VIA MEDICA

REVIEW

Anaesthesiology Intensive Therapy
2016, vol. 48, no 1, 49–54
ISSN 1642–5758
10.5603/AIT.2016.0006
www.ait.viamedica.pl

Anaesthetic perioperative management according to the ERAS protocol

Bartosz Horosz, Katarzyna Nawrocka, Małgorzata Malec-Milewska

Department of Anaesthesiology and Intensive Therapy,
Medical Centre for Postgraduate Education (MCPE), Poland

Abstract

After many years of experience in surgery, a series of recommendations have been created by a group of European specialists to improve the quality of perioperative care and maximize postoperative outcomes. Early mobilization and oral feeding, preoperative oral intake of carbohydrate-rich fluids, proper fluid and pain management, intensive postoperative nausea and vomiting prophylaxis, and antimicrobial and thromboembolism prophylaxis are the interventions that may decrease surgery-induced metabolic stress and facilitate the return of bowel function and early discharge. The *Enhanced Recovery After Surgery* (ERAS) Society is the group that focuses on these perioperative issues. This paper aims to summarize the role of anaesthesiologists in the implementation of the ERAS protocol.

Key words: perioperative care, ERAS, fast track, anaesthesia

Anaesthesiology Intensive Therapy 2016, vol. 48, no 1, 49–54

Since the early 90s of the previous century, the enhanced recovery after surgery (ERAS) protocol for complex perioperative care that aims to improve treatment outcomes has been popularised and modified. The protocol was pioneered by the Danish surgeon Henrik Kehlet who published deliberations on postoperative care in 1995 that caused much commotion not limited to the surgical field. According to Kehlet, some perioperative procedures that had been used for colon surgery for years had not been scientifically confirmed, and new strategies needed to be introduced [1]. The most controversial suggestions regarded the avoidance of intensive preoperative bowel preparation, the early oral feeding and restrictive intravenous fluid therapy [2]. The data in the published literature have revealed that complex perioperative care, early nutrition, ambulation, and proper pain management shorten hospitalisations and more importantly reduce the incidence of complications [3]. To formulate the appropriate guidelines, studies on perioperative care had to be reviewed in detail. In 2001, a special working group managed by Olle Ljungqvist (Sweden) was appointed in London and included European experts in surgery. Since that time, the consensus guidelines of the ERAS society have been developed regarding perioperative managements for individual types of surgeries (i.e., surgeries of the GI tract and pancreas and major urologic procedures) [4-7]. Guidelines for gynaecological and orthopaedic surgeries are being designed.

The ERAS protocol is mainly addressed to physicians in surgical disciplines who care for patients to qualify and prepare them for surgery. However, to achieve success with the protocol, the collaboration of all personnel involved in perioperative care is essential (i.e., surgeons, anaesthesiologists, nurses, physiotherapists, dieticians, and family members).

The aim of the review is to present the ERAS assumptions related to the procedures managed by the anaesthesia team, the implementation of which can beneficially affect postoperative outcomes.

COMPONENTS OF THE ERAS PROTOCOL

The ERAS protocol contains the following recommendations: preoperative preparation and counselling, curtailed fasting, avoidance of preoperative bowel preparation, preoperative supply of carbohydrate-rich drinks, the avoidance of pharmacological premedication, thromboembolism prophylaxis, antibiotic prophylaxis, epidural anaesthesia, intraoperative use of short-acting anaesthetics and opioids, restricted parenteral supply of sodium and fluids, prevention of hypothermia, prevention of postoperative nausea

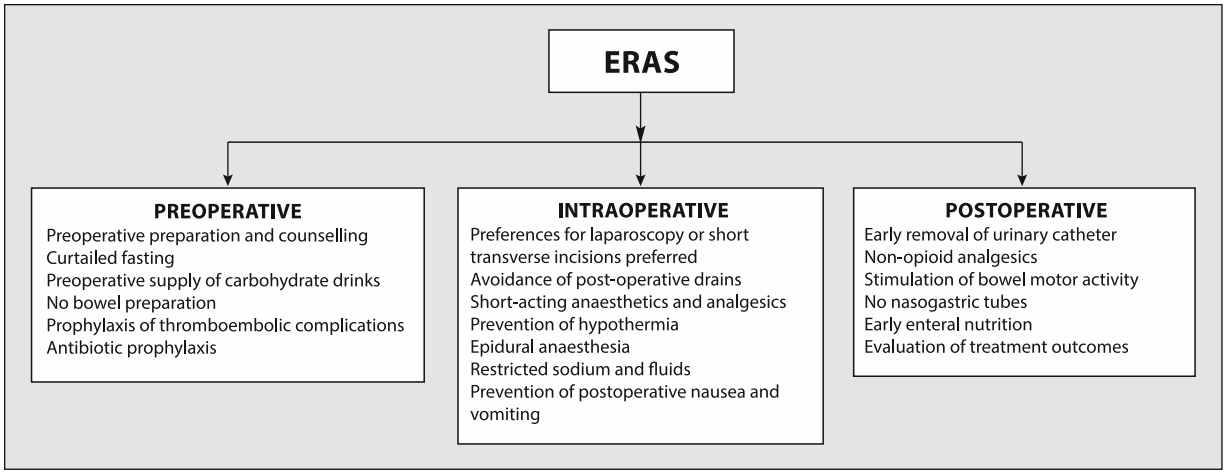

Figure 1. The ERAS guidelines divided into individual stages of perioperative care

and vomiting (PONV), pain management based on non-opioid drugs, early enteral nutrition, stimulation of GI motor activity, limited use of naso-gastric tubes, preferences for laparoscopy (with short transverse incisions), avoidance of post-operative drains when possible, early mobilisation, early removal of urinary catheters, and evaluations of the implemented protocol and treatment outcomes (Fig. 1).

Many components of the protocol are directly connected to the activities of the anaesthesia team. Anaesthesiologists address the preparation for anaesthesia, determine the fasting regime during the immediate preoperative period (which affects the supply of carbohydrate drinks), abandon classic premedication, and introduce PONV prophylaxis. Intraoperatively, anaesthesiologists employ restrictive, low-sodium fluid therapy, prevent hypothermia, and use short-acting drugs. Moreover, anaesthesiologists make decisions regarding intra- and postoperative analgesia (i.e., epidural anaesthesia and non-opioid analgesics).

PREOPERATIVE PREPARATION AND COUNSELLING

All patients undergoing elective surgery are counselled surgically and anaesthesiologically. During the anaesthetic visit, the anaesthesiologist takes the patient's history, performs a physical examination while paying special attention to factors suggestive of a difficult intubation, evaluates the potential use of individual anaesthesia techniques and provides detailed information about the type of anaesthesia planned and options for relieving postoperative pain. Moreover, anaesthesiological counselling substantially allays anxiety [8]. In Poland, it is obligatory to obtain written informed consent for anaesthesia. Many Polish centres have anaesthesiology outpatient clinics that patients who are scheduled for elective surgeries can visit. The protocol assumes that anaesthesiological counselling should take place approximately 2 weeks before surgery. During counselling, the patient should also be informed about the pre-surgery dietary preparation. Unless some dietary interventions are recommended (e.g., supplementation with special nutritional preparations such as Nutridrink), patients are generally advised not to engage in radical diets, to drink a minimum of 2 litres of liquids per day and to refrain from alcohol. A crucial element for improving treatment outcomes is the early cessation of smoking and moderate physical efforts [9, 10]. The patient should exercise moderately for 30 min a day, and fast walking is one option. This type of physical activity considerably increases the efficiencies of the cardiovascular and respiratory systems, and the surgical procedure places considerable strain on these systems inter alia due to significant metabolic changes. In 2013, Singh and co-workers [11] reviewed the data regarding this management. In their publication, these authors emphasised that increased physical efficiency and performance prior to surgery can reduce the incidence of postoperative complications, shorten hospital stay and improve the quality of life.

PREOPERATIVE SUPPLY OF CARBOHYDRATE DRINKS

In 2011, the recommendations of the European Society of Anaesthesiology (ESA) were published. These recommendations advocate that patients who are anaesthetised for elective surgery should abstain from solid foods for 6 hours before the procedure and be allowed to drink clear fluids for 2 hours before the procedure. The guidelines clearly emphasise that longer fasting and liquid restriction are not encouraged because they do not minimise the risk of aspiration complications [2]. Moreover, it has been highlighted that longer fasting has negative effects on treatment outcomes, for example, longer fasting increases perioperative

insulin-resistance (which causes metabolic complications in the perioperative period), adversely affects the nitrogen balance and worsens the quality of life of patients [12]. The ESA recommendations have been supported by numerous studies including a Cochrane meta-analysis conducted in 2010 in which various strategies of preoperative fasting were compared [13].

Surgical procedures induce a metabolic response comparable to that of severe trauma. As early as the 20s and 30s of the last century, Cuthbertson evaluated the effects of trauma on the human body [14]. Studies and observations performed over many decades have demonstrated that all traumas, including surgery, induce the following cascade of events: increased secretion of catecholamines, stimulation of the hypothalamic-pituitary-adrenal axis that results in the release of glucocorticosteroids, and increased production of cytokines (e.g., IL-6 and TNF-α) and chemokines. The above events result in body alterations that prevent hypotension and mobilise the body for the healing process. Glycogenolysis, lipolysis and proteolysis are initiated by hormones and sympathetic stimulation, and substantial amounts of glucose are released into the blood [15]. The increased secretion of insulin does not induce proper hypoglycaemic effects; rather these effects result from the actions of cytokines and hormones. These effects reduce the transport of glucose to the cells, which directly induces insulin-resistance [16]. As demonstrated by Thorell et al. in 1999 [17], insulin resistance is a factor that is associated with prolonged hospitalizations, increased risks of postoperative complications and worse treatment outcomes. Therefore, it is beneficial to counteract the development insulin resistance via appropriate surgery preparation. One management with clinically demonstrated efficacy is the oral supply of 400 ml of a carbohydrate-rich drink 2 hours before the induction of anaesthesia. The solution used contains a 12.5% isosmolar (240 mOsmol kg H_2O^{-1}) mixture of sugars (simple and complex sugars, polysaccharides and lactose) and electrolytes (sodium, potassium, calcium, magnesium, chloride and phosphate) and provides 50 kcal in 100 mL [18]. The supply of carbohydrates in this form provides an energy substrate and induces the preoperative release of insulin, which positively modifies the body's response to trauma (it sensitises the tissues to the actions of other anabolic hormones) [19].

PREMEDICATION

According to the ERAS protocol, classic premedication with anxiolytics is not recommended. The administration of drugs that reduce anxiety (anxiolytics) and have sedative effects in the period prior to the induction of anaesthesia prolongs the time needed to restore normal cognitive functions, delays the oral supply of liquids and thus elicits adverse effects in terms of optimal perioperative care [20]. Furthermore, the abandonment of this type of pharmacological management has not been found to markedly increase patient anxiety. The findings of a study published in 2002 demonstrated no differences in the severity of anxiety in patients who were premedicated with diazepam and a placebo group [21]. Patients who are appropriately informed and prepared for surgery exhibit suitably low levels of stress prior to elective surgery [8]. One of the crucial elements of the protocol is the preoperative administration of drugs for pain relief and the prevention of PONV.

EPIDURAL ANAESTHESIA AND PAIN MANAGEMENT

Anaesthetic care is not confined to the provision of anaesthesia. This care also involves the management of postoperative pain. The form of postoperative pain control depends on many factors, and the essential factors are the type and extent of the surgery. In the ERAS protocol, the techniques of regional anaesthesia are considered to be of great importance, particularly epidural anaesthesia (EA). The technique has many assets that accelerate convalescence following surgical procedures [22]. Whenever possible, it is recommended that a thoracic epidural catheter be inserted to provide analgesia with a local anaesthetic that does not include opioids. EA has been demonstrated to beneficially affect the restoration of bowel motor activities, to limit the metabolic response, to reduce the resultant postoperative insulin resistance and thus the incidence of metabolic complications and to shorten hospitalization [23]. An important element of pain management is the use of pre-emptive analgesia or rather preventive analgesia (used pre-, intra- and postoperatively). For this purpose, analgesics from all drug groups are used, regional analgesia techniques are employed, and drugs that inhibit hyperalgesia are administered (to limit the development of CNS sensitisation). The type of pharmacotherapy depends on the anticipated extent of the tissue trauma. A variety of classic analgesics are applied (i.e., metamizole, paracetamol, non-steroidal anti-inflammatory drugs, and opioids) in addition to the use of gabapentinoids (i.e., gabapentin and pregabalin), α-2 agonists (i.e., clonidine and dexmedetomidine), and intravenous infusions of lidocaine and ketamine. The Polish recommendations for postoperative pain management fit perfectly with the ERAS suggestions. The guidelines published in 2014 recommend epidural analgesia as a method for treating postoperative pain after procedures involving extensive tissue trauma. Moreover, the guidelines highlight pre-emptive analgesia to modify nociception and multimodal analgesia, which is beneficial for both pain relief and reducing the doses of individual drugs and hence reducing the risks of adverse side effects [24]. Postoperative pain management also includes techniques involving local anaesthetics (LAs), such as injections of LAs into the region of the surgical wound,

and transversus abdominis plane (TAP) block. This type of management has been demonstrated to significantly reduce the requirements for analgesics, particularly opioids [25–27].

PREVENTION OF POSTOPERATIVE NAUSEA AND VOMITING

One of the crucial fears of patients who are anaesthetised for elective surgery is the preoperative anxiety associated with postoperative nausea and vomiting (PONV). This issue affects 15–30% of patients who undergo general anaesthesia [28]. The ERAS protocol recommends prophylactic management for all patients with a moderate or high risk of PONV. The risk should be assessed using the Apfel risk score, which is based on the following four factors: female gender, smoking abstinence, history of PONV or motion sickness, and anticipated use of opioids during the postoperative period [29]. When more than two risk factors are present (i.e., a moderate risk), antiemetic prophylaxis should be used in the form of the intravenous supply of dexamethasone after the induction of anaesthesia or a 5-HT_3 antagonist (e.g., ondansetron) before the completion of surgery. For patients with Apfel scores of 3 or 4, intensive PONV prevention is recommended. This prevention includes the administration of two antiemetics during anaesthesia (dexamethasone and a 5-HT_3 antagonist, metoclopramide or droperidol). Moreover, the use of total intravenous anaesthesia with propofol, which is believed to have antiemetic properties, ought to be considered instead of anaesthesia with volatile anaesthetics [30].

SHORT-ACTING AGENTS

The anaesthesia technique should allow for the quickest possible convalescence. Therefore, short-acting drugs are recommended for general anaesthesia. Amongst the commonly used opioids, the best choice is continuously infused remifentanil, the effects of which are limited to several minutes after the completion of the infusion. When unavailable, fentanyl can be administered, but it should be remembered that the half-life of fentanyl is 30 minutes. The recommended muscle relaxant is rocuronium, which acts for approximately 60 minutes after the induction dose and for 15 minutes after the maintenance dose. Additionally, the effect of rocuronium can be quickly reversed not only with neostigmine, which is traditionally used but also with sugammadex. For the maintenance of anaesthesia, total intravenous anaesthesia (TIVA) with propofol or inhalation anaesthesia with volatile anaesthetics (e.g., sevoflurane or desflurane) should be chosen. The doses of the drugs used for general anaesthesia should be tailored individually. Moreover, the use of an epidural block or other additional agents that can decrease the demand for drugs (e.g., drugs applied for pre-emptive analgesia) should be taken into account [24, 31].

RESTRICTED SODIUM AND FLUIDS AND EARLY ENTERAL NUTRITION

The maintenance of fluid balance is a crucial postoperative issue. Recent experiences that are supported by numerous clinical studies confirm that liberal fluid therapy, which is universally used, can contribute to the development of many postoperative complications. Fluid overload resulting from the excessive supply of crystalloids carries the risk of tissue oedema, which hinders the healing of intestinal anastomoses and delays the return of intestinal motor functions, which results in prolonged paralytic ileus [32]. Excessive fluid supply burdens the coagulation system [33, 34]. In their study conducted in 2002 [33], Lobo and colleagues demonstrated a shortened period of hospitalization from 9 to 6 days and a shortened duration of paralytic ileus from 6.5 to 4 days in patients following large bowel resection who received restrictive sodium-low fluid therapy, i.e., < 2000 mL of fluids and < 77 mmoL of sodium per day. In the ERAS protocol, intensive intestinal preparations prior to colorectal surgery are abandoned [35], which is crucial for the hydration of the patients before surgery. According to the traditional approach, at 24 h before the procedure, patients scheduled for intestinal surgeries are fasted and drink mineral water and a special osmotic preparation to cleanse the GI tract. Consequently, the patients were dehydrated upon admission to the operating theatre. Due to the abandonment of this management strategy and the encouragement and education of patients regarding proper nutrition and hydration before surgery, their water-electrolyte balance is assumed to be normal. According to the ERAS recommendations, oral fluids should be initiated as early as 2 h after the completion of surgery (it is assumed that during the first 24 h, the patient should drink approximately 800 ml of water [37]). There is no need for additional fluids during surgery. It is recommended that the drip infusion be maintained for intravenous access and the provision of supplement fluids depending on perioperative blood loss. Intraoperative hypotonia should be treated with vasoconstricting drugs (e.g., ephedrine and noradrenaline). This management is more physiological (reduced arterial pressure results from vasodilation and the abolition of the physiological compensatory mechanisms caused by epidural and general anaesthesia), enables the quicker restoration of GI motor functions and reduces the incidence of cardiovascular complications. In a study of radical cystectomies, Wuethricht and colleagues [39] demonstrated that the above management reduces the number of postoperative complications by 22% and shortens the hospitalization time from 17 to 15 days. Balanced crystalloids are recommended for perioperative fluid therapy (e.g., a compound electrolyte solution or Ringer's solution). The routine use of colloids, such as hydroxylated starch preparations and gelatines, does not seem recom-

mendable, although there are no explicit data suggesting that they cause adverse effects during the course of surgery. The supply of 0.9% NaCl should be abandoned due to its non-physiological composition; excessive sodium and chloride resulting from its use can lead to hyperchloraemic acidosis and induce kidney damage (acute renal failure caused by renal vasoconstriction) [39]. Moreover, hyperkalaemia is not an indication for the administration of 0.9% NaCl. A randomized study conducted in 2005 demonstrated that the intuitive supply of 0.9% NaCl solution to patients with renal failure (as a perioperative fluid therapy before kidney transplant) caused a greater increase in serum potassium compared to that observed in patients who received balanced crystalloids (Ringer's solution) [40].

PREVENTION OF HYPOTHERMIA

The issues associated with perioperative thermoregulation are increasingly being discussed. Surgical access, the abolition of the physiological protective mechanisms that ensure proper thermal homeostasis of the body (due to the effects of general anaesthesia and sympathetic block accompanying conduction anaesthesia), low temperature in the operating theatre and the administration of cool infusion fluids results in decrease of the core temperatures of anaesthetised patients who can increase the risk of severe complications, e.g., the modification of enzymatic processes. In this manner, hypothermia adversely affects the coagulation system and alters the pharmacokinetics of drugs. Intraoperative hypothermia impairs the functions of the immune and cardiovascular systems [41]. In studies performed in the 90s of the previous century, Frank and co-workers [42, 43] highlighted that perioperative hypothermia results in a higher percentage of cardiovascular complications and is associated with increased demands for blood transfusions. Moreover, due to effects on the local immunological response, the risk of surgical wound infections is tripled [44]. A reduction in body temperature during surgery leads to the development of postoperative tremors, which substantially increase the metabolic requirements of the body and oxygen consumption [45]. The proper management is to initiate temperature monitoring before the induction of anaesthesia and to continue this monitoring throughout the procedure and during the postoperative period. A variety of methods can be used to prevent this common perioperative complication. For example, pre-warming can be applied. Intraoperatively, passive methods, such as covering the patient with several layers of drapes (which reduces the heat loss by convection from 15 to 30% depending on the cover used) and active methods can be used. The latter methods involve the use of forced warm air systems (this prevents the loss of heat resulting from radiation and convection) and devices that warm the infusion fluids and blood preparations to a pre-set temperature [46, 47]. Analysis of the available forms of hypothermia prevention suggests that several measures that limit heat loss should be used and intensified during long-duration surgical procedures [48].

SUMMARY

The ERAS protocol seems to be a simple tool for reducing the incidence of postoperative complications and shortening hospitalisation. The multi-directional nature of this protocol necessitates the collaboration of all of the personnel involved in perioperative care in which anaesthesiologists play a crucial role. The aspirations of anaesthesiologists for beneficial changes and their determination to overcome traditional protocols are promising in terms of the optimal use of the existing surgical protocols and the marked reduction of the incidence of complications, which will hopefully occur in the very near future.

ACKNOWLEDGEMENTS

1. The authors declare no financial disclosure.
2. The authors declare no conflict of interest.

References:

1. *Kehlet H, Wilmore DW*: Multimodal strategies to improve surgical outcome. Am J Surg 2002; 183: 630–641. doi: 10.1016/S0002-9610(02)00866-8.
2. *Smith I, Kranke P, Murat I et al.:* Perioperative fasting in adults and children: guidelines from the European Society of Anaesthesiology. Eur J Anaesthesiol 2011; 28: 556–569. doi:10.1097/EJA.0b013e3283495ba.1
3. *Kehlet H, Buchler MW, Beart RW, Billingham RP, Williamson R*: Care after colonic operation-is it evidence-based? Results from a multinational survey in Europe and the United States. J Am Coll Surg 2006; 202: 45–54.
4. *Gustafsson UO, Scott MJ, Schwenk W et al.*: Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS®) Society recommendations. Clin Nutr 2012; 31: 783–800. doi: 10.1016/j.clnu.2012.08.013.
5. *Mortensen K, Nilsson M, Slim K et al.*: Consensus guidelines for enhaced recovery after gastrectomy. Enhanced Recovery After Surgery (ERAS) Society recommendations. Br J Surg 2014; 101: 1209–1229. doi: 10.1002/bjs.9582.
6. *Lassen K, Coolsen MM, Slim K et al.*: Guidelines for perioperative care for pancreaticoduodenectomy: Enhanced Recovery After Surgery (ERAS®) Society recommendations. Clin Nutr 2012; 31: 817–830. doi: 10.1016/j.clnu.2012.08.011.
7. *Certanola Y, Valerio M, Presson B et al.*: Guidelines for perioperative care after radical cystectomy for bladder cancer: Enhanced Recovery After Surgery (ERAS) society recommendations. Clin Nutr 2013; 32: 897–887. doi: 10.1016/j.clnu.2013.09.014.
8. *Sjöling M, Nordahl G, Olofsson N, Asplund K:* The impact of preoperative information on state anxiety, postoperative pain and satisfaction with pain management. Patient Educ Couns 2003; 51: 169–176.
9. *Turan A, Mascha EJ, Roberman D et al.*: Smoking and perioperative outcomes. Anaesthesiology 2011; 114: 837– 846. doi: 10.1097/ALN.0b013e318210f560.
10. *Mayo NE, Feldman L, Scott S et al.*: Impact of preoperative change in physical function on postoperative recovery: argument supporting prehabilitation for colorectal surgery. Surgery 2011; 150: 505–514. doi: 10.1016/j.surg.2011.07.045.
11. *Singh F, Newton RU, Galvão DA, Spry N, Baker MK:* A systematic review of pre-surgical exercise intervention studies with cancer patients. Surg Oncol 2013; 22: 92–104. doi: 10.1016/j.suronc.2013.01.004.

12. *Hausel J, Nygren J, Lagerkranser M et al.*: A carbohydrate-rich drink reduces preoperative discomfort in elective surgery patients. Anesth Analg 2001; 93: 1344–1350.
13. *Brady M, Kinn S, Stuart P*: Preoperative fasting for adults to prevent perioperative complications. Cochrane Database Syst. Rev 2003; CD004423.
14. *Cuthbertson DP:* The disturbance of metabolism produced by bony and non-bony injury, with notes on certain abnormal conditions of bone. Biochem J. 1930; 24: 1244–1263.
15. *Wilmore DW*: From Cuthbertson to fast-track surgery: 70 years of progress in reducing stress in surgical patients. Ann Surg 2002; 236: 643–648.
16. *Thorell, A, Nygren J, Hirshman MF et al.*: Surgery-induced insulin resistance in human patients: relation to glucose transport and utilization. Am J Physiol 1999; 276 (Endocrinol Metab 39): E754–E761.
17. *Thorell A, Nygren J, Ljungqvist O*: Insulin resistance: a marker of surgical stress. *Curr Opin Clin Nutr Metab Care 1999*; 2: 69–78.
18. *Bisgaard T, Kristiansen VB, Hjortsø NC, Jacobsen LS, Rosenberg J, Kehlet H*: Randomized clinical trial comparing an oral carbohydrate beverage with placebo before laparoscopic cholecystectomy. Br J Surg 2004; 91: 151–158.
19. *Nygren J, Soop M, Thorell A, Efendic S, Nair KS, Ljungqvist O*: Preoperative oral carbohydrate administration reduces postoperative insulin resistance. Clin Nutr 1998; 17: 65–71.
20. *Cumo W, Hidalgo MP, Schmidt AP et al.*: Effect of pre-operative anxiolysis on postoperative pain response in patients undergoing total abdominal hysterectomy. Anaesthesia 2002; 57: 740–746.
21. *Walker KJ, Smith AF*: Premedication for anxiety in adult day surgery. Cochrane Database Syst Rev 2009; CD002192. doi: 10.1002/14651858.CD002192.pub2.
22. *Rigg JR, Jamrozik K, Myles PS et al.*: Epidural anaesthesia and analgesia and outcome of major surgery: a randomised trial. Lancet 2002; 359: 1276–1282.
23. *Jørgensen H, Wetterslev J, Møiniche S, Dahl JB*: Epidural local anaesthetics versus opioid-based analgesic regimens on postoperative gastrointestinal paralysis, PONV and pain after abdominal surgery. Cochrane Database Syst Rev 2000; CD001893.
24. *Misiołek H, Cettler M, Woroń J, Wordliczek J, Dobrogowski J, Mayzner-Zawadzka E:* The 2014 guidelines for post-operative pain management. Anaesthesiol Intensive Ther 2014; 46: 221–244. doi: 10.5603/AIT.2014.0041.
25. *Favuzza, J, Delaney CP*: Outcomes of discharge after elective laparoscopic colorectal surgery with transversus abdominis plane blocks and enhanced recovery pathway. J Am Coll Surg 2013; 217: 503–506. doi: 10.1016/j.jamcollsurg.2013.03.030.
26. *Johns N, O'Neill S, Ventham NT, Barron F, Brady RR, Daniel T:* Clinical effectiveness of transversus abdominis plane (TAP) block in abdominal surgery: a systematic review and meta-analysis. Colorectal Dis. 2012; 14: e635–642. doi: 10.1111/j.1463-1318.2012.03104.x.
27. *Liu SS, Richman JM, Thirlby R, Wu L:* Efficacy of continuous wound catheters delivering local anesthetic for postoperative analgesia: a quantitative and qualitative systematic review of randomized controlled trials. J Am Coll Surg 2006; 203: 914–932.
28. *Apfel CC, Korttila K, Abdalla M et al.*: IMPACT Investigators: A factorial trial of six interventions for the prevention of postoperative nausea and vomiting. N Engl J Med 2004; 350: 2441–2451.
29. *Gupta S, Choudhary R*: *A comparative clinical study of prevention of post-operative nausea and vomiting using granisetron and ondansetron in laparoscopic surgeries*. The Internet Journal of Anesthesiology 2009; 26 Number 1.
30. *Scuderi PE, James RL, Harris L, Mims GR 3rd*: Multimodal antiemetic management prevents early postoperative vomiting after outpatient laparoscopy. Anesth Analg 2000; 91: 1408–1414.
31. *White PF, Kehlet H, Neal JM, Schricker T et al.*: Fast-Track Surgery Study G. The role of the anesthesiologist in fast-track surgery: from multimodal analgesia to perioperative medical care. Anesth Analg 2007; 104: 1380–1396.
32. *Prien T, Backhaus N, Pelster F, Pircher W, Bünte H, Lawin P:* Effect of intraoperative fluid administration and colloid osmotic pressure on the formation of intestinal edema during gastrointestinal surgery. J Clin Anesth 1990; 2: 317–323.
33. *Lobo DN, Bostock KA, Neal KR, Perkins AC, Rowlands BJ, Allison SP:* Effect of salt and water balance on recovery of gastrointestinal function after elective colonic resection: a randomised controlled trial. *Lancet* 2002; 359: 1812–1818.
34. *Brandstrup B, Tønnesen H, Beier-Holgersen R et al.*: Danish Study Group on Perioperative Fluid Therapy: Effects of intravenous fluid restriction on postoperative complications: comparison of two perioperative fluid regimens randomized assessor-blinded multicenter trial. Ann Surg 2003; 238: 641–648.
35. *Contant CM, Hop WC, van't Sant HP et al.*: Mechanical bowel preparation for elective colorectal surgery: a multicentre randomised trial. Lancet 2007; 370: 2112–2117.
36. *Holte K, Nielsen KG, Madsen JL, Kehlet H*: Physiologic effects of bowel preparation. Dis Colon Rectum 2004; 47: 1397–1402.
37. *Soop M, Carlson GL, Hopkinson J et al.*: Randomized clinical trial of the effects of immediate enteral nutrition on metabolic responses to major colorectal surgery in an enhanced recovery protocol. Br J Surg 2004; 91: 1138–1145.
38. *Wuethrich PY, Burkhard FC, Thalmann GN, Stueber F, Studer UE:* Restrictive deferred hydration combined with preemptive norepinephrine infusion during radical cystectomy reduces postoperative complications and hospitalization time. Anesthesiology 2014; 120: 365–377. doi: 10.1097/ALN.0b013e3182a44440.
39. *Schnermann J, Ploth DW, Hermle M*: Activation of tubuloglomerular feedback by chloride transport. Pfluegers Arch Eur J Physiol 1976; 362: 229–240.
40. *O'Malley CMN, Frumento RJ, Hardy MA et al.*: A randomized, double-blind comparison of lactated Ringer's solution and 0.9% NaCl during renal transplantation. Anesth Analg 2005; 100: 1518–1524.
41. *Horosz B, Malec-Milewska M*: Inadvertent perioperative hypothermia. Anaesthesiol Intensive Ther 2013; 45: 41–47. doi: 10.5603/AIT.2014.0019.
42. *Frank SM, Fleisher LA, Breslow MJ et al.*: Perioperative maintenance of normothermia reduces the incidence of morbid cardiac events: a randomized clinical trial. JAMA 1997; 277: 1127–1134.
43. *Rajagopalan S, Mascha E, Na J, Sessler DI*: The effects of mild perioperative hypothermia on blood loss and transfusion requirement. *Anesthesiology* 2008; 108: 71–77.
44. *Kurz A, Sessler DI, Lenhardt R*: Perioperative normothermia to reduce the incidence of surgical wound infection and shorten hospitalization. N Eng J Med 1996; 334: 1209–1215.
45. *Frank SM, Fleisher LA, Olson KF et al.*: Multivariate determinates of early postoperative oxygen consumption: the effects of shivering, core temperature, and gender. Anesthesiology 1995; 83: 241–249.
46. *Sessler DI, McGuire J, Sessler AM*: Perioperative *thermal insulation*. Anesthesiology *1991*; 74: 875–879.
47. *Horosz B, Malec-Milewska M:* Methods to prevent intraoperative hypothermia. Anaesthesiol Intensive Ther 2014; 46: 96–100. doi: 10.5603/AIT.2014.0019.
48. *Forbes S, Eskicioglu C, Nathens A, et al.*: Evidence-based guidelines for prevention of perioperative hypothermia. J Am Coll Surg 2009; 209: 492–503. doi:10.1016/j.jamcollsurg.2009.07.002.

Corresponding author:
Horosz Bartosz. MD
Department of Anaesthesiology and Intensive Therapy, MCPE
W. Orłowski hospital
ul. Czerniakowska 231, 00–416 Warszawa, Poland
e- mail: bartosz.horosz@cmkp.edu.pl

Received: 17.06.2015
Accepted: 11.01.2016