Title

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Authors

Navidi, Bijan
Kiai, Kianusch
Rofail, Michael

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CLINICAL REVIEW

MAC versus Conscious Sedation for Gastrointestinal Endoscopy: Quality and Throughput

Bijan Navidi, MD, Kianusch Kiai, MD and Michael Rofail

Introduction

More than 98% of Gastrointestinal (GI) endoscopic procedures in the US are performed with sedation to ease patient discomfort and to provide optimal conditions by reducing patient movement or autonomic pain reflexes.[1] The sedation agents used have historically varied due to provider preference, patient preference, and pharmacological and geographic availability. They all share the need to be safe and have a short-acting profile to efficiently sedate at endoscopy centers with multiple quick outpatient procedures. Colonoscopies or esophagogastroduodenoscopies (EGDs), generally are performed under 30 minutes. The two most common types of sedation are intravenous conscious sedation (IVCS) controlled by the endoscopist, and monitored anesthesia care (MAC) sedation provided by an anesthesiologist. Since the adoption of MAC as the primary form of GI sedation at UCLA, we examined the perioperative stages in a typical procedure to determine any significant differences in time efficiency and productivity between patients receiving the two different sedation methods. We further divided MAC sedation into two subgroups based on method of administration to examine for differences between intermittent IV boluses on an as needed basis throughout the case or as a single bolus with a continuous propofol drip to maintain an adequate sedation.

Pharmacokinetics

With IVCS, midazolam with or without an analgesic like fentanyl is typically administered for sedation.[2] These medications are fast-acting and short-lived. Midazolam's distribution half-life is 4 to 18 minutes with a duration of action (DOA) of 1 to 2 hours. Fentanyl's distribution half-life is 15 minutes with DOA of about 1 hour.[3,4] With MAC sedation, the anesthesiologist provides a deeper level of sedation using a single anesthetic medication, propofol without the need for an analgesic because it suppresses both awareness and the brain's ability to register any acute procedural pain.[1] Propofol has an even shorter pharmacokinetic profile with a distribution half-life of 2 to 4 minutes and a DOA of 5 to 10 minutes which makes it more titratable while providing a faster recovery, without lingering sedation or common side-effects seen, such as nausea, grogginess, or anterograde amnesia.[5] Given its ultra-short action, propofol can be easily dosed to effect in boluses as needed, or more commonly as a bolus followed by a continuous infusion. Typical infusions range from 100-150mcg/kg/min to maintain a constant level of adequate sedation in 85% of patients.[5] If the patient requires additional sedation, such as during moments of higher stimulation, additional small boluses of propofol, usually 10-20mg, are given. Because of its ideal pharmacological profile, MAC sedation with propofol has become the primary form of GI sedation at UCLA, providing optimal sedation with increased efficiency that offsets the cost of having an additional sedation provider. In the US, propofol sedation for GI procedures has increased from 14% in 2003 to 53% of commercially insured patients and 47.6% of Medicare patients in 2013.[2] MAC sedation has also decreased hospital resources and healthcare costs by allowing for a greater number of GI procedures to be safely done in community endoscopy centers, especially in patients with comorbidities like sleep apnea, obesity, or chronic sedative or narcotic users who would have previously been done in the hospital due to an increased risk of respiratory obstruction or apnea under IVCS.

Review

We examined the electronic medical record (EMR) for all the GI procedures at five UCLA outpatient community endoscopy centers from March 2019 to November 2022. Each center included a core group of endoscopists totaling 33, and a rotating set of 22 anesthesiologists providing MAC sedation at each site. Only single EGD or colonoscopy procedures were reviewed. Out of a total of 24,687 cases, 18,426 had complete data available with 1897 IVCS cases (225 EGD and 1672 colonoscopy) and 16,529 propofol sedation cases (3,467 EGD and 13,062 colonoscopy). The MAC cases included both methods of propofol administration with a Bolus Only (BO) sedation group with 4 anesthesiologists in 3,321 colonoscopies and 946 EGDs, and a Bolus Continuous Drip (BCD) sedation group with 18 anesthesiologists in 9,741 colonoscopies and 2,521 EGDs. All patients received the same standard monitors with supplemental oxygen via nasal canula or mask. Prior to starting the procedure adequacy of sedation was assessed with both verbal cues or by manual stimulation such as a jaw thrust for EGDs or rectal lube placement for colonoscopies. At these GI centers, all the endoscopists utilized CO2 insufflation instead of air which allows for rapid absorption and reduced postprocedural pain.

Discussion

We compared the sedation methods for these GI procedures including the time intervals between key intraoperative and recovery events. The first metric was the time from sedation start to procedure start. The average time for this stage was fastest within the MAC BO group followed by the BCD group and then finally the IVCS group. See Table 1. These times were expected given the pharmacokinetics of propofol versus fentanyl and midazolam. The average MAC time from the administration of medications to start of procedure was 34% faster with EGDs and 28% faster with colonoscopies when compared to IVCS. Within the MAC groups, BO sedation was 34% faster with EGDs and 28% faster with colonoscopies. These results likely reflect the larger initial bolus of propofol given immediately before the proceduralist was ready to scope in this sedation group. Although the difference in times may not seem large, in the context of how quickly it takes to complete an endoscopic procedure such as an EGD (which can be as short as 7 minutes), the time to sedate a patient with IVCS can consist of more than half the total procedure time.

The time required to complete the procedure is another important intraoperative metric in comparing sedation styles. Even with the patient populations biased against MAC sedation, the combined MAC groups were faster than the IVCS sedation in both EGDs and colonoscopies, at 6m53s and 18m5s to 7m4s and 19m26s respectively. See Table 2. However, the difference was more profound when comparing the MAC BO group to IVCS procedures times with EGDs 8.3% and colonoscopies 6.6% shorter.

Regardless of sedation type, the recovery period for all the GI cases based on the Aldrete Scoring System averaged between 20 to 22 minutes. These differences in recovery time were felt to be insignificant, however patients under MAC sedation had a faster return to baseline cognitive function without lingering tiredness, and generally reported a higher satisfaction level, with a 23.5% decrease in nausea during the first 24 hours following their procedures.[6]

Finally, we compared the overall time from when a patient receives sedation to recovery and stable enough to go home. The MAC sedation groups were both shorter in length than the IVCS group, and within MAC subgroups, the BO group was the fastest. See Table 3. Compared to IVCS, MAC BO was 12% shorter on average (5m11s) for EGDs and 8.4% shorter (4m21s) for colonoscopies. The MAC BCD group was also faster than IVCS by just over 5.5% for both procedures. These shorter overall times equate to quicker turnover at every stage of care, directly affecting subsequent patients and reducing bottlenecks and increasing endoscopy center productivity.

Conclusion

Based on these metrics, we conclude that MAC propofol sedation is a faster and more effective form of sedation over IVCS for outpatient GI colonoscopies and EGDs. Furthermore, MAC sedation provided with intermittent propofol boluses was faster than MAC given as an initial bolus and maintained by a continuous propofol infusion. The efficacy of MAC sedation was seen in nearly every aspect of patient care. This included time to achieve an adequate level of sedation; intraoperative time to finish the procedure, and the total time from sedation to the patient completing recovery. This is important as additional minutes during one case can affect the start of subsequent patients. These delays can quickly accumulate when performing up to 32 procedures in a day. These delays can add up to as much as 2.5 hours/day depending on the total number of cases, type of procedures, and sedation styles.

Published literature shows mixed results on the efficacy of MAC versus IVCS. One meta-analysis of randomized controlled trials (RCTs) of cirrhotics getting endoscopies concluded MAC sedation had faster sedation adequacy, recovery, and discharge, but had longer procedure times than IVCS.[7] Another meta-analysis concluded the opposite with no significant difference between sedation types for EGDs and colonoscopies in regard to procedure times, patient perceived intraprocedural pain, amnesia, or cardiopulmonary complications. They reported a time reduction with MAC for colonoscopies in recovery time, discharge time, and improved sedation conditions but not for EGD's.[1] Our endoscopists' satisfaction with MAC sedation over IVCS matched the literature with a statistically significant difference. This may be from improved patient conditions during the procedure or the reduction in endoscopist stress and their increased ability to focus on the procedure knowing another physician was involved in monitoring and controlling the sedation.[2]

This review does have limitations and the results must be interpreted in the context.

The patient populations are inherently different between the MAC sedation and IVCS sedation groups. The MAC sedation groups are older as MAC is covered by Medicare and also include patients with comorbidities not able to be performed under IVCS. Additionally, the sample sizes are unequal the IVCS group patients was much smaller, about $1/10^{th}$ the total MAC sedation cases (2,015 vs 20,568). Further studies with a larger IVCS populations are needed to get more accurate differences between sedation groups. Similarly, the GI proceduralists use varying techniques, experiences, and utilize different insufflation amounts which influence patients' pain and the amount of sedation. Differences should be lost in the averages but those more comfortable in IVCS will inherently perform more cases using that sedation form and thus may also bias the data. Likewise, variability among the sedation amounts and the time during the procedure the last sedative was given or propofol drip stopped varies within each sedation group and can influence each of the measured metrics despite the cases being averaged together. With the total medication dosages unavailable at the time of this review, the extent of their quantities influencing sedation times will need to be explored in future studies. Similarly, any unexpected delays from proceduralist pausing during the case, equipment malfunctions, or the amount

of treatment or biopsies being performed can theoretically affect any of the times and may not be the same within each of the sedation groups. Human error in documentation of the measured times can also affect the data. Lastly, the limitations of the anesthesia EMR times for MAC sedation which only document to the minute unlike the nursing procedural times that document down to the second, can limit the studied times. This discrepancy may bias the data for each case by 1 to 2 minutes. Sedation time that starts or ends up to the 59th second would be rounded down to the minute.

NOTE ± 1-2 min error is inherent to all anesthesia times given the CareConnect EMR only records by the minute and not the second. All seconds for anesthesia are a product of obtaining the averages.

Table 1: Average Time Sedation to Procedure Start (mm:ss)

	IVCS	MAC (BO)	MAC (BCD)	MAC (Combined)
EGD	3:43	1:15	1:54	1:43
Colonoscopy	3:28	1:18	1:49	1:37

Table 2: Average Time Procedure Start to End (mm:ss)

	IVCS	MAC (BO)	MAC (BCD)	MAC (Combined)
EGD	7:04	6:29	7:02	6:53
Colonoscopy	19:26	18:09	20:10	19:05

Table 3: Average Time Sedation Start to Recovery Complete (mm:ss)

	IVCS	MAC (BO)	MAC (BCD)	MAC (Combined)
EGD	42:28	37:17	39:37	38:59
Colonoscopy	51:40	47:19	50:09	49:26

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