

## SPECIAL ARTICLE

# Patient safety under deep sedation for digestive endoscopic procedures

Julián Álvarez<sup>1</sup>, Rafael Cabadas<sup>2</sup>, Manuel de-la-Matta<sup>3</sup>, Board of Directors of the Sociedad Española de Anestesiología y Terapéutica del Dolor (SEDAR), and members of the Comisión Nacional de la Especialidad de Anestesiología y Reanimación (CNE Anestesiología y Reanimación)

<sup>1</sup>Department of Anesthesiology. Complejo Hospitalario Universitario de Santiago de Compostela. Universidad de Santiago de Compostela. Chairman of the Sociedad Española de Anestesiología, Reanimación y Terapéutica del Dolor. Chairman of the Comisión Nacional de la Especialidad de Anestesiología y Reanimación. <sup>2</sup>Manager of the Department of Anesthesiology, Resuscitation and Pain Therapeutics. Hospital Povisa. Vigo, Spain. President of the Sociedad Gallega de Anestesiología (AGARyD). <sup>3</sup>Department of Anesthesiology. Hospital Universitario Virgen del Rocío. Sevilla, Spain

## INTRODUCTION

Deep sedation with propofol has become widespread in the digestive endoscopy setting over the past few years, partly offsetting the use of conscious sedation with benzodiazepines and opioids. The technique's safety when administered by non-anesthesiologists has traditionally raised controversy, usually disguised as scientificism when the real issue is mainly financial in nature, often covered up by dubious debates on the financial sustainability of the health system (1-20).

In 2011, the Sociedad Española de Anestesiología, Reanimación y Terapéutica del Dolor, together with 20 additional societies from European countries (4), revoked the recommendations issued by the European Society of Gastroenterology (5) on propofol administration by non-anesthesiologists because of it being "highly dangerous for the safety and quality of endoscopic procedures". The FDA had previously rejected propofol use by non-anesthetists in the US back in 2005 (21), which was confirmed in 2010 (22) and presently remains in force, based on the recommendations and standards issued by the Joint Commission (23) and the Declaration of Helsinki (24), among other sources.

In Spain, propofol prescribing information includes the following: "Propofol must only be administered in hospitals or day therapy units with anesthetists or in intensive care patients", further specifying that it "must not be administered by the person performing the diagnostic or surgical procedure" (25).

Anesthesiologists are not overtly against this debate but, as physicians, we believe in scientific evidence rather than dialectical controversy, and it is important to remark that discussion should focus on central aspects, leaving corporate considerations aside. In our view, key items to be discussed should be related to: a) sedation-induced mor-

bidity and mortality (that is, factors involved in safety); b) which professional should administer the technique; and c) the financial issues involved.

## SEDATION-RELATED MORBIDITY AND MORTALITY IN ENDOSCOPIC PROCEDURES

Sedation-related mortality in digestive endoscopy is unknown. Reported data are highly variable. Cohen (3) reported a very low propofol-associated mortality, one case per 158,000 sedation procedures for digestive endoscopy. Recently, Vargo (17) reported ten deaths among 1,380,000 patients, but denies any links between death and sedation in most cases. However, no other series finds such favorable results. Agostoni (8) reported three deaths in a series of 16,894 adults undergoing sedation with propofol (0.017%), and Wehrmann (26) reported four deaths among 9,547 sedation procedures with propofol (0.041%) as well as 28 ICU admissions; adult mortality rates oscillate therefore between one case per 2,500 and one case per 5,000 patients.

The paper by Vargo (17) deserves a thorough analysis in our view. It concludes the following: "The need for an anesthesiologist is difficult to justify on safety grounds for most standard endoscopic procedures". In this paper, Vargo seems to suggest that mild-moderate sedation as led by an endoscopist is safe.

González-Huix (18) quotes this and other papers in his recent disputed editorial in the *Revista Española de Enfermedades Digestivas*, where the author concludes: "In summary, current evidence shows that sedation for endoscopy, as led by endoscopists themselves with prior education and training, is safe, effective and cost-effective. Even in complex situations such as ERCP, sedation may be accomplished with an acceptable risk not above that

Received: 08-09-2016  
Accepted: 16-09-2016

Correspondence: Rafael Cabadas. Department of Anesthesiology, Resuscitation and Pain Therapeutics. Hospital Povisa. Rúa de Salamanca, 5. 36211 Vigo, Pontevedra  
e-mail: cabadas@me.com

Álvarez J, Cabadas R, de-la-Matta M, Board of Directors of the Sociedad Española de Anestesiología y Terapéutica del Dolor (SEDAR), and members of the Comisión Nacional de la Especialidad de Anestesiología y Reanimación (CNE Anestesiología y Reanimación). Patient safety under deep sedation for digestive endoscopic procedures. *Rev Esp Enferm Dig* 2016;109(2):137-143.

DOI: 10.17235/reed.2016.4572/2016

*of sedation administered by anesthesiologists*", and goes to the extent of stating that endoscopic sedation outcomes are better when performed by an endoscopist rather than an anesthetist.

The crucial fact underlying this reflection by González-Huix (18), ill-informed in our view, is that Vargo (17) compared morbidity in mainly mild-moderate endoscopist-led sedation *versus* anesthesiologist-administered deep sedation with propofol and general anesthesia. Both unfortunately and inconceivably, González-Huix made the serious statistical error of granting validity to a comparison between sharply different, hence incomparable cohorts in terms of variables.

Furthermore, it is surprising that Vargo (17) did not record the extent of the trial's complexity, nor the objective sedation levels. Different drugs and different sedation levels do not allow comparisons with a minimum of scientific rigor.

Mortality discussion is also peculiar as the author does not consider the higher mortality rate in the group of patients sedated by endoscopists, which he refers to as "similar". However, a simple, superficial analysis of table VII in the paper reveals a significant methodological incident. The author states that "patient 1" bears no relation to sedation but has a vasovagal response with arrhythmia and hypotension. Thus, excludes this patient from the mortality rate. The same occurs with those in the esophagogastroduodenoscopy group. Therefore, this study shows higher mortality rates among patients sedated by endoscopists. And this fact is even more serious when considering that the objective sedation level in the endoscopist-sedated group was mild to moderate with midazolam and morphine.

Furthermore, the presence of an anesthesiologist in the room not only guarantees adequate sedation for each procedure but also ensures appropriate vital function monitoring, which allows the prevention of complications and adequate management should they arise. Stating that just one of ten patients died from sedation is complete speculation; perhaps Vargo ignores the fact that most of the complications mentioned may be avoided with adequate sedation by an appropriately trained professional (5,15), both regarding sedation and intensive complication management.

Vargo (17) is not original in his stance, and reiterates the attempts to justifying deep sedation safety when administered by non-anesthesiologists or nurses under direct supervision by an endoscopist (1-4,6,9), and his methods are disputable when as early as in the introduction he affirms that "*a prospective study in this setting would be unpractical given the low frequency of adverse events*". Such disregard of prospective studies is both unacceptable and dubious.

Another statement of Vargo's, based on a paper by Adeyemo et al. (14) quoted in the editorial by González-Huix (5), refers to "a 2.5% increase in the number of perforations when propofol is used and administered

by anesthesiologists". However, this article surprisingly does not say that it was an anesthesiologist who sedated patients, and recognizes that endoscopist skills were not taken into account, which in our view may be the most important factor for endoscopy-related mechanical complications. Another limitation in this paper is its failure to assess patient selection criteria, since those at greater risk of perforation were likely selected for colonoscopy under propofol to provide sedation levels capable of increasing patient tolerance.

Most studies referred to with a large number of patients are retrospective, with patients selected from databases designed for a different purpose (8,12,14,19). The retrospective study by Wernli et al. (19) discussed data from medical claims regarding over three million colonoscopies. Their results found a 13% increase in adverse events within 30 days of the procedure when anesthesia services were used for sedation. This study, with the most significant limitations according to the authors, shows that risk increased more in patients from regions where anesthesia services were less prevalently used. That is, complications increase when anesthesia units only care for severely ill patients, which will also involve an increase in complications when cared for by anesthetists, not because of the latter but due to the baseline severity.

As acknowledged by González-Huix (5), deeper sedation obviously entails greater risk, and such greater risk is what prompted the emergence of specifically trained, certified professionals such as anesthesia and resuscitation specialists.

The fact that patients requiring deep sedation are actually undergoing general anesthesia without muscle relaxation or instrumental airway control should be taken into account. Such patients have a risk equal to or greater than the risk of general anesthesia patients, and therefore require a certified professional with the skills and competencies of the anesthesiology and resuscitation specialty.

González-Huix (5) also advocates for the safety of propofol sedation by endoscopists in complex or prolonged procedures based on the study by Pérez-Cuadrado Robles (20), a retrospective case-control study of 60 patients from a single endoscopy unit, and the study by De Witt (10), which includes 80 patients sedated for echoendoscopy and describes significant complications in 50% of cases, which they call "minor" (SpO<sub>2</sub> below 90%, heart rate and blood pressure changes over 25% of baseline (including severe hypotension), significantly increased ETCO<sub>2</sub>, or a severe cough which makes endoscopy difficult) but may aggravate clinical status. The underestimation or relativization of complications from propofol sedation as administered by non-anesthesiologists in some papers remains controversial (26-34). As an example, we mention here some of these reports where authors usually conclude that propofol sedation by non-anesthesiologists is a safe technique following the identification of multiple incidences, some of them potentially serious.

Rex et al. (1), in a series of 36,000 patients, found a significant incidence in every 500-1,000 patients, and defined significant incidence as an apnea or respiratory compromise event. In the aforementioned paper by Wehrmann (26), there were 135 reported complications within 9,547 patients, 40 patients required ventilation support and nine received orotracheal intubation. Thoda et al. (27), within a study of 27,500 endoscopies, found hypoxemia (SpO<sub>2</sub> < 90%) in 6.7% of patients, and severe hypoxemia (SpO<sub>2</sub> < 85%) in 0.62% of patients during upper endoscopy, and in 0.25% during colonoscopy. Hypotension (SBP < 90 mm Hg) was present in 3.5% of endoscopies and 1.2% of the remaining endoscopic procedures. Fatima et al. (28), in a series of 806 patients, reported hypotension (SBP < 90 mmHg) in 13% of patients, hypoxemia (SpO<sub>2</sub> < 90%) in 0.7%, and a need for ventilation support in 0.5%. Horiuchi et al. (29), in a series of 10,662 patients, reported no significant respiratory or hemodynamic incidences except for the use of O<sub>2</sub> in 0.26% of patients. Schilling et al. (30), in a series of 150 patients older than 80 years who were sedated with midazolam and meperidin *versus* propofol by non-anesthesiologists, found 16% cardiovascular complications in the midazolam group *versus* 23.7% in the propofol group. Coté et al. (31), among 799 patients, found hypoxemia in 12.8%, hypotension in 0.5%, and failure to complete the procedure in 0.6% of patients. Slagelse et al. (32), in a study of 2,527 patients, reported that 4.7% of patients had hypoxemia, 2.4% needed aspiration for secretions or regurgitation, 1.3% had blood pressure changes above 30%, and 0.9% required ventilation support. Jemsen et al. (33), in a study with 1,764 patients, found hypoxemia in 4.4%, with significant differences between gastroscopy (5.7%) and colonoscopy (2.9%); 19 patients (1.1%) required respiratory support. Redondo-Cerezo et al. (34), in a series of 446 patients sedated with propofol, reported a 9% complication rate with 8% respiratory complications.

### THE APPROPRIATE PRACTITIONER FOR SEDATION WITH PROPOFOL DURING DIGESTIVE ENDOSCOPY

Our opinion is crystal clear, but scientific opinions must be carefully based. Anesthesiologists at endoscopy units not only guarantee adequate sedation for a given procedure but also hemodynamic control and vital sign stability, thus preventing complications and treating complications appropriately should they arise (15). This type of care benefits patients and gastroenterologists alike, as the latter may perform the procedures they have been trained to perform without distraction or worry regarding the sedation process and the patient's general status.

We have already mentioned the paper by Adeyemo et al. (14), which attributes a 2.5% increase in perforations to propofol administration by anesthesiologists. Other claims along these lines have been published, whose

scientific rigor cannot stand up to the slightest analysis. The meta-analysis by Bo et al. (9) included ERCP studies involving sedation by anesthesiologists in order to justify sedation safety when performed by endoscopists or endoscopy nurses. Their claims are uncertain, and our stance is firm: for complex procedures such as ERCP, patients must be sedated or anesthetized by an anesthesiologist. As anesthesiologist-directed sedation increases efficacy for advanced endoscopic procedures, as acknowledged by Buxbaum J, Vargo et al. (47), who reported a study of 1,171 ERCPs, 40% of them with the help of an anesthesiologist, and found a procedure failure rate of 13% with sedation by non-anesthesiologists and 8.9% failed procedures with sedation by anesthesiologists, mainly due to higher rates of failed sedation in the gastroenterology group, 7.0% *versus* 1.3% for anesthesiologists. The risk run by a patient under deep sedation undergoing a lengthy procedure in the prone position, with no instrumental airway management, and with an endoscope within the upper airway, is very high, and requires an anesthesiologist to be present to solve any complications that may emerge during the procedure.

When analyzing recommendations of practitioners potentially responsible for the administration of deep sedation we find no level-1 evidence supporting such practice; and the strongest evidence-recommendation on deep sedation only specifies that a fully dedicated person must administer it (4). No study validates specific training in the setting of sedation by non-anesthesiologists. The evidence-recommendation to support non-anesthesiologist training for deep sedation would be level 4, grade D; this represents the most inconsistent evidence level and recommendation grade possible (4).

Given the scarce evidence supporting deep sedation by non-anesthesiologists, automated drug delivery systems have been considered as an alternative.

In the study by Pambianco et al. (35) no anesthesiologists take part. The study compares propofol administration by a robotic system (SEDASYS) managed by endoscopists *versus* a control group using standard sedation with benzodiazepines and opioids, also managed by endoscopists. In our view, this approach is completely lacking in scientific rigor. Most interesting was an incidence of serious complications, including hypoxemia, of 5.8% in the SEDASYS group, which increased to 8.7% in the control group. With these results one cannot claim, as the authors do, that "no scientific evidence shows fewer adverse events for endoscopic sedation when managed by an anesthesiologist rather than an endoscopist or a sedation delivery system". This statement is incorrect because no studies have compared sedation by an anesthesiologist *versus* a non-anesthesiologist using the same drugs, at the same doses, in the same patients, for the same procedures. There is no sense in providing such categorical statements in the absence of supporting scientific evidence.

With regard to patient stay at the unit as a measure of efficiency, no significant differences have been found

between anesthesiologists and endoscopists according to the study by Thornley et al. (36), in contrast with the assertions of Dr. González-Huix in his editorial. A careful review of the above-mentioned paper shows no significant differences in recovery time between patients sedated by anesthesiologists and non-anesthesiologists. Differences only emerge when trainees play a role. Furthermore, in the study by Thornley the outcomes of care, both in terms of pain severity and patient satisfaction, improve with sedation by anesthesiologists.

### **THE FINANCIAL ASPECT OF CONTROVERSY REGARDING DEEP SEDATION BY NON-ANESTHESIOLOGISTS IN THE ENDOSCOPY SETTING**

The demand for deep sedation by anesthesiologists in endoscopy units has increased exponentially in nearby countries, and this trend is expected to continue in the upcoming years (37). Given this fact, the FDA has been requested to revise their decision to prohibit propofol use by non-anesthesiologists (21). This assessment is based on the assertion that sedation by endoscopists may be more efficient than sedation by anesthesiologists (38). The reasons for this reassessment are primarily economic, since 40% of the cost of an endoscopic procedure is estimated to derive from sedation (38).

A cost-analysis is key when considering the use of any procedure or technology in the health care setting, but cost considerations cannot be placed above patient safety.

Furthermore, approaching the discussion of endoscopy-related overall costs without questioning the role of the endoscopist also represents a bias in our view. The American Society for Gastrointestinal Endoscopy, in their Clinical Practice Guidelines, supports the performance of endoscopic procedures by non-physicians after appropriate training, and indicates that procedures carried out by such staff will require direct or indirect guidance by a specialist practitioner, a practice that is granted a 1B evidence-recommendation level (39). There is adequate evidence supporting the performance of endoscopic procedures by qualified nurses and other technicians (39-41). This clinical practice model is cost-effective and safe (40,41). In fact, endoscopic procedures by non-physicians represent a widely recognized, accepted practice in many Western countries (39-43), and its implementation in Spain, following an appropriate assessment of its expedience, may bring about a direct, significant decrease in procedure-related costs with no impact on patient safety.

However, the implementation of GI procedures by non-physicians may involve an increase in care offer in terms of the number of available hours for endoscopic GI diagnosis per inhabitant and per year, which will consequently have an impact on reducing waiting lists for GI diagnostic studies, as well as the fact that the aforemen-

tioned waiting lists are not sedation-dependent but endoscopic time availability-dependent.

There is no denying that efficiency is relevant for our National Health System sustainability. Our Society has clearly demonstrated an interest in optimizing processes in order to reduce hospital stay and perioperative complications. However, we think that the assumption of anesthesiology specialty-related roles and competencies by other non-competent practitioners simply because of low process-inherent complication rates cannot be justified neither on clinical or economic grounds (equity claims are increasingly common and high), nor from a patient safety standpoint.

Most anesthesiologists agree on the impossibility of providing sedation for all patients included in colon cancer screening programs. Sedation by non-anesthesiologists for ASA I-II patients using midazolam and fentanyl (drugs for which specific antagonists are available) and a well-defined sedation scale with graphically recorded values every five minutes, avoiding deep sedation and the complications deriving thereof, may be acceptable as it will, in our view, guarantee patient safety.

Deep sedation, propofol use, sedation for severely ill patients, and sedation for prolonged, complex procedures must be performed by an anesthesiologist in order to provide adequate sedation while keeping patient risk at a minimum.

Debate with regard to the organizational model for endoscopy units will by no means be limited to who administers sedation since, as already discussed, the need for a gastroenterology specialist during these procedures has been questioned. Anyway, as anesthesiologists, we are convinced, as it could not be otherwise, that such a debate must be led and moderated with the rigor, honesty and commitment of the Sociedad Española de Patología Digestiva (SEPD), Sociedad Española de Endoscopia Digestiva (SEED), and Sociedad Española de Anestesiología y Reanimación. We therefore advocate that the debate in our country on who should be responsible for endoscopic procedures be led by the Sociedad Española de Patología Digestiva (SEPD) and Sociedad Española de Endoscopia Digestiva (SEED), and the debate on sedation be led by the Sociedad Española de Anestesiología, Reanimación y Terapéutica del Dolor (SEDAR).

It is the anesthesia and resuscitation units within hospitals who should provide and schedule sedation procedures not only in the endoscopy setting but also in growing areas such as interventional radiology, bronchoscopy, etc. The progressive, dramatic decrease in morbidity and mortality witnessed in our operating rooms in only a few lustra clearly reveals the interest and commitment of our specialty in consistently providing safe anesthesia and sedation (44-46). Indeed, with knowledge and competence, human resource efficiency may be balanced with procedure quality and safety.

There is a final aspect that warrants discussion. We are physicians and are thus concerned with care quality, as

well as with our services' legal safety. We therefore deem it as appropriate to include the conclusion of a report issued by the Juridical Area of the Consejo General de Colegios Oficiales de Médicos, regarding the competencies of dentists with regard to sedation: "...the program corresponding to the Anesthesiology and Resuscitation specialty clearly delineates the competencies of said specialists in the setting of anesthesia techniques; according to both the exclusivity and the adequacy principles, (...) it may be concluded that it is these specialists who have the professional competencies for sedation and general anesthesia, since in both cases patients lose or may lose their consciousness. Therefore, any health care providers, including dentists, wishing to use sedation as an anesthetic technique must necessarily request the help and commitment of doctors who are specialists in Anesthesiology and Resuscitation".

## CONCLUSIONS

Spanish anesthesiologists, as well as our European counterparts, believe that deep sedation is a topic that must not be trivialized under any circumstances whatsoever due to its high morbidity and mortality rates. A technique cannot be claimed to be safe when a high percentage of patients develop varying degrees of respiratory depression (hence hypoxemia) and hypotension. Corporatism aside, we would like to know the views of most endoscopists in our country, rather than the opinions of just a few.

We are certain that cooperation between the Sociedad Española de Patología Digestiva (SEPD), Sociedad Española de Endoscopia Digestiva (SEED), and Sociedad Española de Anestesiología, Reanimación y Terapéutica del Dolor (SEDAR) will open the way to a satisfactory solution for us all, and most significantly for our patients.

## REFERENCES

- Rex DK, Heuss LT, Walker JA, et al. Trained registered nurses/endoscopy teams can administer propofol safely for endoscopy. *Gastroenterology* 2005;129:1384-91. DOI: 10.1053/j.gastro.2005.08.014
- Tohda G, Higashi S, Wakahara S, et al. Propofol sedation during endoscopic procedures: Safe and effective administration by registered nurses supervised by endoscopists. *Endoscopy* 2006;38:360-7. DOI: 10.1055/s-2005-921192
- Cohen LB, Ladas SD, Vargo JJ, et al. Sedation in digestive endoscopy: The Athens international position statements. *Aliment Pharmacol Ther* 2010;32:425-42. DOI: 10.1111/j.1365-2036.2010.04352.x
- Dumonceau JM, Riphaus A, Aparicio JR, et al; NAAP Task Force Members. European Society of Endoscopy, European Society of Gastroenterology and Endoscopy Nurses and Associates, and the European Society of Anaesthesiology. Guideline: Non-anesthesiologist administration of propofol for GI endoscopy. *Endoscopy* 2010;42:960-74. DOI: 10.1055/s-0030-1255728
- Perel A. Non-anesthesiologists should not be allowed to administer propofol for procedural sedation: A Consensus Statement of 21 European National Societies of Anaesthesia. *Eur J Anaesthesiol* 2011;28:580-4. DOI: 10.1097/EJA.0b013e328348a977
- Riphaus A. Endoscopy: Consensus on approving propofol sedation by non-anesthesiologists. *Nat Rev Gastroenterol Hepatol* 2010;7:187-8. DOI: 10.1038/nrgastro.2010.35
- Porostocky P, Chiba N, Colacino P, et al. A survey of sedation practices for colonoscopy in Canada. *Can J Gastroenterol* 2011;25:255-60. DOI: 10.1155/2011/783706
- Agostoni M, Fanti L, Gemma M, et al. Adverse events during monitored anesthesia care for GI endoscopy: An 8-year experience. *Gastrointest Endosc* 2011;74:266-75. DOI: 10.1016/j.gie.2011.04.028
- Bo LL, Bai Y, Bian JJ, et al. Propofol vs traditional sedative agents for endoscopic retrograde cholangiopancreatography: A meta-analysis. *World J Gastroenterol* 2011;17:3538-43. DOI: 10.3748/wjg.v17.i30.3538
- De Witt J, McGreevy K, Sherman S, et al. Nurse-administered propofol sedation compared with midazolam and meperidine for EUS: A prospective, randomized trial. *Gastrointest Endosc* 2008;68:499-509. DOI: 10.1016/j.gie.2008.02.092
- Riphaus A, Geist F, Wehrmann T. Endoscopic sedation and monitoring practice in Germany: Re-evaluation from the first nationwide survey 3 years after the implementation of an evidence and consent based national guideline. *Z Gastroenterol* 2013;51:1082-8. DOI: 10.1055/s-0033-1335104
- Cooper GS, Kou TD, Rex DK. Complications following colonoscopy with anesthesia assistance: A population-based analysis. *JAMA Intern Med* 2013;173:551-6. DOI: 10.1001/jamainternmed.2013.2908
- Garewal D, Waikar P. Propofol sedation for ERCP procedures: A dilemma? Observations from an anesthesia perspective. *Diagn Ther Endosc* 2012;2012:639190. E-pub: 2012 Jan 5. DOI: 10.1155/2012/639190
- Adeyemo A, Bannazadeh M, Riggs T, et al. Does sedation type affect colonoscopy perforation rates? *Dis Colon Rectum* 2014;57:110-4. DOI: 10.1097/DCR.0000000000000002
- Briz Sáenz J, Aguilera Celorrio L, Gilsanz Rodríguez F. Los anestesiólogos somos los garantes de la seguridad y calidad en las salas de endoscopia. *Rev Esp Anestesiol Reanim* 2015;62:425-7. DOI: 10.1016/j.redar.2015.06.008
- Hagan KB, Thirumurthi S, Gottumukkala R, et al. Sedation in the endoscopy suite. *Curr Treat Options Gastroenterol* 2016;14:194-209. DOI: 10.1007/s11938-016-0089-8
- Vargo JJ, Niklewski PJ, Williams JL, et al. Patient safety during sedation by anesthesia professionals during routine upper endoscopy and colonoscopy: An analysis of 1,38 million procedures. *Gastrointest Endosc* 2016. DOI: 10.1016/j.gie.2016.02.007
- González-Huix Lladó F. Sedación en endoscopia en el año 2016: ¿es segura la sedación con propofol dirigida por el endoscopista en situaciones complejas? *Rev Esp Enferm Dig* 2016;108:237-9. DOI: 10.17235/reed.2016.4383/2016
- Wernli KJ, Brenner AT, Rutter CM, et al. Risk associated with anesthesia services during colonoscopy. *Gastroenterology* 2016;150:888-94. DOI: 10.1053/j.gastro.2015.12.018
- Pérez-Cuadrado Robles E, González Ramírez A, Lancho Seco Á, et al. Safety and risk factors for difficult endoscopist-directed ERCP sedation in daily practice: A hospital-based case-control study. *Rev Esp Enferm Dig* 2016;108:240-5. DOI: 10.17235/reed.2016.4206/2016
- FDA. FDA/CDER to Williams & Connolly LLP (American College of Gastroenterology) - Petition Denial. June 27, 2005. Document ID FDA-2005-P-0059-0080. Disponible en: [http://digestivehealth.net/images/FDA-2005-P-0059-0080\\_1\\_.pdf](http://digestivehealth.net/images/FDA-2005-P-0059-0080_1_.pdf)
- Vargo J. Update on endoscopist-administered propofol sedation for endoscopic procedures. *Gastroenterol Hepatol (NY)* 2011;7(3):189-97. PMID: PMC3079150
- <http://www.jointcommissioninternational.org/assets/3/7/Hospital-5E-Standards-Only-Mar2014.pdf>
- Mellin-Olsen J, Pelosi P, Van Aken H. Declaración de Helsinki sobre la seguridad de los pacientes en Anestesiología. *Rev Esp Anestesiol Reanim* 2010;57:594-5. DOI: 10.1016/S0034-9356(10)70287-5
- Ficha técnica propofol. Disponible en: [http://www.aemps.gob.es/cima/pdfs/es/ft/61297/FT\\_61297.pdf](http://www.aemps.gob.es/cima/pdfs/es/ft/61297/FT_61297.pdf)
- Wehrmann T, Riphaus A. Sedation with propofol for interventional endoscopic procedures: A risk factor analysis. *Scand J Gastroenterol* 2008;43:368-74. DOI: 10.1080/00365520701679181
- Tohda G, Higashi S, Wakahara S, et al. Propofol sedation during endoscopic procedures: Safe and effective administration by registered

- nurses supervised by endoscopists. *Endoscopy* 2006;38:360-7. DOI: 10.1055/s-2005-921192
28. Fatima H, DeWitt J, LeBlanc J, et al. Nurse-administered propofol sedation for upper endoscopic ultrasonography. *Am J Gastroenterol* 2008;103:1649-56. DOI: 10.1111/j.1572-0241.2008.01906.x
  29. Horiuchi A, Nakayama Y, Hidaka N, et al. Low-dose propofol sedation for diagnostic esophagogastroduodenoscopy: Results in 10,662 adults. *Am J Gastroenterol* 2009;104:1650-5. DOI: 10.1038/ajg.2009.250
  30. Schilling D, Rosenbaum A, Schweizer S, et al. Sedation with propofol for interventional endoscopy by trained nurses in high-risk octogenarians: A prospective, randomized, controlled study. *Endoscopy* 2009;41:295-8. DOI: 10.1055/s-0028-1119671
  31. Coté GA, Hovis RM, Anstas MA, et al. Incidence of sedation-related complications with propofol use during advanced endoscopic procedures. *Clin Gastroenterol Hepatol* 2010;8:137-42. DOI: 10.1016/j.cgh.2009.07.008
  32. Slagelse C, Vilmann P, Hornslet P, et al. Nurse-administered propofol sedation for gastrointestinal endoscopic procedures: First Nordic results from implementation of a structured training program. *Scand J Gastroenterol* 2011;46:1503-9. DOI: 10.3109/00365521.2011.619274
  33. Jensen JT, Vilmann P, Horsted T, et al. Nurse-administered propofol sedation for endoscopy: A risk analysis during an implementation phase. *Endoscopy* 2011;43:716-22. DOI: 10.1055/s-0030-1256515
  34. Redondo-Cerezo E, Sánchez-Robaina A, Martínez Cara JG, et al. Gastroenterologist-guided sedation with propofol for endoscopic ultrasonography in average-risk and high-risk patients: A prospective series. *Eur J Gastroenterol Hepatol* 2012;24:506-12. DOI: 10.1097/MEG.0b013e328350fcbd
  35. Pambianco DJ, Vargo JJ, Pruitt RE, et al. Computer-assisted personalized sedation for upper endoscopy and colonoscopy: A comparative, multicenter randomized study. *Gastrointest Endosc* 2011;73:765-72. DOI: 10.1016/j.gie.2010.10.031
  36. Thornley P, Al Beshir MA, Gregor J, et al. Efficiency and patient experience with propofol vs conventional sedation: A prospective study. *World J Gastroenterol* 2016;8:232-8. DOI: 10.4253/wjge.v8.i4.232
  37. Inadomi JM, Gunnarsson CL, Rizzo JA, et al. Projected increased growth rate of anesthesia professional-delivered sedation for colonoscopy and EGD in the United States: 2009 to 2015. *Gastrointest Endosc* 2010;72:580-6. DOI: 10.1016/j.gie.2010.04.040
  38. Birk J, Bath RK. Is the anesthesiologist necessary in the endoscopy suite? A review of patients, payers and safety. *Expert Rev Gastroenterol Hepatol* 2015;9:883-5. DOI: 10.1586/17474124.2015.1041508
  39. Day LW, Siao D, Inadomi JM, et al. Non-physicians performing lower and upper endoscopy: A systematic review and meta-analysis. *Endoscopy* 2014;46:401-10. DOI: 10.1055/s-0034-1365310
  40. Ikenberry SO, Anderson MA, Banerjee S, et al. American Society for Gastrointestinal Endoscopy. Endoscopy by non-physicians. *Gastrointest Endosc* 2009; 69:767-70. DOI: 10.1016/j.gie.2008.11.006
  41. Stephens M, Hourigan LF, Appleyard M, et al. Non-physician endoscopists: A systematic review. *World J Gastroenterol* 2015;21:5056-71. DOI: 10.3748/wjg.v21.i16.5056
  42. Spencer RJ, Ready RL. Utilization of nurse endoscopists for sigmoidoscopic examinations. *Dis Colon Rectum* 1977;20:94-6. DOI: 10.1007/BF02587321
  43. Massl R, Van Putten PG, Steyerberg EW, et al. Comparing quality, safety, and costs of colonoscopies performed by nurse vs physician trainees. *Clin Gastroenterol Hepatol* 2014;12:470-7. DOI: 10.1016/j.cgh.2013.08.049
  44. Gaba DM. Anaesthesiology as a model for patient safety in healthcare. *BMJ* 2000;320:785-8. DOI: 10.1136/bmj.320.7237.785
  45. Van Aken H, Staender S, Mellin-Olsen J, et al. Patient safety in anaesthesiology. *Best Pract Res Clin Anaesthesiol* 2011;25:ix:x. DOI: 10.1016/j.bpa.2011.02.012
  46. Schleppers A, Prien T, Van Aken H. Helsinki Declaration on patient safety in anaesthesiology: Putting words into practice - Experience in Germany. *Best Pract Res Clin Anaesthesiol* 2011;25(2):291-304. DOI: 10.1016/j.bpa.2011.02.011
  47. Buxbaum J, Roth N, Motamedi N, et al. Anesthetist-directed sedation favors success of advanced endoscopic procedures. *Am J Gastroenterol* 2016. DOI: 10.1038/ajg.2016.285