



Surgical Management of Colorectal Cancer in the Elderly Patient

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14.1 Epidemiology

Colorectal cancer is the third most common cancer in men and the second most common in women with 1,360,000 newly diagnosed patients worldwide [1] and almost 694,000 estimated deaths in 2012. There is a higher incidence in older populations [2]; in fact, the highest risk of developing a colorectal cancer occurs around the age of 70 years, while it is infrequently diagnosed before the age of 40 years. Seventy-five percent of colorectal cancer diagnoses are in patients over 65 years. In both Europe and the United States, approximately 50% of colorectal cancer patients are older than 70 years of age, and, among these, colorectal cancer is the second leading cause of cancer death [3]. Moreover, life expectancy has lengthened in elderly patients. According to World Health Organization (WHO) reports, estimated life expectancy at age 60 years was 21.5 years in women and 18.5 years in men in 2012 [4]. Increasing life expectancy corresponds to a rapid increase of the elderly population. Thus, age could be considered as a major risk factor for the development of this cancer [5].

14.2 Who Is “Elderly?”

Elderly patients form a specific population due to comorbidities, disability, and organ-specific physiological changes that have impaired their enrollment in clinical trials and thus the transposition of current guidelines which have been established in younger patients. One of the most difficult problems in evaluating the outcomes of colorectal surgery in elderly patients is that there is no clear definition of an

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elderly patient, with ages varying from 65 to 80 years in different publications [6]. “Elderly” is a very subjective definition that arises from the environmental culture of the patient: it has been defined as a chronological age of ≥ 65 years of age, which, in turn, has been divided into early and late elderly for those who are 65–74 years of age and over 75 years, respectively [7].

14.3 Histopathology

Adenocarcinoma occurs in more than 95% of colorectal cancer with lesions that can be infiltrative, ulcerated, or polypoid; histologically, it can be well differentiated, moderately differentiated, or poorly differentiated. Mucinous adenocarcinoma (5%) is diagnosed when mucosa occurs in more than 50% of the tumor tissue and usually has a worse prognosis. Other histotypes (<5%) are lymphomas, sarcomas, and carcinoid tumors. In accordance with the international literature data, the proportion of right-sided colon cancer is relatively high in patients aged under 40 years and over 80 years. Right-sided colon cancer is more likely to be detected at an advanced stage with severe symptoms. Polypoid-type early cancer is dominant in the left colon, while the proportion of flat-type early cancer is significantly higher in the right colon than in the left colon.

14.4 Risk Assessment

Elderly patients frequently have one or more comorbidities and are often “frail”; for these reasons, they have a very high risk of morbidity and mortality. While the cut-off for a definition of elderly patients varies from 65 to 70 years of age [8], as previously said, defining elderly patients based on functional status is more accurate than age itself. Aging, especially if associated with cancer, is commonly associated with a functional decline, cognitive disorders, frailty, comorbidities, malnutrition, falls, and polypharmacy, resulting in increased vulnerability and institutionalization as well as an increase in health system costs.

The International Society of Geriatric Oncology (SIOG) recommended that patients affected by colorectal diseases ≥ 65 years of age undergoing surgery should experience a preoperative whole-patient assessment of the most common physiological side effects of aging, physical and mental ability, and social support [9]. Many studies have shown that age alone is not a significant prognostic factor in survival after colonic surgery [10]. Several authors have tried to quantify the correlation between comorbidities and postoperative mortality or morbidity [11]. Physical frailty increases the risk of major complications following surgery [odds ratio (OR) 4.1 (1.4–11.6)] in patients ≥ 75 years (range 75–93) and is predictive for both complications and survival in patients ≥ 70 years following surgery [12].

It is mainly frail elderly patients who suffer postoperative complications such as cardiac problems, pneumonia, and deep vein thrombosis. Due to the high rate of postoperative complications in the elderly, geriatricians designed the

comprehensive geriatric assessment (CGA) as a multidimensional tool that accurately predicts postoperative morbidity, in order to assess preoperative risks and physiological reserves of the elderly. The results of the CGA can lead to developing individualized geriatric intervention programs, and in many subfields of geriatrics, the CGA is used to evaluate geriatric conditions that are associated with frailty [13]. A preoperative CGA may be used to assess the condition of each patient's health within 6 months of surgery. In this protocol all patients related face-to-face with a geriatric team, composed of geriatricians, nurse specialists, dieticians, and pharmacists. The preoperative CGA had eight domains: burden of comorbidity (Charlson Comorbidity Index, CCI), polypharmacy, physical function according to activities of daily living (ADL), instrumental ADL (IADL), cognitive status (Mini-Mental State Examination), risk of postoperative delirium (Nursing Delirium Screening Scale), Geriatric Depression Scale, and nutritional status (Mini Nutritional Assessment). The definition of "deficit" in each domain is a score of 3 or more for comorbidities [14], the regular use of eight or more drugs [15], poor physical function assessed by using the ADL, poor physical function assessed by using the IADL [16], cognitive dysfunction assessed by using the Mini-Mental State Examination, severe depression, and malnutrition.

As seen in a recent Korean large study [17], a preoperative CGA indicating "high risk" (patient who had deficits in two or more domains) was associated with major postoperative complications (Clavien-Dindo grade II or higher within 30 days of surgery) in elderly patients who underwent surgery for colorectal cancer. Thus, using the CGA, we are able to identify elderly colorectal cancer patients who should be given greater attention during pre- and postoperative management in order to achieve a clinical benefit.

14.5 Diagnosis and Screening

Colorectal cancer in older patients is more often diagnosed at a later stage than in younger patients. As a result, older patients more frequently require emergency and palliative surgery, which increases the risk of perioperative morbi-mortality. Delays in colorectal cancer diagnosis are multifactorial: older people consult later, symptoms could be atypical or poorly recognized, and investigations and screening are generally organized up to the age of 74 years.

Colorectal cancer screening leads to detecting polyps, precancerous lesions, and early colorectal cancer with lower incidence of cancer (17–33%) and reduction of mortality from 11 to 53% [18]. At present many screening methods are available such as fecal occult blood test (FOBT), endoscopy, and CT colonography, but neither is universally accepted in elderly patients. Many consensus documents (3, 4, 5, 6) are recommended (Table 14.1).

Screening for colorectal cancer with the fecal occult blood test (FOBT) reduces colorectal cancer mortality [18]. Nevertheless, studies that have demonstrated the benefit of colorectal cancer screening with FOBT enrolled few or no elderly patients. The majority of other organized mass screening programs and the national

Table 14.1 Screening programs for colorectal cancer in the elderly

US Multi-Society Task Force and the American Cancer Society	Discontinuation of surveillance colonoscopy should be considered in persons with serious comorbidities and expectancy of life less than 10 years
American Gastroenterological Association	Individualized approach
American Geriatrics Society	Not recommended in patients with high comorbidity and with expectancy of life <5 years
British Society of Gastroenterology	FOB every 2 years, ages 50–69, plan to extend to over 75 years

screening program for colorectal cancer are restricted to a population aged 50–74 years. The efficacy of colorectal cancer screening with FOBT has never been prospectively evaluated in elderly subjects.

Age is a critical factor in the occurrence of adverse events related to colonoscopy. Adequate bowel preparation is more difficult to achieve in very old patients. Thus, patient selection for colonoscopy is an important challenge. In the elderly population, the risk of colorectal surveillance may outweigh its benefit due to comorbidities and specific age-related risks. Most of the society agree that colorectal cancer screening in the elderly should be tailored. Older patients have a 30% higher risk of perforation during colonoscopy than younger patients [19] and a higher morbidity if the colonoscopy is performed under general anesthesia. Bowel preparation should be considered in elderly patients because adverse events have been observed with minor ones like abdominal pain, nausea, and fecal incontinence and major ones like electrolyte abnormalities, aspiration pneumonia, ischemic colitis, and acute kidney failure [20]. Many considerations relate to the compliance and the high incidence (5–60%) of poor bowel preparation. Poor bowel preparation plays a key role in the completion of colonoscopy with a high risk of being unsuccessful in very elderly patients (52–95%) [21]. It is still debated when to interrupt the surveillance in the elderly. Most authors agree with the decision to go through an individual assessment that considers the risks and the benefits and balances these with the patients' health, functional status, and expectancy of life.

14.6 Surgical Treatment

Age continues to be considered as one of the main factors of perioperative mortality after colorectal surgery. However, elderly patients are more susceptible to postoperative infectious complications, particularly chest complications. The resection of nonmetastatic tumors in operable elderly patients with long life expectancy is common sense; however, in patients with short life expectancy, a multidisciplinary meeting including, if possible, a geriatrician should decide on the treatment strategy. The survival benefit of liver metastatic surgery is maintained above 70 years in selected patients. There are, however, no consistent data regarding patients over 80 years.

Surgery is the gold standard for the treatment of colorectal cancer, and it is performed either with curative intent or for problem-solving when patients present with colon perforation or obstruction. In fact, colorectal cancer can particularly manifest as an acute abdomen characterized by occlusion (15–20% of cases) and perforation (3–8% of cases) [22]. These events are characteristic in geriatric age; in fact, the incidence of most surgical interventions as a matter of urgency is for patients aged over 70 years, while patients between 60 and 70 years most frequently undergo elective surgery [23]. Although in recent years, thanks to the use of staplers, the prognosis of colorectal carcinoma has significantly improved for elective operations, for those in an emergency it has remained poor [24]. The high mortality linked to emergency interventions [25] emphasizes the importance of careful preoperative assistance that aims to improve comorbidities and the special deficit conditions due to the colorectal cancer (state of anemia and malnutrition). Therefore, a close collaboration between surgical associations and geriatric societies is necessary in order to produce guidelines for the perioperative assessment and the management of postoperative geriatric events [26, 27].

14.7 Laparoscopic Colorectal Surgery in Elderly Patients

Over the past decade, many studies have widely demonstrated that a laparoscopic surgical approach to colon resections is not inferior to open colon resections. It has been proven to be a safe procedure, even in high-risk patients [28]. Most evidence suggests that laparoscopic colorectal surgery (LCS) can be performed safely for several pathologic conditions in elderly patients [29]. In addition, recent randomized controlled trials and a meta-analysis show, with Level 1 evidence, that laparoscopic colorectal surgery achieves good oncological results compared to the open method [30].

The short-term benefits of laparoscopic colorectal surgery compared to the open method are well known and include less pain, better pulmonary function, shorter postoperative small bowel obstruction, and shorter hospital stay [31]. Decreases in blood loss and postoperative pain reduce the stress of surgery and therefore reduce overall morbidity. The reduction in cardiovascular complications might also be due to decrease in blood loss. Bowel obstruction and ileus are also reduced in laparoscopic colorectal surgery. The exposure of intestines and major trauma to the abdominal wall might increase in incidence of bowel paralysis and adhesion in open colorectal surgery. A recent systematic review on the incidence of nonsurgical (cardiopulmonary) complications in randomized clinical trials addressing surgery for colorectal cancer found that laparoscopic colectomy reduces the incidence of postoperative cardiac complications [32]. Large-scale, randomized studies and reviews that compare long-term results between laparoscopic colorectal surgery and open colorectal surgery in all generations report no difference in colon cancer patients [33].

These outcomes are particularly important in elderly patients who are at a higher risk of postoperative morbidity and mortality than younger ones. It would seem

natural then that laparoscopic colorectal surgery should be the ideal surgical approach for elderly patients. The only area where laparoscopic colorectal surgery did not show a benefit over open colorectal surgery was for operative time. Despite the fragility of elderly patients and the longer operative times needed to perform laparoscopy, many studies show that laparoscopy for colorectal surgery does not create a greater risk in elderly patients [34].

In conclusion, laparoscopic colorectal surgery is a safe and good option in elderly patients. Advanced age should not be a contraindication for laparoscopic colorectal surgery, even for complex procedures, such as laparoscopic rectal resection. Safer laparoscopic colorectal surgery can be provided to elderly patients with rectal cancer by selecting an appropriate operative procedure according to each individual patient's condition.

14.8 Robotic Colorectal Surgery in Elderly Patients

Robotic technology for colorectal surgery was introduced for the first time in 2002 by Weber et al. in order to improve the feasibility of a minimally invasive surgical approach, starting out with laparoscopy at least 20 years ago. As with all new techniques, robotic colorectal surgery started to be performed in selected patients, young people with low BMI and ASA scores and good performance status: at the beginning, patients older than 70 years were ruled out of robotic colorectal surgery. Some concerns were recognized with the use of robotics in the elderly population, especially when considering a longer operative time as reported by several studies; furthermore, some procedures require prolonged and steep Trendelenburg position (e.g., rectal and prostatic surgery), with possible consequences regarding pulmonary and cardiovascular implications. When robotic colorectal surgery was shown to be feasible and safe, with improved systemic outcomes for young patients, many authors started to use this robotic approach with elderly patients too. Their results assessed the feasibility of extending the benefits of this improved minimally invasive approach to elderly people as well [35].

Colorectal cancer is one of the most frequent malignancies worldwide, especially in elderly people. Over the last two decades, minimally invasive techniques have been extensively used for the surgical management of this disease, with better short-term outcomes and equivalent oncological results when compared to open surgery, including in the elderly. The robotic surgical approach has been shown to be a feasible, safe, and oncologically adequate treatment for colorectal disease. As many authors have already demonstrated, it offers satisfactory systemic outcomes in terms of short hospital stay, early first flatus, quick soft diet intake, good systemic procedure tolerance, low conversion, and postoperative complication rate. All these benefits have been demonstrated for elderly patients as well.

As is compatible with the reports of high-volume robotic centers, age alone cannot be considered an exclusion criteria to the robotic surgical approach; moreover,

elderly people with comorbidities can benefit, even more than younger patients, from this technological improvement. The high conversion rate and long learning curve of laparoscopy may be overcome by robotic surgery that represents the natural evolution of minimal access surgery, with the addition of a computer interface between the surgeon and the patient.

At present, there is no evidence that robotic surgery should be considered better than conventional minimally invasive surgery, with only a few randomized clinical trials having been performed.

Nevertheless, considering the high direct costs, minimally invasive robot-assisted surgery should be done on a case-by-case basis, tailored to each patient with their specific histories and comorbidities.

14.9 Fast Track

Enhanced recovery after surgery (ERAS) is a multidisciplinary approach to obtain better results for patients after a surgical procedure. Fast-track protocol focuses on preoperative, intraoperative, and postoperative period, and the main goal is to reduce surgical stress to optimize perioperative management [36]. Many authors have demonstrated that ERAS in colorectal surgery is feasible and safe. Adherence to protocol leads to minimizing morbidity and reducing the length of hospital stay [37]. Some studies in the literature have reported that elderly patients undergoing colorectal surgery could benefit from the ERAS protocol and that it improves postoperative outcomes when compared to traditional perioperative management [38].

The ERAS protocol includes the following statements:

- Preoperative phase: assessment with complete nutritional status, preadmission education and preoperative multidisciplinary counseling, no mechanical bowel preparation for colon resections, and carbohydrate-rich drinks 1 day prior to and 2 h before surgery
- Intraoperative phase: antibiotic prophylaxis, epidural analgesia, avoidance of opioid analgesia, no nasogastric tube and drains when possible, and no fluid overload
- Postoperative phase: oral fluids during the early postoperative period (meaning 6–8 h after surgery), soft-food diet by the second postoperative day, early mobilization and rehabilitation, removal of urinary catheter on postoperative day 1, and early termination of IV fluid

Results from the Perioperative Italian Society Registry demonstrate that elderly patients can be managed with the ERAS protocol with good reported outcomes in terms of reduction of hospital stay, compliance rates, morbidity, and readmission rates [39].

14.10 Outcomes After Colorectal Surgery in Elderly Patients

Elderly patients are often categorized as high-risk patients due to their having significant comorbidity with increasing postoperative morbidity and mortality. As a result of this, age has received increasing multidisciplinary attention as a prognostic factor for postoperative complications.

The impact of age on postoperative outcomes after major colorectal surgery remains controversial. Furthermore, curative surgery of colonic cancer in elderly patients is debatable, especially in very elderly patients who have limited prospects of survival.

Historically there has been a tendency to exclude very old patients from entering clinical trials (not just those within surgery), making evidence-based clinical decision-making more challenging [40]. The majority of randomized controlled trials evaluating the efficacy of chemotherapy and surgery as treatment for colorectal cancer do not include patients over the age of 75 years. It is difficult, therefore, to accurately guide this group of patients who have been assessed as being fit for surgery. Traditionally, patients over the age of 80 years undergoing segmental colonic resection have been less likely to receive adjuvant therapies or additional surgery (for recurrence or metastatic disease) following their diagnosis of colorectal cancer when compared to patients under the age of 80 years [41]. However, studies have supported the view that even very frail older people can be offered tailored colorectal chemotherapy regimens safely [42]. Some authors promote extensive surgery, including multistage procedures, as performed in younger patients [43]; others promote less aggressive surgery [44], withholding curative treatment with radical surgical procedures and opting for more “conservative” or palliative therapies in elderly patients. In a systematic review, published in the *Lancet* in 2000, it has been demonstrated that a resection of the tumor is performed less often in elderly patients than in younger patients [45].

Improved diagnostic procedures, intensive perioperative care, better anesthesia, and surgical techniques have made it possible to perform high-risk surgical procedures in older age patients. As a result of this, many recent publications have encouraged the same surgical approach as for younger patients [46]. Nowadays, many studies demonstrate that age alone is not a predictor of postoperative complications [47]. Elderly patients have similar rates of morbidity and mortality as younger patients of the same clinical status. Therefore, it is better to talk about biological age rather than chronological age when assessing risk factors for surgery, which focuses more on the overall condition of the patient.

A number of predictive tools, such as validated online risk calculators (e.g. www.riskcalculator.facs.org), are available in order to assess risk of morbidity and mortality after surgery based on the comorbid and general health status of elderly patients [48]. Any effect of age on systemic complications can be explained by other factors such as patient’s American Society of Anesthesia (ASA) grading, performance status, and Charlson Comorbidity Index Scores. It would be beneficial to test these tools on local populations and use these rather than age alone as criteria to select surgical treatment.

Another specific problem related to evaluation of outcomes of colorectal surgery in elderly patients is the significantly higher number of emergency presentations. It is well documented that emergency surgery is related to a higher mortality rate than elective surgery [49]. However, for those patients presenting as acute surgical emergencies, often with physiological derangement, clinical decision-making is challenging and treatment options limited. There is little available evidence upon which to base a surgical opinion of when to operate and when not to operate. The latter of which is invariably more difficult. Surgical intervention for obstructing colonic tumors (segmental resection or proximal defunctioning stoma) has been the mainstay of treatment. However, colonic stenting, which was previously seen as a “bridge” to surgery, is becoming increasingly readily available for the definitive management of obstructing colonic tumors.

In conclusion, age itself is not a risk factor for the development of complications in patients undergoing surgery for colorectal cancer. Age alone should not be a reason to avoid therapeutic or palliative surgery in these patients; instead, patient selection should focus on clinical condition and assessment scores. The type and number of comorbidities influence postoperative mortality and morbidity. Treatment of these comorbidities prior to surgery may influence postoperative outcome.

References

1. Ferlay J, Soerjomataram I, Dikshit R, et al. Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. *Int J Cancer*. 2015;136(5):E359–86.
2. Kahn KL, Adams JL, Weeks JC, et al. Adjuvant chemotherapy use and adverse events among older patients with stage III colon cancer. *JAMA*. 2010;303(11):1037–45.
3. Folprecht G, Cunningham D, Ross P, Glimelius B, Di Costanzo F, Wils J, Scheithauer W, Rougier P, Aranda E, Hecker H, Köhne CH. Efficacy of 5-fluorouracil-based chemotherapy in elderly patients with metastatic colorectal cancer: a pooled analysis of clinical trials. *Ann Oncol*. 2004;15:1330–8.
4. Mathers CD, Stevens GA, Boerma T, White RA, Tobias MI. Causes of international increases in older age life expectancy. *Lancet*. 2015;385(9967):540–8.
5. de Rijke JM, Schouten LJ, Hillen HF, Kiemeny LA, Coebergh JW, van den Brandt PA. Cancer in the very elderly Dutch population. *Cancer*. 2000;89:1121–33.
6. Seishima R, Okabayashi K, Hasegawa H, Tsuruta M, Shigetani K, Matsui S, et al. Is laparoscopic colorectal surgery beneficial for elderly patients? A systematic review and meta-analysis. *J Gastrointest Surg*. 2015;19:756–65.
7. Bircan HY, Koc B, Ozcelik U, Adas G, Karahan S, Demirag A. Are there any differences between age groups regarding colorectal surgery in elderly patients? *BMC Surg*. 2014;14:44.
8. Uyar D, Frasure HE, Markman M, et al. Treatment patterns by decade of life in elderly women (C70 years of age) with ovarian cancer. *Gynecol Oncol*. 2005;98:403–8.
9. Papamichael D, Audisio R, Horiot JC, et al. Treatment of the elderly colorectal cancer patient: SIOG expert recommendations. *Ann Oncol*. 2009;20:5–16.
10. Hermans E, Van Schaik PM, Prins HA, et al. Outcome of colonic surgery in elderly patients with colon cancer. *J Oncol*. 2010;2010:1–5. <https://doi.org/10.1155/2010/865908>.
11. Kristjansson SR, Farinella E, Gaskell S, et al. Surgical risk and post-operative complications in older unfit cancer patients. *Cancer Treat Rev*. 2009;35:499–502.
12. Tan KY, Kawamura YJ, Tokomitsu A, et al. Assessment for frailty is useful for predicting morbidity in elderly patients undergoing colorectal cancer resection whose comorbidities are already optimized. *Am J Surg*. 2012;204:139–43.

13. Pal SK, Katheria V, Hurria A. Evaluating the older patient with cancer: understanding frailty and the geriatric assessment. *CA Cancer J Clin.* 2010;60:120–32.
14. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis.* 1987;40:373–83.
15. Topinková E, Mádllová P, Fialová D, Klán J. New evidence-based criteria for evaluating the appropriateness of drug regimen in seniors. Criteria STOPP (screening tool of older person's prescriptions) and START (screening tool to alert doctors to right treatment). *Vnitr Lek.* 2008;54:1161–9.
16. Stone SP, Ali B, Auberleek I, Thompsell A, Young A. The Barthel index in clinical practice: use on a rehabilitation ward for elderly people. *J R Coll Physicians Lond.* 1994;28:419–23.
17. Lee YH, Oh H-K, Kim D-W, et al. Use of a comprehensive geriatric assessment to predict short-term postoperative outcome in elderly patients with colorectal cancer. *Ann Coloproctol.* 2016;32(5):161–9.
18. Lindholm E, Brevinge H, Haglund E. Survival benefit in a randomized clinical trial of faecal occult blood screening for colorectal cancer. *Br J Surg.* 2008;95:1029–36.
19. Day LW, Kwon A, Inadomi JM, Walter LC, Somsouk M. Adverse events in older patients undergoing colonoscopy: a systematic review and meta-analysis. *Gastrointest Endosc.* 2011;74:885–96.
20. Lukejohn W, Velayos F. Colorectal cancer screening and surveillance in the elderly: updates and controversies. *Gut Liver.* 2015;9(2):143–51.
21. Lee-Kong S, Lisle D. Surgical management of complicated colon cancer. *Clin Colon Rectal Surg.* 2015;28:228–33.
22. Darby CR, Berry AR, Mortensen N. Management variability in surgery for colo-rectal emergencies. *Br J Surg.* 1992;79:206–10.
23. Fukuda N, Wada J, Niki M, et al. Factors predicting mortality in emergency abdominal surgery in the elderly. *World J Emerg Surg.* 2012;7:1.
24. Van Gestel YR, Lemmens VE, De Hingh IH, et al. Influence of comorbidity and age on 1-, 2-, and 3-month postoperative mortality rates in gastrointestinal cancer patients. *Ann Surg Oncol.* 2013;20:371–80.
25. Kumar R, et al. A population-based study of metastatic colorectal cancer in individuals aged ≥ 80 years: findings from the South Australian Clinical Registry for metastatic colorectal cancer. *Cancer.* 2013;119:722–8.
26. Kang CY, Halabi WJ, Chaudhry OO, Nguyen V, et al. A nationwide analysis of laparoscopy in high-risk colorectal surgery patients. *J Gastrointest Surg.* 2013;17(2):382–91.
27. Schiphorst AHW, Verweij NM, Pronk A, Borel Rinkes IH, Hamaker ME. Non-surgical complications after laparoscopic and conventional surgery for colorectal cancer – a systematic review of randomized controlled trials. *Eur J Surg Oncol.* 2015;41:1118–27.
28. Senagore AJ, Madbouly KM, Fazio VW, Duepre HJ, Brady KM, Delaney CP, et al. Advantages of laparoscopic colectomy in older patients. *Arch Surg.* 2003;138:252–6.
29. Bonjer HJ, Hop WC, Nelson H, Sargent DJ, Lacy AM, Castells A, et al. Laparoscopically assisted vs open colectomy for colon cancer. A meta-analysis. *Arch Surg.* 2007;142:298–303.
30. Odermatt M, Flashman K, Khan J, Parvaiz A. Laparoscopic assisted abdominoperineal resection for low rectal cancer provides a shorter length of hospital stay while not affecting the recurrence or survival: a propensity score-matched analysis. *Surg Today.* 2016;46:798–806.
31. Fleshman J, Sargent DJ, Green E, et al. Laparoscopic colectomy for cancer is not inferior to open surgery based on 5-year data from the COST study group trial. *Ann Surg.* 2007;246:655–62.
32. Kuhry E, Schwenk WF, Gaupset R, Romild U, Bonjer HJ. Long term results of laparoscopic colorectal cancer resection. *Cochrane Database Syst Rev.* 2008;2:CD003432. <https://doi.org/10.1002/14651858>.
33. Yamamoto S, Watanabe M, Hasegawa H, et al. Short-term surgical outcomes of laparoscopic colonic surgery in octogenarians: a matched case-control study. *Surg Laparosc Endosc Percutan Tech.* 2003;13:95–100.

34. Buchs NC, Addeo P, Bianco FM, et al. Safety of robotic general surgery in elderly patients. *J Robot Surg.* 2010;4:91–8.
35. Zeng WG, Zhou ZX. Mini-invasive surgery for colorectal cancer. *Chin J Cancer.* 2014;33:277–84.
36. ERAS Compliance Group. The impact of enhanced recovery protocol compliance on elective colorectal cancer resection. *Ann Surg.* 2015;261(6):1153–9.
37. Adamina M, Kehlet H, Tomlison GA, Senagore AJ, Delaney CP. Enhanced Recovery pathways optimize health outcomes and resource utilization: a meta analysis of randomized controlled trials in colorectal surgery. *Surgery.* 2011;149:830–40.
38. Bagnall NM, Malietz G, Kennedy RH, et al. A systematic review of enhanced recovery after colorectal surgery in elderly patients. *Color Dis.* 2014;16:947–56.
39. Braga M, Pecorelli N, Scatizzi M, Borghi F, Missana G, Radrizzani D, PeriOperative Italian Society. Enhanced recovery program in high-risk patients undergoing colorectal surgery: results from the Perioperative Italian Society Registry. *World J Surg.* 2016;41:860–7.
40. McMurdo ME, Roberts H, Parker S, Wyatt N, Helen May H, et al. Improving recruitment of older people to research through good practice. *Age Ageing.* 2011;40:659–65.
41. Smith JJ, Lee J, Burke C, Contractor KB, Dawson PM. Major colorectal cancer resection should not be denied to the elderly. *Eur J Surg Oncol.* 2002;28:661–6.
42. Seymour MT, Thompson LC, Wasan HS, Middleton G, Brewster AE, Shepherd SF, et al. Chemotherapy options in elderly and frail patients with metastatic colorectal cancer (MRC FOCUS2): an open-label, randomized factorial trial. *Lancet.* 2011;377:1749–59.
43. Wobbes T. Carcinoma of the colon and rectum in geriatric patients. *Age Ageing.* 1985;14(6):321–6.
44. Violi V, Pietra N, Grattarola M, et al. Curative surgery for colorectal cancer: long-term results and life expectancy in the elderly. *Dis Colon Rectum.* 1998;41(3):291–8.
45. Colorectal Cancer Collaborative Group. Surgery for colorectal patients in elderly patients: a systematic review. *Lancet.* 2000;356:968–74.
46. Basili G, Lorenzetti L, Biondi G, Preziuso E, Angrisano C, Carnesecchi P, Roberto E, Goletti O. Colorectal cancer in the elderly. Is there a role for safe and curative surgery? *ANZ J Surg.* 2008;78(6):466–70.
47. Paksoy M, Ipek T, Colak T, Cebeci H. Influence of age on prognosis and management of patients with colorectal carcinoma. *Eur J Surg.* 1999;165(1):55–9.
48. Kristjansson SR, Nesbakken A, Jordhoy MS, Skovlund E, Audisio RA, Johannessen HO, Bakka A, Wyller TB. Comprehensive geriatric assessment can predict complications in elderly patients after elective surgery for colorectal cancer: a prospective observational cohort study. *Crit Rev Oncol Hematol.* 2010;76(3):208–17.
49. Ugolini G, Rosati G, Montroni I, Zanotti S, Manaresi A, Giampaolo L, Blume JF, Taffurelli M. Can elderly patients with colorectal cancer tolerate planned surgical treatment? A practical approach to a common dilemma. *Color Dis.* 2009;11(7):750–5.