Modifications in endoscopic practice for the elderly

This is one of a series of statements discussing the use of GI endoscopy in common clinical situations. The Standards of Practice Committee of the American Society for Gastrointestinal Endoscopy (ASGE) prepared this text. This guideline updates a previously issued guideline on this topic.[1] In preparing this guideline, a search of the medical literature was performed using PubMed. Additional references were obtained from the bibliographies of the identified articles and from recommendations of expert consultants. When limited or no data exist from well-designed prospective trials, emphasis is given to results from large series and reports from recognized experts. Guidelines for appropriate use of endoscopy are based on a critical review of the available data and expert consensus at the time the guidelines are drafted. Further controlled clinical studies may be needed to clarify aspects of this guideline. This guideline may be revised as necessary to account for changes in technology, new data, or other aspects of clinical practice. The recommendations were based on reviewed studies and were graded on the strength of the supporting evidence (Table 1).[2] The strength of individual recommendations is based on both the aggregate evidence quality and an assessment of the anticipated benefits and harms. Weaker recommendations are indicated by phrases such as "we suggest," whereas stronger recommendations are typically stated as "we recommend."

This guideline is intended to be an educational device to provide information that may assist endoscopists in providing care to patients. This guideline is not a rule and should not be construed as establishing a legal standard of care or as encouraging, advocating, requiring, or discouraging any particular treatment. Clinical decisions in any particular case involve a complex analysis of the patient's condition and available courses of action. Therefore, clinical considerations may lead an endoscopist to take a course of action that varies from these guidelines.

The use of GI endoscopy in geriatric patients is increasing as a larger proportion of the population is reaching an advanced age. In the year 2010, 40.3 million people (13.0% of the total population) were 65 years of age and older, and 5.5 million were aged 85 years of age and older in the United States.[3] The number of individuals 65 years and older is expected to increase to more than 20% of the total U.S. population by 2030, with individuals 85 years and older representing the fastest growing segment of this group. This guideline is intended to provide guidance regarding endoscopic practice issues in the elderly. Previous guidelines have defined geriatric patients as those 65 years of age and older, and patients of advanced age as those 80 years of age and older.[1] Because physiologic age is a continuum, this guideline is not intended to apply to rigidly defined age ranges.

PREPROCEDURE PREPARATION

Preparation for endoscopy in the elderly differs little from that for other adults. For upper endoscopic procedures, the recommendations for cessation of ingestion of solids and liquids are the same as for younger patients.[4] Colonoscopy preparations are broadly classified into 2 categories: electrolyte-balanced polyethylene glycol–based preparations and sodium phosphate solutions. Earlier studies demonstrated similar tolerability and efficacy of the 2 regimens in the elderly.[5,6] However, sodium phosphate works by an osmotic mechanism of action, resulting in fluid and electrolyte shifts that can result in hyperphosphatemia, hypernatremia, hypokalemia, and worsening kidney function.[5-8] These combinations are potentially fatal in the elderly, therefore, sodium phosphate should be avoided as a colonoscopy preparation in the elderly, particularly those with renal disease or cardiac dysfunction.[9,10] Magnesium-based cathartics have been demonstrated to cause life-threatening hypermagnesemia in elderly patients, including those without preexisting renal disease.[11] Consequently, the use of magnesium-based bowel preparations as a sole colonoscopy preparation should generally be avoided in the elderly. As with any bowel preparation, it is important to maintain adequate hydration throughout the bowel preparation process to reduce the risk of dehydration-related adverse events in the elderly.[12]

Adequate colonoscopy preparation remains a concern in the elderly. Patients of advanced age are less likely to tolerate high-volume oral preparations.[13] As a result, the rates of poor colonic preparations in the elderly may be as high as 16% to 21%, which is much higher than other age groups.[14-16] Poor colonic preparation has been noted to be the single most important impediment to adequate colonoscopy.[15] Although outcomes data with colonoscopy

TABLE 1. GRADE system for rating the quality of evidence for guidelines

Quality of evidence	Definition	Symbol
High quality	Further research is very unlikely to change our confidence in the estimate of effect.	⊕⊕⊕⊕
Moderate quality	Further research is likely to have an important impact on our confidence in the estimate of effect and may charge the estimate.	⊕⊕⊕◯
Low quality	Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.	⊕⊕◯◯
Very low quality	Any estimate of effect is very uncertain.	⊕◯◯◯

Adapted from Guyatt et al.[2]

preparations in the elderly are lacking, the use of split-dosage preparations should be considered for elderly patients.

Preprocedure assessment of elderly patients for endoscopic procedures should be similar to that for all patients, with particular attention to the patient's cardiopulmonary status and comorbid conditions that may affect sedation or performance of the procedure. Elderly patients are more likely to have underlying heart disease and implanted cardiac devices and recommendations should be followed according to the ASGE technology status report for these devices.[17] Similarly, guidelines regarding the management of antithrombotic or antiplatelet agents have been published, but the continued use or discontinuation of these agents should be individualized based on the clinical scenario.[18,19] Prophylactic antibiotics are not recommended for most routine endoscopic procedures.[20] There are no specific changes for the use of prophylactic antibiotics in the elderly. Recent guidelines on the optimal geriatric preoperative assessment recommend additional evaluation of the patient's cognitive ability and capacity to understand the anticipated surgery/procedure, screening for depression, and documenting the patient's baseline functional status.[21] Patients with cognitive impairment, signs or symptoms of depression, or functional limitations should be referred to their primary care physician or geriatrician for further evaluation.[21]

SEDATION AND ANALGESIA

Most GI endoscopy is performed by using moderate sedation. Guidelines regarding conscious sedation and monitoring of adult patients have been previously published.[22] Monitoring procedures for the elderly are the same as the standard procedures used for all patients including monitoring devices, resuscitative equipment, and pharmacologic agents. Sedation in the elderly requires awareness of this population's increased response to sedatives. A variety of physiologic processes contribute to the increase in sensitivity and sedation risk in geriatric patients.[23] Arterial oxygenation progressively deteriorates with age and has been attributed to a mismatch of ventilation and perfusion.[24] Cardiorespiratory stimulation in response to hypoxia or hypercarbia is blunted and delayed. Narcotic and non-narcotic central nervous system depressants produce greater respiratory depression and a greater incidence of transient apnea and episodic respirations. The risk of aspiration also increases as a result of a significant increase in the sensory stimulus threshold required for reflexive glottic closure.[25]

The age-related increase in lipid fraction of body mass yields an expansion of the distribution volume for pharmacologic agents that are highly lipid soluble, including benzodiazepines. In conjunction with reduced hepatic and renal clearance mechanisms, this can prolong recovery for elderly patients after sedation. Finally, a complex interplay among heightened central nervous system sensitivity and alterations in drug receptors, volumes of distribution, and intercompartmental transfer contributes to the reduced dose requirements of all standard sedative agents. Nevertheless, age alone is not a major determinant of morbidity. Rather, age-related diseases and rapid or excessive dosing contribute more to the cardiopulmonary adverse events of sedation than dose itself.[23] One prospective cohort study of patients of advanced age undergoing colonoscopy with standard moderate sedation demonstrated a higher rate of oxygen desaturation compared with younger adults (27% vs 19%, $P = .0007$).[15]

The primary modification in sedation practices required in the geriatric population is administration of fewer agents at a slower rate and with lower initial and cumulative doses.[26,27] Doses based solely on milligram per kilogram of body weight may produce profound respiratory depression and hypotension. As in younger adults, midazolam and/or narcotics are generally used. Fentanyl may have an advantage over meperidine in the elderly because of its faster onset of action and shorter half-life, thereby allowing faster recovery from sedation.[28] Propofol has a narrower margin of safety in elderly patients, but has been shown to be safe when used in elderly patients with continuous monitoring.[29-32] Minimizing the use of sedation or no sedation is an option for reducing anesthesia-related adverse events during endoscopic procedures.

PROCEDURAL INDICATIONS AND OUTCOMES

For patients in any age group, endoscopy should be performed only when the results will influence clinical

management or outcome. The indications for GI endoscopy among the elderly are largely the same as those for younger adults, with variation in the relative frequency based on the development of age-related diseases.[33] The same relative and absolute contraindications also pertain, without respect to age.[33] Increased attention should be paid, however, to the comorbid risk engendered by age-related diseases, such as cardiac and pulmonary dysfunction. Significant risk may outweigh the acknowledged benefits of a procedure.

Upper endoscopy

Upper endoscopy in the elderly often provides diagnostic information that affects clinical therapeutic decisions.[34-36] A recent retrospective study of 3147 elderly patients undergoing upper endoscopy demonstrated that significant findings (ie, any finding that affected therapeutic decisions and prognosis) were identified in 49.5% of patients.[37] The yield of EGD was most significant for the following procedural indications: GI bleeding (74%), reflux symptoms (53%), weight loss (53%), dysphagia (50%), and anemia (49%). In this study, 9.8% of patients were diagnosed with peptic ulcer disease or a new diagnosis of malignancy. Furthermore, patients older than 85 years of age had a threefold increase in the prevalence of peptic ulcer disease or malignancy compared with patients 65 to 69 years of age (odds ratio [OR] 3.1; 95% CI, 2.0-4.7; $P = .001$). Multivariate analysis demonstrated that factors associated with relevant findings were male sex (OR 1.4; 95% CI, 1.2-1.5), weight loss (OR 1.4; 95% CI, 1.03-1.9), bleeding (OR 2.2; 95% CI, 1.6-3.1), and symptoms of GERD (OR 1.7; 95% CI, 1.4-2.1).[37] Initial upper endoscopy has been demonstrated to be cost-effective in patients older than 50 years of age with new-onset dyspepsia.[38]

EGD is safe and well tolerated in the elderly. A small series of 64 patients of advanced age undergoing upper endoscopy demonstrated no procedure-related mortality.[39] In a study of patients with high-risk endoscopic lesions who underwent therapeutic endoscopy, geriatric patients had similar rates of successful endoscopic therapy, mortality rates, and length of hospitalization compared with younger patients.[40] Although moderate sedation significantly improves tolerance of EGD, elderly patients have a better tolerance for undergoing unsedated upper endoscopy compared with younger patients.[41] Several studies have demonstrated the utility of ultrathin endoscopes in allowing for unsedated upper endoscopy, including in elderly patients.[42-46] Small-caliber upper endoscopes have also been shown to reduce the likelihood of oxygen desaturation and dysrhythmias during the procedure.[47,48] Patients undergoing unsedated upper endoscopy typically receive topical anesthetics to the oropharynx and it is important to be cognizant of the rare risk of methemoglobinemia associated with some of these agents.

Upper endoscopy with PEG tube placement

The role of upper endoscopy with PEG placement remains controversial in elderly patients, particularly in patients with dementia.[49,50] Age has been shown to be a significant predictor of post-PEG death, with patients of advanced age having poorer survival rates after PEG placement compared with patients younger than 70 years of age.[51] Studies have demonstrated 30-day mortality rates of 19% to 24% in elderly patients after PEG placement, largely attributed to underlying medical comorbidities and not to procedure-related adverse events.[52-54] Given that endoscopic gastrostomy placement is invasive and may be associated with adverse events, one must consider whether the benefits of the treatment outweigh the risks for each patient.[55-57]

Colonoscopy

As the population ages, the use of colonoscopy in the elderly continues to increase.[58] Much of the use of colonoscopy in the elderly population remains for the purpose of colorectal cancer screening and surveillance. There is no consensus regarding when to discontinue colonoscopy screening for colorectal cancer.[59,60] Although octogenarians have a higher prevalence of colonic neoplasia (28.6%) compared with patients 50 to 54 years of age (13.8%), the mean extension in life expectancy with colonoscopy has been demonstrated to be lower for octogenarians than for the younger group (0.13 years vs 0.85 years).[61] Another study demonstrated similarly low rates of median survival after colonoscopy in patients 80 years of age and older, regardless of comorbidities.[62]

The U.S. Preventive Services Task Force recommends against routine colonoscopy screening in adults age 76 to 85 years of age and against all colorectal cancer screening in adults older than 85 years of age because of the decreasing benefit and increased risk of the procedures.[63] The decision to perform screening colonoscopy in patients of advanced age should be individualized based on the patient's functional status, comorbid conditions, ability to tolerate the colonoscopy preparation, and willingness to undergo the procedure. Recent multisociety task force guidelines for colonoscopy surveillance after screening and polypectomy have been published and suggest that patients with high-risk adenomas are at higher risk for the development of advanced neoplasia compared with patients undergoing routine colorectal cancer screening and may therefore derive a greater potential benefit from colonoscopy.[64] The decision to continue colonoscopy surveillance should be individualized based on the assessment of benefit, risk, and comorbidities.[64]

A study of 1000 consecutive colonoscopies in patients 65 years or age and older compared with 1000 consecutive colonoscopies in patients younger than 65 years of age demonstrated similar crude completion rates for both groups (88.1% vs 87.6%, $P = .18$), higher diagnostic yield in the older group (65% vs 45%, $P < .0001$), higher rates of

carcinoma in the older group (7.1% vs 1.3%, $P < .0001$), and similar adverse event rates in both groups (0.2% per group).[65] Another study demonstrated significantly lower rates of complete colonoscopy in octogenarians compared with nonoctogenarians (90% vs 99%, $P = .002$).[15] A recent small Japanese study of colorectal endoscopic submucosal dissection demonstrated no significant differences in en bloc resection rates, curative rates, procedure times, or adverse events in octogenarians compared with younger patients.[66]

Although colonoscopy in the elderly is considered safe, advanced age is a risk factor for procedure-related adverse events.[67] A large retrospective analysis of Medicare beneficiaries noted a 75% higher risk of serious adverse events (defined as perforation, GI bleed, or administration of blood transfusions) in patients of advanced age undergoing colonoscopy compared with patients 66 to 69 years of age.[68] Another retrospective study of the California Medicaid claims database concluded that patients 80 years of age and older had a higher rate of colonoscopy-related perforation (115 per 100,000 procedures; 95% CI, 95-138) than younger patients (68 per 100,000 procedures for patients 50-65 years of age; 95% CI, 53-86; $P = .16$).[67] In this study, invasive interventions such as foreign-body removal, submucosal injection, and hemostasis were associated with higher rates of perforation compared with diagnostic colonoscopy (adjusted OR 6.12; 95% CI, 3.16-11.83; $P < .001$), but this was not specifically studied in the elderly population.[67] A recent meta-analysis of 20 studies also concluded that octogenarians had a higher rate of cumulative adverse events (incidence rate ratio 1.7; 95% CI, 1.5-1.9) and a greater risk of perforation during colonoscopy (incidence rate ratio 1.6; 95% CI, 1.2-2.1) compared with younger patients.[69]

Endoscopic retrograde cholangiopancreatography

Pancreaticobiliary diseases including choledocholithiasis and malignant obstructive jaundice are relatively common in the elderly. A prospective study of 118 patients of advanced age demonstrated that biliary obstruction was the leading indication for ERCP (73.7%).[70] Another retrospective analysis of patients of advanced age undergoing ERCP identified that patients 80 years of age and older were more likely to present with cholangitis than younger patients (28.5% vs 16.1%, $P = .001$).[71] Periampullary diverticula have been noted more frequently in patients of advanced age compared with younger patients, but this anatomic finding has not been reported to affect cannulation rates, which range from 88% to 98% in this population.[71,72] Most studies have demonstrated therapeutic success rates of ERCP in octogenarians that are comparable to success rates in younger patients.[70,71,73,74]

ERCP in the elderly is safer and has a lower rate of morbidity and mortality compared with alternative operative interventions.[75] A prospective, multicenter study demonstrated that age was not a risk factor for adverse events after biliary sphincterotomy.[76] Overall, adverse events including pancreatitis, perforation, and bleeding from ERCP in the elderly are not different from the rates observed in younger populations, although patients of advanced age are more prone to prolonged sedation and hypotension.[71,73,77] One series noted that pancreatitis was less likely to develop in octogenarians after ERCP (0.14% vs 1.16%, $P = .003$), and the authors postulated that increased age may be protective of the development of post-ERCP pancreatitis.[74]

Endoscopic ultrasound

Data specifically evaluating EUS in the elderly is lacking, although EUS has been noted to be highly diagnostic in this population with a low rate of adverse events. A retrospective study evaluated the efficacy and safety of 265 EUS procedures in 232 patients older than 80 years of age.[78] Approximately half of the EUS procedures were performed for the evaluation of the pancreatobiliary system, but more than two thirds of the EUS-guided FNAs were performed to evaluate pancreatobiliary pathology. Overall, EUS-guided FNA was performed in 35.8% of all cases, of which 65.2% were positive or suspicious for malignancy. In patients who underwent EUS for biliary dilation, the yield was 100% if there was jaundice or a biliary stricture noted with previous imaging. In contrast, the yield of EUS for biliary dilation was only 35% in patients without jaundice or imaging demonstrating a biliary stricture. All patients with positive findings were found to have common bile duct stones. In this study, there were no sedation- or procedure-related adverse events. Another study demonstrated similar rates of EUS-related adverse events in patients 75 years of age and older compared with patients younger than 75 years of age (4.8% vs 3.1%, $P = .49$).[79] In this study, all adverse events were attributable to FNA.[79]

Enteroscopy

There are limited data regarding enteroscopy in the elderly. One single-center, retrospective study evaluated the efficacy and safety of double-balloon enteroscopy (DBE) in elderly patients compared with younger patients.[80] A significantly higher percentage of elderly patients underwent DBE for the evaluation of obscure GI bleeding compared with younger patients (96% vs 80%, $P = .0008$). Patients 75 years of age and older were more likely to have angioectasias (39% vs 23%, $P = .01$) and were more likely to require endoscopic therapy (46.8% vs 29.2%, $P = .01$). There was no significant difference in the mean number of procedures per patient, percentage of upper DBE versus lower DBE procedures, or procedure duration between the age groups. No major adverse events were observed in the elderly group.

Capsule endoscopy

Capsule endoscopy is a very safe procedure with few reported adverse events. There have been concerns about the theoretical interaction of capsule endoscopy with cardiac defibrillators, although no adverse events have been reported in the literature. The effects of aging on capsule endoscopy have been prospectively studied.[81] The rates of complete small-bowel visualization with transit in the cecum was similar in patients younger than 40 years of age, 40 to 64 years of age, and 65 years of age and older (81.2% vs 77.8% vs 78.8%, respectively; P = not significant for all comparisons). Univariate analysis identified a trend with a higher rate of poorly visualized mucosa in the oldest age group (32.2%) versus the youngest age group (12.65%, P = .057). Elderly patients were found to have a higher number of pathologic findings compared with patients younger than 65 years of age (P < .001), including angiodysplasias (34.6% vs 9.4% [younger than 40 years of age] vs 19.5% [40-64 years of age], P = .024) and tumors (7.7% vs 0% [younger than 40 years of age] vs 0% [40-64 years of age]).

SUMMARY

- We recommend that with optimal periprocedure evaluation and care, diagnostic and therapeutic endoscopic interventions can be safely performed in elderly patients. ⊕⊕⊕○
- We recommend that electrolyte-balanced polyethylene glycol–based colonoscopy preparations be used in elderly individuals to avoid potentially harmful fluid and electrolyte shifts. ⊕⊕⊕○
- We suggest using split-dosage cathartic bowel preparations in the elderly for colonoscopy preparation. ⊕⊕○○
- We recommend evaluating the patient's baseline functional status, cognitive ability, and capacity to understand the anticipated endoscopic procedure as part of the preprocedure assessment in the elderly. ⊕⊕⊕○
- We recommend standard monitoring procedures in the elderly during moderate sedation with heightened awareness of this population's increased response to sedatives. ⊕⊕⊕○
- We recommend that lower initial doses of sedatives than standard adult dosing should be considered in the elderly and that titration should be more gradual to allow assessment of the full dose effect at each dose level. ⊕⊕⊕○
- We suggest that practitioners exercise additional caution when performing colonoscopy in elderly patients because this procedure may confer a higher risk of adverse events. ⊕⊕○○
- We recommend that colonoscopic screening and surveillance for colorectal cancer in patients of advanced age be individualized based on general health and comorbid medical illnesses. ⊕⊕⊕○

REFERENCES

1. Qureshi WA, Zuckerman MJ, Adler DG, et al. ASGE guideline: modifications in endoscopic practice for the elderly. Gastrointest Endosc 2006;63:566-9.
2. Guyatt GH, Oxman AD, Vist GE, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ 2008;336:924-6.
3. Intercensal Estimates of the Resident Population by Sex and Age for the United States: April 1, 2000 to July 1, 2010. U.S. Census Bureau, 2011. Available at: http://www.census.gov/prod/2011pubs/12statab/pop.pdf. Accessed October 28, 2012.
4. Faigel DO, Eisen GM, Baron TH, et al. Preparation of patients for GI endoscopy. Gastrointest Endosc 2003;57:446-50.
5. Thomson A, Naidoo P, Crotty B. Bowel preparation for colonoscopy: a randomized prospective trial comparing sodium phosphate and polyethylene glycol in a predominantly elderly population. J Gastroenterol Hepatol 1996;11:103-7.
6. Seinelä L, Pehkonen E, Laasanen T, et al. Bowel preparation for colonoscopy in very old patients: a randomized prospective trial comparing oral sodium phosphate and polyethylene glycol electrolyte lavage solution. Scand J Gastroenterol 2003;38:216-20.
7. Beloosesky Y, Grinblat J, Weiss A, et al. Electrolyte disorders following oral sodium phosphate administration for bowel cleansing in elderly patients. Arch Intern Med 2003;163:803-8.
8. Khurana A, McLean L, Atkinson S, et al. The effect of oral sodium phosphate drug products on renal function in adults undergoing bowel endoscopy. Arch Intern Med 2008;168:593-7.
9. Wexner SD, Beck DE, Baron TH, et al. A consensus document on bowel preparation before colonoscopy: prepared by a task force from the American Society of Colon and Rectal Surgeons (ASCRS), the American Society for Gastrointestinal Endoscopy (ASGE), and the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES). Gastrointest Endosc 2006;63:894-909.
10. Mamula P, Adler DG, Conway JD, et al. Colonoscopy preparation. Gastrointest Endosc 2009;69:1201-9.
11. Onishi S, Yoshino S. Cathartic-induced fatal hypermagnesemia in the elderly. Intern Med 2006;45:207-10.
12. Lichtenstein GR, Cohen LB, Uribarri J. Review article: bowel preparation for colonoscopy–the importance of adequate hydration. Aliment Pharmacol Ther 2007;26:633-41.
13. Chatrenet P, Friocourt P, Ramain JP, et al. Colonoscopy in the elderly: a study of 200 cases. Eur J Med 1993;2:411-3.
14. Lagares-Garcia JA, Kurek S, Collier B, et al. Colonoscopy in octogenarians and older patients. Surg Endosc 2001;15:262-5.
15. Lukens FJ, Loeb DS, Machicao VI, et al. Colonoscopy in octogenarians: a prospective outpatient study. Am J Gastroenterol 2002;97:1722-5.

16. Arora A, Singh P. Colonoscopy in patients 80 years of age and older is safe, with high success rate and diagnostic yield. Gastrointest Endosc 2004;60:408-13.

17. Petersen BT, Hussain N, Marine JE, et al. Endoscopy in patients with implanted electronic devices. Gastrointest Endosc 2007;65:561-8.

18. Anderson MA, Ben-Menachem T, Gan SI, et al. Management of antithrombotic agents for endoscopic procedures. Gastrointest Endosc 2009;70:1060-70.

19. Zuckerman MJ, Hirota WK, Adler DG, et al. ASGE guideline: the management of low-molecular-weight heparin and nonaspirin antiplatelet agents for endoscopic procedures. Gastrointest Endosc 2005;61:189-94.

20. Banerjee S, Shen B, Baron TH, et al. Antibiotic prophylaxis for GI endoscopy. Gastrointest Endosc 2008;67:791-8.

21. Chow WB, Rosenthal RA, Merkow RP, et al. Optimal preoperative assessment of the geriatric surgical patient: a best practices guideline from the American College of Surgeons national surgical quality improvement program and the American Geriatrics Society. J Am Coll Surg 2012;215:453-66.

22. Lichtenstein DR, Jagannath S, Baron TH, et al. Sedation and anesthesia in GI endoscopy. Gastrointest Endosc 2008;68:815-26.

23. Muravchick S. Anesthesia for the geriatric patient. Curr Opin Anaesthesiol 2002;15:621-5.

24. Boss GR, Seegmiller JE. Age-related physiological changes and their clinical significance. West J Med 1981;135:434-40.

25. Shaker R, Ren J, Bardan E, et al. Pharyngoglottal closure reflex: characterization in healthy young, elderly and dysphagic patients with predeglutitive aspiration. Gerontology 2003;49:12-20.

26. Peacock JE, Lewis RP, Reilly CS, et al. Effect of different rates of infusion of propofol for induction of anaesthesia in elderly patients. Br J Anaesth 1990;65:346-52.

27. Darling E. Practical considerations in sedating the elderly. Crit Care Nurs Clin North Am 1997;9:371-80.

28. Hayee B, Dunn J, Loganayagam A, et al. Midazolam with meperidine or fentanyl for colonoscopy: results of a randomized trial. Gastrointest Endosc 2009;69:681-7.

29. Cohen LB, Hightower CD, Wood DA, et al. Moderate level sedation during endoscopy: a prospective study using low-dose propofol, meperidine/fentanyl, and midazolam. Gastrointest Endosc 2004;59:795-803.

30. Heuss LT, Schnieper P, Drewe J, et al. Conscious sedation with propofol in elderly patients: a prospective evaluation. Aliment Pharmacol Ther 2003;17:1493-501.

31. Riphaus A, Stergiou N, Wehrmann T. Sedation with propofol for routine ERCP in high-risk octogenarians: a randomized, controlled study. Am J Gastroenterol 2005;100:1957-63.

32. Horiuchi A, Nakayama Y, Tanaka N, et al. Propofol sedation for endoscopic procedures in patients 90 years of age and older. Digestion 2008;78:20-3.

33. Early DS, Ben-Menachem T, Decker GA, et al. Appropriate use of GI endoscopy. Gastrointest Endosc 2012;75:1127-31.

34. Van Kouwen MC, Drenth JP, Verhoeven HM, et al. Upper gastrointestinal endoscopy in patients aged 85 years or more. Results of a feasibility study in a district general hospital. Arch Gerontol Geriatr 2003;37:45-50.

35. Seinelä L, Ahvenainen J, Rönneikkö J, et al. Reasons for and outcome of upper gastrointestinal endoscopy in patients aged 85 years or more: retrospective study. BMJ 1998;317:575.

36. Theocharis GJ, Arvaniti V, Assimakopoulos SF, et al. Acute upper gastrointestinal bleeding in octogenarians: clinical outcome and factors related to mortality. World J Gastroenterol 2008;14:4047-53.

37. Buri L, Zullo A, Hassan C, et al. SIED Appropriateness Working Group. Upper GI endoscopy in elderly patients: predictive factors of relevant endoscopic findings. Intern Emerg Med 2013;8:141-6.

38. Delaney BC, Wilson S, Roalfe A, et al. Cost effectiveness of initial endoscopy for dyspepsia in patients over age 50 years: a randomised controlled trial in primary care. Lancet 2000;356:1965-9.

39. Clarke GA, Jacobson BC, Hammett RJ, et al. The indications, utilization and safety of gastrointestinal endoscopy in an extremely elderly patient cohort. Endoscopy 2001;33:580-4.

40. Lee TC, Huang SP, Yang JY, et al. Age is not a discriminating factor for outcomes of therapeutic upper gastrointestinal endoscopy. Hepatogastroenterology 2007;54:1319-22.

41. Abraham NS, Fallone CA, Mayrand S, et al. Sedation versus no sedation in the performance of diagnostic upper gastrointestinal endoscopy: a Canadian randomized controlled cost-outcome study. Am J Gastroenterol 2004;99:1692-9.

42. Sorbi D, Gostout CJ, Henry J, et al. Unsedated small-caliber esophagogastroduodenoscopy (EGD) versus conventional EGD: a comparative study. Gastroenterology 1999;117:1301-7.

43. Carey EJ, Sorbi D. Unsedated endoscopy. Gastrointest Endosc Clin N Am 2004;14:369-83.

44. Garcia RT, Cello JP, Nguyen MH, et al. Unsedated ultrathin EGD is well accepted when compared with conventional sedated EGD: a multicenter randomized trial. Gastroenterology 2003;125:1606-12.

45. Dumortier J, Napoleon B, Hedelius F, et al. Unsedated transnasal EGD in daily practice: results with 1100 consecutive patients. Gastrointest Endosc 2003;57:198-204.

46. Thota PN, Zuccaro G Jr, Vargo JJ, et al. A randomized prospective trial comparing unsedated esophagoscopy via transnasal and transoral routes using a 4-mm video endoscope with conventional endoscopy with sedation. Endoscopy 2005;37:559-65.

47. Lieberman DA, Wuerker CK, Katon RM. Cardiopulmonary risk of esophagogastroduodenoscopy. Role of endoscope diameter and systemic sedation. Gastroenterology 1985;88:468-72.

48. Cooper MW, Davison CM, Austin CA. Arterial oxygen saturation during upper gastrointestinal endoscopy in elderly patients: the role of endoscope diameter. Age Ageing 1995;24:254-6.

49. DeLegge MH, McClave SA, DiSario JA, et al. Ethical and medicolegal aspects of PEG-tube placement and provision of artificial nutritional therapy. Gastrointest Endosc 2005;62:952-9.

50. Finucane TE, Christmas C, Travis K. Tube feeding in patients with advanced dementia: a review of the evidence. JAMA 1999;282:1365-70.

51. Smith BM, Perring P, Engoren M, et al. Hospital and long-term outcome after percutaneous endoscopic gastrostomy. Surg Endosc 2008;22:74-80.

52. Mitchell SL, Tetroe JM. Survival after percutaneous endoscopic gastrostomy placement in older persons. J Gerontol A Biol Sci Med Sci 2000;55:M735-9.

53. Callahan CM, Haag KM, Weinberger M, et al. Outcomes of percutaneous endoscopic gastrostomy among older adults in a community setting. J Am Geriatr Soc 2000;48:1048-54.

54. Grant MD, Rudberg MA, Brody JA. Gastrostomy placement and mortality among hospitalized Medicare beneficiaries. JAMA 1998;279:1973-6.

55. Rabeneck L, McCullough LB, Wray NP. Ethically justified, clinically comprehensive guidelines for percutaneous endoscopic gastrostomy tube placement. Lancet 1997;349:496-8.

56. Lo B, Dornbrand L. Guiding the hand that feeds. Caring for the demented elderly. N Engl J Med 1984;311:402-4.

57. Jain R, Maple JT, Anderson MA, et al. The role of endoscopy in enteral feeding. Gastrointest Endosc 2011;74:7-12.

58. Singh H, Demers AA, Xue L, et al. Time trends in colon cancer incidence and distribution and lower gastrointestinal endoscopy utilization in Manitoba. Am J Gastroenterol 2008;103:1249-56.

59. Levin B, Lieberman DA, McFarland B, et al. Screening and surveillance for the early detection of colorectal cancer and adenomatous polyps, 2008: a joint guideline from the American Cancer Society, the US Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology. Gastroenterology 2008;134:1570-95.

60. Rex DK, Johnson DA, Anderson JC, et al. American College of Gastroenterology guidelines for colorectal cancer screening 2009 [corrected]. Am J Gastroenterol 2009;104:739-50.

61. Lin OS, Kozarek RA, Schembre DB, et al. Screening colonoscopy in very elderly patients: prevalence of neoplasia and estimated impact on life expectancy. JAMA 2006;295:2357-65.

62. Kahi CJ, Azzouz F, Juliar BE, et al. Survival of elderly persons undergoing colonoscopy: implications for colorectal cancer screening and surveillance. Gastrointest Endosc 2007;66:544-50.

63. Screening for colorectal cancer: U.S. Preventive Services Task Force recommendation statement. Ann Intern Med 2008;149:627-37.

64. Lieberman DA, Rex DK, Winawer SJ, et al. Guidelines for colonoscopy surveillance after screening and polypectomy: a consensus update by the US Multi-Society Task Force on Colorectal Cancer. Gastroenterology 2012;143:844-57.

65. Karajeh MA, Sanders DS, Hurlstone DP. Colonoscopy in elderly people is a safe procedure with a high diagnostic yield: a prospective comparative study of 2000 patients. Endoscopy 2006;38:226-30.

66. Uraoka T, Higashi R, Kato J, et al. Colorectal endoscopic submucosal dissection for elderly patients at least 80 years of age. Surg Endosc 2011;25:3000-7.

67. Arora G, Mannalithara A, Singh G, et al. Risk of perforation from a colonoscopy in adults: a large population-based study. Gastrointest Endosc 2009;69:654-64.

68. Warren JL, Klabunde CN, Mariotto AB, et al. Adverse events after outpatient colonoscopy in the Medicare population. Ann Intern Med 2009;150:849-57, W152.

69. Day LW, Kwon A, Inadomi JM, et al. Adverse events in older patients undergoing colonoscopy: a systematic review and meta-analysis. Gastrointest Endosc 2011;74:885-96.

70. Riphaus A, Stergiou N, Wehrmann T. ERCP in octogenarians: a safe and efficient investigation. Age Ageing 2008;37:595-9.

71. Fritz E, Kirchgatterer A, Hubner D, et al. ERCP is safe and effective in patients 80 years of age and older compared with younger patients. Gastrointest Endosc 2006;64:899-905.

72. Katsinelos P, Paroutoglou G, Kountouras J, et al. Efficacy and safety of therapeutic ERCP in patients 90 years of age and older. Gastrointest Endosc 2006;63:417-23.

73. Katsinelos P, Kountouras J, Chatzimavroudis G, et al. Outpatient therapeutic endoscopic retrograde cholangiopancreatography is safe in patients aged 80 years and older. Endoscopy 2011;43:128-33.

74. Lukens FJ, Howell DA, Upender S, et al. ERCP in the very elderly: outcomes among patients older than eighty. Dig Dis Sci 2010;55:847-51.

75. Smith AC, Dowsett JF, Russell RC, et al. Randomised trial of endoscopic stenting versus surgical bypass in malignant low bileduct obstruction. Lancet 1994;344:1655-60.

76. Freeman ML, Nelson DB, Sherman S, et al. Complications of endoscopic biliary sphincterotomy. N Engl J Med 1996;335:909-18.

77. Sugiyama M, Atomi Y. Endoscopic sphincterotomy for bile duct stones in patients 90 years of age and older. Gastrointest Endosc 2000;52:187-91.

78. Attila T, Faigel DO. Endoscopic ultrasound in patients over 80 years old. Dig Dis Sci 2011;56:3065-71.

79. Benson ME, Byrne S, Brust DJ, et al. EUS and ERCP complication rates are not increased in elderly patients. Dig Dis Sci 2010;55:3278-83.

80. Hegde SR, Iffrig K, Li T, et al. Double-balloon enteroscopy in the elderly: safety, findings, and diagnostic and therapeutic success. Gastrointest Endosc 2010;71:983-9.

81. Papadopoulos AA, Triantafyllou K, Kalantzis C, et al. Effects of ageing on small bowel video-capsule endoscopy examination. Am J Gastroenterol 2008;103:2474-80.