Introduction

The use of endoscopist-directed nurse-administered propofol sedation (EDNAPS) remains controversial because of concerns related to its safety, despite minimal evidence of improvement in safety with the use of anesthetic assisted sedation[1–42]. In Australia, propofol is generally administered by specialist anesthetists [1]. Since 2000, Canberra Hospital, a major teaching hospital of the Australian National University Medical School, in Australia’s largest inland city and capital, has used EDNAPS for most endoscopic procedures [2]. Despite accumulated evidence in regard to the safety of EDNAPS for routine endoscopic procedures, very few major teaching hospitals in Australia have adopted EDNAPS even for low-risk patients. In addition, EDNAPS is not used in many other western countries. EDNAPS provides the advantage of significantly reducing the cost of the endoscopic procedure without adversely affecting a patient’s clinical outcome [3]. To date, the use of propofol sedation has mainly been assessed in the community setting rather than a tertiary referral center [3]. This article analyses the safety of the use of EDNAPS for endoscopic procedures in a tertiary referral center.

Patients and methods

Between January 2004 and November 2012 at our institution, reports for all endoscopic procedures performed in the endoscopy unit were generated using a standardized reporting system, in which key parameters such as indication, results, interventions, and conclusion were mandated. A program of quality assurance with mandatory reporting of unplanned events, which were reviewed at unit meetings every 6 weeks, was also ongoing. In addition, over the study period, details of all Medical Emergency Team (MET) calls were gastrointestional (GI) hemorrhage (n=11; 8 variceal, 3 nonvariceal), dysphagia (n=5), PEG removal (n=1), and dyspepsia (n=1). Fifteen of 22 patients, including all of those who had a colonoscopy, made a full recovery and returned to the ward or were discharged home. In the gastroscopy group, seven were intubated and admitted to Intensive Care, of whom six were emergency cases for gastrointestinal bleeding (n=4 variceal, n=2 non variceal) and one in which the indication was PEG removal. Two deaths occurred in the intubated group.

Conclusions: In a tertiary referral center, EDNAPS for low-to-moderate risk (ASA ≤2) patients undergoing gastroscopy and colonoscopy is very safe. Gastroscopy is associated with greater anesthetic risk than colonoscopy and those with high ASA scores needing urgent endoscopy for upper gastrointestinal hemorrhage are at particular risk of cardiorespiratory decompensation.
Nurse sedationist prerequisites
The following requirements must be fulfilled before a registered nurse (RN) is permitted to administer propofol in the endoscopy unit:

- Registration as a RN with the Australian Health Practitioner Regulation Agency since 2012 and prior to that in the Australian Capital Territory Nurses Board;
- Annual written and practical assessment, conducted by a senior RN with experience in EDNAPS, for which a 100% score is required;
- Annual hands-on supervised administration of propofol observed by a senior staff member;
- Annual session with an anesthetist in the operating room in regard to advanced and basic life support, including airway maintenance (endotracheal intubation and laryngeal mask airway);
- Annual accreditation by the Department of Anesthesia;
- Provision of propofol sedation for at least 250 procedures/year in order to maintain accreditation; and
- Participation in the quality assurance program of the endoscopy center.

Patient selection
Patient selection criteria evolved over the duration of the study. The current exclusion criteria for EDNAPS are as follows:

- Age < 18 years, body mass index > 35 or weight > 120 kg;
- Allergy to propofol (allergy to eggs or soybean);
- Prior complications with anesthesia;
- Difficult intubation/airway management (e.g., facial deformity) or potential risk of aspiration of gastric content;
- Significant cardiopulmonary disease;
- Obstructive sleep apnea requiring continuous positive airway pressure or bi-level positive airway pressure;
- Recent cerebrovascular disease or ischemic heart disease event or acute myocardial infarction; and
- Significant mental health issues.

Sedation regimen
Details of the sedation regimen have been published before [2]. All patients receive supplemental oxygen. Most fit adult patients receive a combination of low-dose short-acting opioid or benzodiazepines or both followed by boluses of propofol. An initial dose of 0 to 5 mg of intravenous (IV) midazolam and 0 to 100 micrograms IV fentanyl is usually given. The first dose of propofol (10 – 30 mg) is then injected and titrated subsequently with boluses of 10 to 30 mg of propofol at up to 1-minute intervals with the aim of inducing a level of sedation whereby patients are able to maintain their own airway without assistance and still able to respond to repeated tactile and noxious stimuli while remaining comfortable. The maximum propofol dose in our EDNAPS cohort was 420 mg. Once propofol is administered, no further opioid or benzodiazepine administration is permitted.

Patient monitoring and post-procedural care
All patients receive ongoing supplemental oxygen during and after the procedure. Automated pulse oximetry is used in all patients, with noninvasive monitoring of blood pressure at 3-minute intervals and continuous heart rate monitoring. This is continued in the recovery area until the patient is alert. Systematic telephone calls were made 24 hours after each procedure as part of follow up.

MET Call Criteria
A MET Call can be triggered by any staff member who is concerned about a patient and trigger criteria deliberately kept broad. Even if there are general concerns without a specific reason, a MET Call can be activated. The criteria for a MET Call are:

- Threatened airway
- Respiratory or cardiac arrest
Respiratory rate of <5 or >36 breaths per minute
• Oxygen desaturation <90%
• Systolic blood pressure <90 mmHg
• Heart Rate <40 or >140 beats per minute
• Decreased level of consciousness
• Drop in Glasgow Coma Score by 2
• Seizures

The alteration in conscious state and Glasgow Coma Score did not lead to a MET call in the endoscopy unit if these changes were attributable to recently administered sedative medication. Physiological derangements of a minor and transient nature did not trigger a MET call but were handled by the attending registered nurse. For instance, patients experiencing obstructed breathing were managed by “chin lift” in which the mandible is pushed forward by the attending nurse. Minor events of this nature were not systematically recorded.

Results

We identified 27,989 patients (mean age 57) who underwent 33,539 endoscopic procedures (16,393 upper endoscopies and 17,146 colonoscopies) using EDNAPS. No endoscopic surgical dissections, endoscopic ultrasound examinations, or small bowel enteroscopies were performed under EDNAPS. The number of endoscopic mucosal resections (for Barrett’s esophagus or for laterally spreading colonic lesions) was not systematically recorded. However, the total number of these procedures was very small – certainly fewer than 0.2% of the total number of procedures. The numbers of percutaneous endoscopic gastrostomy (PEG) tube placements and emergency procedures were also not systematically recorded in the computerized database. During the EDNAPS study period, 118 PEG gastrostomy tubes were inserted. Over the 43 months from October 2004 to April 2008, 180 emergency procedures were performed using EDNAPS. The estimated total number of emergency procedures over the study period was calculated to be 398 (180 × 95/43). There were no esophageal, duodenal, or colonic stent placements in the series nor were there any cystogastrostomies for pancreatic pseudocysts. Over the 9-year period, there were 23 MET call cases, 18 related to upper endoscopies and five patients who had undergone colonoscopies. The demographic details and clinical course of the patients receiving MET Calls are outlined in the Table 1 and Fig. 1.

In the colonoscopy group, the reason for the MET calls was oxygen desaturation (<90%) in one patient whereas in the rest of the patients (n = 4), the reason was transient hypotension with a recorded systolic blood pressure of <90 mmHg systolic, which resolved with IV fluid. All the MET calls after gastroscopy were related to oxygen desaturation (oxygen saturation range 51% to 86%). In seven cases, mask ventilation and subsequent endotracheal intubation were performed and the patients were then transferred to the intensive care unit. The gastroscopy indications in the MET call group requiring intubation were acute gastrointestinal bleeding (n = 6; four variceal bleeding, two due to peptic ulcer disease) and one related to PEG tube insertion. Two of the intubated patients died after periods of 8 and 12 days, respectively. The other five patients who underwent endotracheal intubation recovered completely.

Each of the deaths occurred after an upper endoscopic procedure. One patient was a 57-year-old man with a history of alcoholism and polysubstance abuse who presented to the Emergency Department in 2005 with acute gastrointestinal bleeding. His ASA score was III and he underwent urgent upper endoscopy with midazolam, fentanyl, and propofol sedation and was found to

<table>
<thead>
<tr>
<th>Table 1 Demographic details of MET call patients.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Patient status</td>
</tr>
<tr>
<td>Inpatient</td>
</tr>
<tr>
<td>Outpatient</td>
</tr>
<tr>
<td>Mean age</td>
</tr>
<tr>
<td>ASA score –</td>
</tr>
<tr>
<td>II</td>
</tr>
<tr>
<td>III</td>
</tr>
<tr>
<td>IV</td>
</tr>
<tr>
<td>Procedure indications</td>
</tr>
<tr>
<td>Upper gastroscopy</td>
</tr>
<tr>
<td>Variceal bleeding</td>
</tr>
<tr>
<td>Non-variceal bleeding</td>
</tr>
<tr>
<td>PEG insertion</td>
</tr>
<tr>
<td>Dysphagia</td>
</tr>
<tr>
<td>Colonoscopy</td>
</tr>
<tr>
<td>Rectal bleeding</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>

ASA, American Society of Anesthesiologists; yr, year; PEG, percutaneous endoscopic gastrostomy

33,539 endoscopic procedures in which endoscopist directed nurse administration of propofol was used

23 METCALLS

n = 16
recovered and were discharged from the unit

n = 7
had endotracheal intubated

6 UGIB (4 variceal, 2 nonvariceal)
1 PEG insertion

n = 5
recovered and were discharged from ICU

n = 2
died

• 57 y.o male (ASA III) presented with variceal haemorrhage and newly diagnosed metastatic hepatocellular carcinoma (2005)
• 86 y.o male (ASA IV) presented with melena due to malignant gastric ulcer from metastatic lung cancer (2004)

Fig. 1 Diagram illustrating the clinical outcome of the MET Call cases.

Number of patients intubated

<table>
<thead>
<tr>
<th>Year</th>
<th>Intubated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>1</td>
</tr>
<tr>
<td>2005</td>
<td>3</td>
</tr>
<tr>
<td>2006</td>
<td>2</td>
</tr>
<tr>
<td>2007</td>
<td>1</td>
</tr>
<tr>
<td>2008</td>
<td>1</td>
</tr>
<tr>
<td>2009</td>
<td>1</td>
</tr>
<tr>
<td>2010</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>0</td>
</tr>
</tbody>
</table>

Fig. 2 Number of patients intubated.
have bleeding esophageal varices. He underwent successful vari-
cellular banding but became cyanotic shortly after the procedure
was completed. He was mask ventilated and then intubated.
There was no evidence of aspiration, and his chest x-ray re-
mained clear. However, he subsequently developed decompensa-
ted liver disease with ascites and imaging revealed multiple liver
lesions, which were consistent with hepatocellular cancer lesions
on computed tomography scan. Palliative care was instituted and
the patient died 8 days after presentation. The second patient
who died was an 86-year-old man with an ASA score of IV who
presented with melena in 2004. He underwent successful upper
endoscopy with a combination of midazolam, fentanyl, and pro-
pofol, which revealed a large gastric ulcer in the body of the
stomach. In the recovery area, he awoke from sedation but subse-
sequently developed shortness of breath and hypoxemia. He was
successfully resuscitated, intubated, and ventilated. There was
no evidence of aspiration. His gastric biopsies subsequently re-
vealed adenocarcinoma and further imaging revealed metastatic
lung cancer. He died 12 days after presentation. In both of these
cases, we believe the deaths were unrelated to administration of
EDNAPS per se.

Analysis of the need for tracheal intubation over the 9-year peri-
on of the study showed that there was no requirement for endo-
tracheal intubation since 2008 (Fig. 2).

Discussion

This report confirms the good safety record of EDNAPS. More
than 30000 patients were sedated using EDNAPS with minimal
major morbidity or mortality. EDNAPS has been shown to be safe
in ambulatory care settings. This study has shown that it is
also safe in a tertiary referral center, in which there are more ur-
gent and semi-urgent cases and in which endoscopists are trained.
The deaths in this series occurred in emergency cases of mod-
erate to high risk and patient factors clearly were contributory. It
is acknowledged that the ASA III and IV cases that led to MET calls
in this series should not have been performed using EDNAPS.
In this regard, it is also noteworthy that during the last 4 years of
the study, emergency endotracheal intubation was not required for
any patient following EDNAPS including those who received
MET calls. We speculate that the safety of EDNAPS for upper
dendoscopic procedures may have improved over the years due
to better patient selection and ongoing improvements in nursing
training and accreditation. Were the two patients who subse-
duently died in this series to be treated today, given our stricter
exclusion criteria and the greater experience of our attending
nursing and medical staff, they would be sedated by specialist an-
esthetists. Nevertheless, given these patients’ advanced coexis-
tent malignancies, it is doubtful whether anesthetic assistance
would have significantly prolonged their lives [3]. There is also
no evidence that resuscitation efforts in these patients were de-
layed or ineffective. Clearly, patient selection is critical if seda-
tion-related complications are to be avoided.

Our results also confirm previous findings that the risk of compli-
cations during EDNAPS is greater during upper endoscopic pro-
cedures than during colonoscopy. Indeed, to our knowledge,
there is still not a single report of death in the literature attribu-
table to EDNAPS for colonoscopy. The reasons why sedation-
related complications and ventilatory support are needed more
often during upper endoscopy are unclear. Possible explanations
include a deeper average level of sedation and a higher incidence
of coughing and laryngospasm during upper endoscopy. In addi-
tion, the occupation of the upper aerodigestive tract by the endo-
scope may make airway support more challenging in these pa-
ients. In this regard, in one small study, to overcome this prob-
lem, a mask adaptor was used instead of traditional mask venti-
lation to provide positive pressure ventilation during upper gas-
trointestinal endoscopy [41]. The potential applicability of such a
device in EDNAPS is unclear, although it may have a role in non-
urgent patients at higher risk of apnea.

It is important to be cognizant of the limitations of EDNAPS. In
particular, it is inappropriate to perform endoscopy on high-risk
patients with EDNAPS. At Canberra Hospital, there are designated
lists for endoscopic procedures to be performed in the endoscopy
unit with anesthetic assistance. It is also compulsory that all
ERCPs be undertaken with the assistance of specialist anesthe-
tists. Finally, there is also provision for performance of upper gas-
trointestinal endoscopy in the operating room in patients who are
seriously ill and potentially unstable, such as those presenting
with substantial variceal bleeding. Only with careful patient
selection and ongoing quality assurance can sedation-related
morbidity and mortality be minimized and the appropriate role
for EDNAPS be defined.

Other limitations of this study include the possibility that some
endoscopic procedures performed in the endoscopic unit may
not have been recorded in the standardized reporting system.
That, however, was minimized by the requirement that each pa-

tient have a typed, computer-generated report before departing
the endoscopy suite. Secondly, there may have been episodes of
physiological deterioration that did not trigger a MET call but
which may have led to medium- or long-term morbidity. That,
too, is unlikely because the MET team in our institution is very
accessible and can be summoned with the push of a button.
Nonetheless, it is acknowledged that details of transient seda-
tion-induced physiological changes were not captured by the
methodology employed in this study. Finally, the applicability of
the results of this study to other tertiary referral centers may be
limited to the extent that higher-risk patients and those under-
going more complex procedures such as ERCP were excluded.

Anesthetist-administered propofol for routine procedures in
endoscopic unit with anesthetic assistance. It is also compulsory that all
nurses. The Australian and New Zealand College of Anaesthetists
has recognized that propofol may be safely administered by non-
anesthetists and, in conjunction with the Gastroenterological So-
ciety of Australia and the Royal Australasian College of Surgeons,
this tripartite group has promulgated an important set of guide-
lines in this regard, which have been updated subsequent to the
current study [6, 43]. We believe that use of EDNAPS is likely to
expand and it has certainly been widely reported in the United
States, Canada, Switzerland, and European Union countries [38–
40, 42]. This study shows that the potential role of EDNAPS in ter-
tiary referral centers and teaching hospitals is substantial.

Competing interests: None
References
5 Bell GD, Charlton JE. Colonoscopy – is sedation necessary and is there any role for intravenous propofol? [Editorial] Endoscopy 2000; 32: 264 – 267
7 Kulling D, Orlandi M, Inauen W. Propofol sedation during endoscopic procedures: how much staff and monitoring are necessary? Gastrointest Endosc 2007; 66: 443 – 449
16 Vysoff IF, Raymond G, Sahai AV. Endoscopist administered propofol for upper GI EUS is safe and effective: a prospective study in 500 patients. Gastrointest Endosc 2004; 60: 356 – 360
18 Meah N, Parikh PB. Efficacy and safety of nurse-administered propofol as an adjunctive agent of conscious sedation in private non-academic gastroenterology practice setting. Am J Gastroenterol 2004; 99: S313

Ooi Marie et al. EDNAPS in a tertiary referral center... Endoscopy International Open 2015; 03: E393–E397