 desaturation episodes were reported. The pooled hypoxia rate was 0.014 (95% CI being 0.008–0.023). Because of the presence of high heterogeneity (99.03%), random effect modeling was used. To explore the heterogeneity, sensitivity analysis using “single study removal method” was used. The study by Thoda et al. contributed maximally to the heterogeneity; however, upon its removal, heterogeneity dropped only marginally to 97.15%. To further account for heterogeneity, we subdivided the studies into 3 groups. Their associated heterogeneity and pooled rates are shown in Table 2 and Figure 2a and b.

Pooled desaturation rates were also calculated for anesthetic agents used for endoscopy

Propofol alone
Propofol was used as the sole anesthetic agent in 14 trials where 2195 patients showed desaturation among a total of 84264 patients. Pooled estimate was 0.012 (0.005–0.026) (P < 0.001) with a heterogeneity of 99.16%.

Propofol with adjuvants
Ten trial/subgroups used propofol in combination with an adjuvant. These adjuvants included fentanyl, meperidine, and midazolam in two trials each, and dexmeditomedine, ketamine, sufentanyl and alfentanyl in one trial each. Desaturation was noted in 736 patients out of 52823 patients in this subgroup. The pooled estimated desaturation rate was 0.018 (95% CI being 0.008–0.041) (P < 0.001) with heterogeneity of 96.64%.

Airway intervention rate
Airway intervention for treating desaturation during the procedure was reported by 25 subgroups where 1746 patients required intervention from 146239 patients. Pooled estimate for intervention rate was 0.002 (95% CI being 0.006–0.001), with a heterogeneity of 97.31%. Once again, the study by Thoda et al. had the highest contribution to heterogeneity. On sensitivity analysis by “single study removal method,” and by dropping this study from the analysis, the heterogeneity decreased to 79.97%. Intervention rates related to anesthetic agent and type of procedure were also estimated; the results are displayed in Table 3 and Figures 3a and b.

Airway-related complications
Twenty-five trials (146239 patients) reported only 19 airway-related complications. Estimated pooled complication rate was 0.001 (95% CI being 0.000–0.001) with I^2 being 69.97%. The study by Walker et al. had the highest contribution to heterogeneity, and upon sensitivity analysis using “single study removal method,” the heterogeneity dropped to 64.65%. The results obtained from various subgroupings are shown in Table 4 and Figure 4a and b. It is interesting to note that no airway-related complications were reported during colonoscopy; however, the estimated pooled rate has a 95% confidence interval, which is more than upper GI endoscopy. The large sample size of patients undergoing upper GI endoscopy explains the paradox.
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Table 2: Desaturation (Hypoxia) rates of various subgroups by procedure

| Group                                      | Pooled estimate | P     | Heterogeneity (%) | Patient number (desaturation/total) |
|--------------------------------------------|-----------------|-------|-------------------|-------------------------------------|
| Upper GI endoscopy                         | 0.01 (<0.01-0.08) | <0.01 | 98.15             | 61/17379                            |
| Colonoscopy                                | 0.01 (0.01-0.02) | <0.01 | 89.56             | 144/20916                           |
| Combined Upper GI endoscopy and colonoscopy| 0.02 (0.01-0.03) | <0.01 | 99.44             | 2726/98792                          |

Figure 2: (a) Pooled hypoxia (desaturation) rates. The diamond (red) at the bottom shows the final net effect with the 95% confidence interval. The line width of individual contributing study/subgroups in the forest plot is proportional to the final effect size. (b) Funnel plot for publication bias in desaturation rates showing asymmetrical distribution of published studies demonstrating a possibility of publication bias

Publication bias
Funnel plot analysis was conducted for all three outcomes.

Hypoxia rates
The graphical funnel plot of the included studies is asymmetrical and deviated to the left. Egger’s regression test calculated an intercept value of -6.48, (P = <0.01), suggesting a likely publication bias. Thus, the possibility of underreporting of desaturation cannot be ruled out [Figure 2b].

Airway intervention
Funnel plot showed asymmetric distribution of studies/groups, which was further confirmed using Egger’s regression test, which showed an X-axis intercept at -5.096 (P = <0.01). Once again the possibility of underreporting of airway interventions remains [Figure 3b].

Airway-related complications
A symmetrical distribution was found on funnel plot, and Egger’s regression test showed intercept at -0.762, (P = 0.23). Thus, publication bias of reporting airway-related complications is unlikely [Figure 4b].

DISCUSSION
The Holy Grail for endoscopic sedation is yet to be found. Newer drugs purported as safe and effective replacements
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Table 3: Pooled airway Intervention (AI) rates based on the procedure and the anesthetic employed

| Group                                      | Pooled estimate | $P$  | Heterogeneity | Number of trials/subgroups | Patient number (AI/total) |
|--------------------------------------------|-----------------|------|---------------|-----------------------------|---------------------------|
| Based on the procedure                     |                 |      |               |                             |                           |
| Upper GI endoscopy                         | 0.001 (0.000-0.002) | <0.01 | 49.40%        | 5                           | 2/19480                   |
| Colonoscopy                                | 0.004 (0.001-0.015) | <0.01 | 0             | 9                           | 9/18815                   |
| Combined Upper GI endoscopy and colonoscopy | 0.001 (0.000-0.008) | <0.01 | 98.49%        | 11                          | 1735/107944               |
| Based on anesthetic agent employed         |                 |      |               |                             |                           |
| Propofol alone                             | 0.001 (0.00-0.004) | <0.01 | 97.53%        | 15                          | 1734/93416                |
| Propofol + Adjuvant                        | 0.004 (0.001-0.018) | <0.01 | 87.82%        | 10                          | 15/52823                  |

Figure 3: (a) Pooled airway intervention rates. The diamond (red) at the bottom shows the final net effect with the 95% confidence interval. The line width of individual contributing study/subgroups in the forest plot is proportional to the final effect size. (b) Funnel plot for publication bias in intervention rates showing asymmetrical distribution of published studies demonstrating a possibility of publication bias.

of propofol (e.g., remimazolam) are yet to prove their mettle.[17] As a result, propofol is likely to remain the mainstream sedative for endoscopic procedures in the short to intermediate term.

Hypoxemia is the most common adverse event encountered with propofol sedation during endoscopic procedures,[4,38,39] The reported incidence of this adverse event is varied depending on the place of research, method of sedation, preemptive use of airway adjuncts, and the personnel involved in the administration of propofol. It is proposed that the pharmacological variability of propofol (both pharmacokinetic and pharmacodynamic) is a major factor contributing to unpredictable hypoxemia. Both light sedation (with associated coughing, laryngospasm) and deep sedation (associated apnea) potentially cause insufficient ventilation and hypoxemia. Yet, our meta-analysis has showed an extremely low risk of hypoxemia when propofol was administered by registered nurses under the guidance of a gastroenterologist. As we do not have any reason to doubt...
The conduct and reporting of the data, the results of the meta-analysis must be accepted.

The results of our meta-analysis might be useful for strategic planning when delivering health care. Health care spending accounts for more than 17.4% of gross domestic product in USA. However, not all indicators of health are directly related to health care spending. In fact, many other countries in the Organisation for Economic Co-operation and Development (OECD) have fared better in many areas compared to USA in spite of lower health care budgets. As a result, it is important to use prudence when it comes to health care spending. In a recent study, Ladabaum et al. reported that mean anesthesia payments for diagnostic colonoscopy amounted to $494.00 per procedure. In the absence of any proven benefits, such as a decrease in the complication rates, it is a waste of resources. However, considering patient satisfaction was better in patients sedated by anesthesia providers, it is essential to consider this aspect of patient care as well.

### Table 4: Pooled rates of airway related complications (ARC) classified by procedure and anesthetic employed

| Group                                      | Pooled estimate | P    | Heterogeneity | Number of trials/subgroups | Patient number (ARC/total) |
|--------------------------------------------|-----------------|------|---------------|----------------------------|----------------------------|
| Based on the procedure                     |                 |      |               |                            |                            |
| Upper GI endoscopy                         | 0.001 (0.000-0.003) | <0.01 | 54.18%        | 5                          | 1/19480                    |
| Colonoscopy                                | 0.002 (0.001-0.011) | <0.01 | 62.85         | 9                          | 0/18815                    |
| Combined Upper GI endoscopy and colonoscopy| 0.000 (0.000-0.001) | <0.01 | 76.42%        | 11                         | 18/107944                  |
| Based on anesthetic agent employed         |                 |      |               |                            |                            |
| Propofol alone                             | 0.000 (0.000-0.001) | <0.01 | 61.98%        | 15                         | 16/93416                   |
| Propofol + Adjuvant                        | 0.002 (0.001-0.013) | <0.01 | 78.80%        | 10                         | 3/52823                    |

**Figure 4**: (a) Pooled airway complication rates. The diamond (red) at the bottom shows the final net effect with the 95% confidence interval. The line width of individual contributing study/subgroups in the forest plot is proportional to the final effect size. (b) Funnel plot demonstrating complications rates with symmetrical distribution of published studies thus demonstrating a publication bias being unlikely.
Various societies entrusted with formulating sedation guidelines might find the results of our meta-analysis informative. In 2010, members of the European Society of Gastrointestinal Endoscopy (ESGE), the European Society of Gastroenterology and Endoscopy Nurses and Associates (ESGENA), and the European Society of Anaesthesiology (ESA) published guidelines for non-anesthesiologist administration of propofol for gastrointestinal endoscopy.[49] However, 21 national societies of anesthesia felt that non-anesthesiologists should not be allowed to administer propofol.[50-53] As a result, these endorsements were later retracted by the societies that endorsed them.[54] It prompted the Dumonceau to question the wisdom and doubt if these retraction statements were all about job preservation and money.

The study has essentially answered the question posed in a recent editorial “Improving safety during sedation by nonanesthesiologists: Do we lead or follow?”[55] It is prudent on the part of anesthesia providers that some of the practices used in the included studies be adapted in their current practice to increase the safety of propofol sedation.

Limitations

It is acknowledged that the practice with regards to supplemental oxygen administration during sedation varies across the world. As a result, some of the findings may be disputable. Yet, considering that both the number of included studies and the patients is very large, the findings cannot be ignored.

The second limitation pertains to our decision to include only propofol studies. Many gastroenterologists perform non-advanced procedures utilizing intravenous conscious sedation, typically using midazolam and fentanyl. However, considering that the propofol typically produces “unconscious sedation,” such a meta-analysis is unlikely to be of significant benefit.

CONCLUSIONS

The current meta-analysis suggests that the risk of sedation related adverse events in patients administered propofol by non-anesthesiologists is extremely low. We could not compare such outcomes with anesthesia providers, as similar studies are not available. It is prudent for anesthesia providers to demonstrate their superiority in prospective randomized controlled trials, if they like to retain exclusive ownership over propofol sedation in patients undergoing GI endoscopy. However, one should also bear in mind that the patient safety demonstrated in clinical trials may not be applicable in non-trial settings unless proper training and regulatory requirements are implemented.

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Conflicts of interest

There are no conflicts of interest.

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