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ARTYKUŁ SPECJALNY / *STATE-OF-THE-ART REVIEW*

It is time for enhanced recovery after surgery in cardiac surgery

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ENHANCED RECOVERY AFTER SURGERY

The concept of enhanced recovery after surgery (ERAS) dates back to 2001 when Professors Ken Faron and Olle Ljungquist, relying on pathophysiological reasons and increasingly strong evidence, emphasised that the quality of perioperative care should be improved in order to achieve a better prognosis of patients undergoing surgical procedures [1]. The issue was subsequently undertaken by Brazilians, who designed the ACERTO programme (in English "Accelerated Total Postoperative Recovery") in 2005–2006 [2]. During successive years, the concept was widened, i.e. "E" was added to the acronym (meaning 'early'), which stressed early implementation of individual elements of ERAS. The ERAS protocol, which predominantly functions in Europe, has become of interest to the American College of Surgeons within the National Surgical Quality Improvement Programme (NSQIP) [3], and the 'Strong for Surgery' initiative was created within the Comparative Effectiveness Research Translation Network (CERTAIN) [4]. The Polish translation of the ERAS acronym is rather long ("*kompleksowa opieka okołooperacyjna dla poprawy wyników leczenia*"), yet pertinently conveys the essence of the issue discussed [5].

Since 2001, many efforts have been made to consider ERAS as an indicator of the quality of perioperative care. The philosophy of ERAS is based on the assumption that since a small group (5–15%) of patients develops a huge proportion (80–90%) of postoperative complications, perioperative care should be individualised [6]. The goal of therapy should be to reduce the number of complications because they are largely responsible for the risk of death [7].

Numerous perioperative algorithms have inadequate diagnostic accuracy and tend to overestimate the baseline risk [6, 8].

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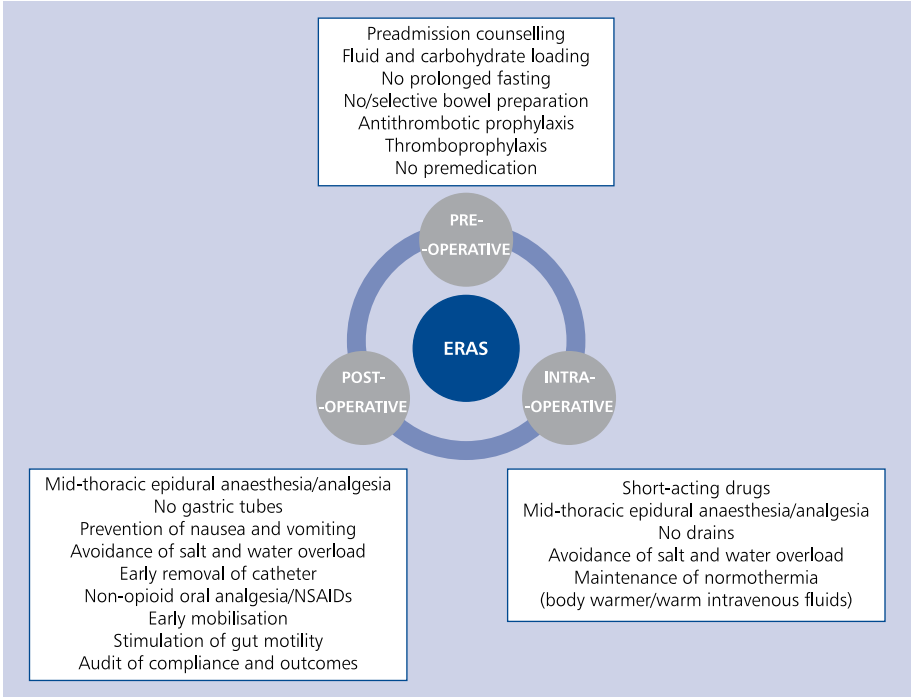

Figure 1. Elements of enhanced recovery after surgery (ERAS) programme in pre- /intra- and post-operative period; NSAIDs — nonsteroidal anti-inflammatory drugs

To increase accuracy, they should be regularly validated based on the changing population of patients undergoing surgical procedures [9]. Therefore, the additive EuroSCORE system (in points) should no longer be applied and replaced by the modified version of EuroSCORE II [10], similarly to the Society of Thoracic Surgeons (STS) score calculator that is evolving continuously [11]. To date, there has been no in-depth worldwide system of perioperative risk assessment because the risk itself is difficult to define (what does it concern? → death/total postoperative prevalence/cardiovascular complications/complications of other organs/prolonged hospitalisation/etc.) and is different for cardiac and non-cardiac surgical procedures. The only universal algorithm is still the American Society of Anaesthesiologists Physical Status Classification System [12].

The ERAS Society is concerned with evidence-based guidelines [1]. Its motto is: "The mission of the ERAS Society is to develop perioperative care and to improve recovery through research, education, audit, and implementation of evidence-based practice" [1]. The recommendations for gastrointestinal [13–16], bariatric [17], and oncologic [18–20] surgical procedures have already been published. There is increasingly strong evidence that the guidelines may be found useful in some other surgical fields, such as orthopaedics, urology, as well as thoracic, maxillofacial, and reconstructive surgery [21–26].

The ERAS protocol was divided into three stages of perioperative care: pre-, intra-, and postoperative. The protocol contains 22 rules (Fig. 1), which seem very logical and are almost intuitively chosen by us; however, they are not always strictly followed in everyday perioperative care [27–30]. A single intervention will not affect the treatment outcomes; only consistent and synergistic use of interventions results in good effects. The above rule is exactly the same as the one applied for prevention of ventilator-associated pneumonia — statistically, a single intervention is useless for prevention, but a wise combination of interventions and their absolute enforcement should prevent new cases of pneumonia [31].

The ERAS principles, focused on early recovery, are to be spread over the later stage of convalescence — late recovery (Table 1).

In the context of ERAS, the differences in the language used by physicians and patients to describe the efficacy of surgery are noteworthy. Physicians focus on mortality, prevalence, duration of hospitalisation, and its costs, while patients pay attention to benefits of surgery — better functioning, improved quality of life after appropriate convalescence (Fig. 2).

The patients' priorities include pain relief, elimination of nausea and vomiting, as well as anxiety and bad mood, possibly early mobilisation and ambulation to function physiologically unaided (eating, drinking, baths, urination, and defecation), and quick discharge in order to return to their home settings and life activities (associated with family, social, professional, and sexual life). All the above elements determine the quality of their life [32].

Enhanced recovery after surgery relies on teamwork [1] based on cooperation of surgeons, anaesthetists, nurses,

Table 1. Major steps in recovery in the perioperative period

Early recovery	Immediate recovery	Late recovery
Operating theatre → Post-operative care unit → Surgical ward	Hospital ward → Home	Home → Work place/ Everyday-life activities
Hours → Days	Days → Weeks	Weeks → Months
Homeostasis	Well-being and convalescence ability	Health-related quality of life

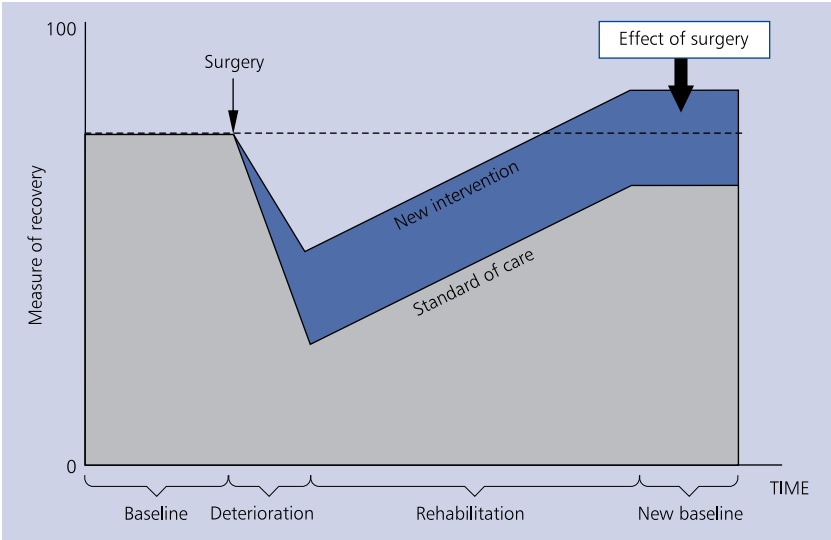

Figure 2. Postoperative convalescence according to enhanced recovery after surgery philosophy [based on: Feldman LS, Can J Anaesth. 2015]

physiotherapists, dieticians, and social workers. Moreover, family and patient`s support and understanding are required.

ENHANCED RECOVERY AFTER CARDIAC SURGERY

The online medical databases contain hundreds of publications regarding surgical treatment and management enabling reduction of complications, shortened hospitalisation, and improved post-treatment quality of life. The suggested protocol of management has been adapted in almost all non-cardiac surgery specialities [13–26]; yet it is cardiac surgery, which is the most common procedure performed worldwide and is associated with high healthcare expenditures. Patients are increasingly old and have additional comorbidities, thus the risk of surgery increases. Therefore, actions should be taken to maintain good treatment outcomes and high quality of care without increasing costs [33]. The fast-track strategy appeared to be safe, but it was just an element of care regarding only the postoperative period. The aim was to shorten mechanical ventilation after surgery and possibly shorten the hospitalisation in the postoperative ward [34]. The standard of enhanced recovery after cardiac surgery (ERACS)/enhanced recovery from heart surgery (ERFHS) currently suggested involves the perioperative period and faces a challenge to change the traditional model of care.

The idea was borrowed from a coach of English cyclists, who besides routine activities focused on minor details improving the results at each stage of preparations for cycling competitions. Those seemingly irrelevant changes resulted in great success of his cyclists. The elimination of seemingly minor imperfections is likely to result in cumulative benefits, which should contribute to better treatment outcomes [35]. The success relies on teamwork involving care and management since the moment that indications for surgical treatment are recognised and patients qualified for surgery (the outpatient cardiology clinic) until the first post-operative follow-up in the above-mentioned clinic.

It would seem that only a small group of patients could be provided with the care described above. However, in-depth analysis reveals that all the elective procedures can be performed using the suggested strategy. Failures should obviously be taken into account; their incidence ranges from 3.3% to 63% [36].

The causes of failures may be various. A high proportion are associated with the patient. The problem occurs when the heart requires intensive pharmacological and mechani-

cal support due to low cardiac output syndrome. A similar situation is observed in cases of excessive haemorrhaging, acute respiratory failure, and severe cognitive disorders in the form of delirium. The surgical procedure per se with prolonged aortic clamping, prolonged extracorporeal circulation, or necessary resternotomy can be the reason why not all ERACS guidelines are fulfilled. Moreover, poor organisation and management are also important. Poor adherence to the protocols of anaesthesia, weaning from mechanical ventilation, sedation, and pain management, as well as unintended hypothermia result in failures.

The preconditions of following the ERACS standard include anaesthesia enabling early extubation (≤ 6 h), adequate pain management, prophylaxis and therapy of nausea and vomiting, early mobilisation, and oral nutrition. The anaesthetics used are of key importance. They should be short acting and should not accumulate in the body. The optimal solution is combined anaesthesia (sevoflurane 0.8–1 MAC; propofol ≥ 3 mg/kg/h; fentanyl 5–15 μg/kg — cumulative dose; rocuronium 0.6–1.0 mg/kg for intubation, 0.075–0.15 maintenance dose) [36]. Such a protocol of anaesthesia was used in the group of patients undergoing cardiac surgical procedures aged > 75 years, and the duration of post-operative mechanical ventilation was shortened by over 10 h [37].

Intraoperative unintended hypothermia is the cause of impaired function of the immune system, prolongation of drug metabolism, coagulopathy, shivers, cognitive disorders, respiratory failure, and increased oxygen requirements — perioperative infarction. The optimal core temperature before completion of extracorporeal perfusion should oscillate around 36°C. The prophylaxis of hypothermia includes warming of patients and infusion fluids, and optimal temperature in the operating theatre.

A significant element of ERACS is the maintenance of normovolaemia in the perioperative period. The avant-garde preparation for surgery is to administer cooled down fluids until the evening of the day preceding the surgical procedure, and on the surgery day maintaining a 2-h withdrawal period before wheeling the patient to the operating room [38]. The objective is to maintain normovolaemia on admitting the patient to the operating suite [39]. The above protocol is in agreement with the guidelines of the American Society of Anaesthesiologists. Fasting since midnight on the day preceding surgery does not decrease the volume of gastric contents and does not increase the pH of gastric juice [40]. The administration of fluids with carbohydrates prevents thirst and hunger, reduces the level of anxiety, and additionally prevents insulin resistance in the postoperative period. The Polish market of medical products offers solutions of carbohydrates enriched with electrolytes, which fulfil the requirements for fluids administered in the preoperative period. Patients with concomitant diabetes mellitus are monitored for glycaemia. The patients prepared in the above-described way are hydrated, "feeded", and do not require intravenous fluids to correct volaemia after the induction of anaesthesia. Fluid requirements during anaesthesia are maintained by intravenous administration of balanced (i.e. with the composition comparable to that of plasma) crystalloids — 1–3 mL/kg cc/h. Restrictive or liberal fluid therapy is no longer considered. The maintenance of zero balance, i.e. fluid supplementation, is a more appropriate term. The transfusion of 0.9% NaCl causes hyperchloraemic acidosis, which induces shrinkage of renal arteries and slows down postoperative intestinal passage; therefore, it should be avoided. Postoperative hyperchloraemia is an independent factor of increased incidence of complications and mortality. It seems reasonable to monitor the concentration of chlorine in the perioperative period. Indications for administering 0.9% solution of NaCl in the postoperative ward is metabolic alkalosis, hyponatraemia, and hypercalcaemia. Synthetic colloids should be used for fluid challenge tests, i.e. to determine whether the patient is a fluid responder. This kind of management is clinically justified in cases of blood loss or objective features of hypovolaemia. However, it should be remembered that solutions of starch impair haemostasis and can induce kidney failure. Monitoring of cardiac output in response to fluids is an element of goal-directed therapy intended for high-risk patients [41]. Following this procedure, the fluid, 250–300 mL, should be administered in a period shorter than 10 min. In surgical procedures with entrance into the thorax, monitoring of dynamic parameters (pulse-pressure variation/stroke volume variation) is useless. The hour volume of urine excreted during surgery does not reflect the filling of the vascular bed. The hour diuresis below 0.5 mL/kg is not a risk factor of kidney failure. Intraoperative oliguria results from the release of stress hormones. It has been documented that fluid clearance during anaesthesia is only a small fraction of the value observed in conscious patients. Permissive oliguria can be tolerated during anaesthesia [42]. In the postoperative period, once liquid administration can be started, intravenous infusions of fluids should be immediately discontinued. To cover fluid demands, patients should receive 1.7 L of fluids per day.

The essential issue of the Polish medical situation is the fact that patients cannot be hospitalised postoperatively in places that are optimal for their conditions. Due to the ungrounded strategy of financing, lack of suitably configured patients' rooms, and inability to freely rotate the nursing personnel, patients cannot be smoothly transferred. The intensive care unit (ICU) is a ward characterised by 24-h continuous locomotion, and high levels of noise and light intensity. Stable, respiratorily efficient, and spontaneously breathing patients should be fully monitored, and should spend their first postoperative night in the ward, where the night and day rhythm is maintained. Such a ward should be prepared for non-invasive breathing support, diagnosis of possible complications, and quick transfer to ICU in emergency, life-threatening cases.

The treatment according to the ERACS philosophy requires standards of management, checklists known and used by the entire personnel involved in the therapy. One of the essentials of ERACS is effective pain management. The maximum intensity of pain is observed in the first two postoperative days. During the first postoperative day, the pain is located in the sternal and sacrolumbar region. Both men and women under 60 years of age are more susceptible to pain. The widespread opinion that older individuals have lower requirements for analgesics is a fallacy. The standard of postoperative pain management has to respect quick completion of IV morphine treatment. The optimal analgesic therapy with reduced parenteral opioids contributes to quicker mobilisation of patients. Patients should assume sitting positions already in the morning of the first postoperative day. Appropriate postoperative convalescence requires huge effort by the medical personnel. According to the regulation of the Minister of Health on ICU organisation, physiotherapists employed in ICUs at the highest referential level should work on a half-time basis, which does not help to carry out modern therapy [43].

Pre-convalescence, as opposed to convalescence, is focused on prevention of possible injuries. The entire sports world seems to be aimed at this. In the medical nomenclature, "pre-convalescence" denotes the use of various pre-emptive interventions before the surgical treatment. The interventions are to improve the patient's physical and mental condition, which consequently should reduce complications, shorten hospitalisation, and enable quick recovery to the pre-therapy condition [44]. This kind of management is complex and involves, exercise, diet, psychotherapy, and changes in life style (quitting smoking or excessive drinking). The inclusion of pre-convalescence to the ERACS programme is likely to limit the incidence of complications. From the organisational point of view, the issue is difficult but feasible.

Fleming et al. [35] published an analysis of a pilot group of patients who underwent surgical procedures for heart diseases carried out within the ERACS programme. The authors introduced a package of activities, which included the interventions mentioned in the present paper and additionally a single dose of oral gabapentin at a dose of 600 mg administered before surgery and lactulose in a daily dose of 15 mL from the first postoperative day until defecation. Their results suggest a real potential of the strategy applied to reduce the incidence of postoperative complications.

The issue of introducing changes into routine surgical treatment of heart diseases remains open for discussion. We do not usurp the right to decide about the form of the ERACS protocol implemented in patients undergoing cardiac surgery. Our aim is to spur the representatives of all medical disciplines involved in surgical treatment of heart diseases into action.

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