Anaesthesia IV

# Anaesthesia, surgery, and challenges in postoperative recovery

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**Surgical injury can be followed by pain, nausea, vomiting and ileus, stress-induced catabolism, impaired pulmonary function, increased cardiac demands, and risk of thromboembolism. These problems can lead to complications, need for treatment in hospital, postoperative fatigue, and delayed convalescence. Development of safe and short-acting anaesthetics, improved pain relief by early intervention with multimodal analgesia, and stress reduction by regional anaesthetic techniques, β-blockade, or glucocorticoids have provided important possibilities for enhanced recovery. When these techniques are combined with a change in perioperative care a pronounced enhancement of recovery and decrease in hospital stay can be achieved, even in major operations. The anaesthetist has an important role in facilitating early postoperative recovery by provision of minimally-invasive anaesthesia and pain relief, and by collaborating with surgeons, surgical nurses, and physiotherapists to reduce risk and pain.**

The specialty of anaesthesia has seen major advances thanks to the development of safer anaesthetic agents, improved knowledge of pain physiology and pain management, and incorporation of a better understanding of perioperative pathophysiology into perioperative care. Concomitantly, development of minimally invasive surgery has further reduced stress responses and pain, thereby providing potential for enhanced recovery. However, an increasing proportion of elderly patients with organ dysfunction has led to demands for further reductions in postoperative complications and the costs of treating them. The transition from inpatient surgery to ambulatory procedures has proceeded at a rate that was unthinkable a few decades ago, but could all surgical procedures ultimately be done on an outpatient basis? If not, why do patients need to be in hospital, and what prevents ambulatory surgery from being the norm?[1]

In recent years, several efforts have been made within the anaesthesiological and surgical professions to improve postoperative outcome and to reduce pain and risk.[1] However, such efforts have not always integrated knowledge existing within the two specialties, even though a multidisciplinary strategy seems obvious in view of the multifactorial pathogenesis of postoperative morbidity, treatment in hospital, and convalescence.[1]

The purpose of this review is to provide an update on perioperative pathophysiology and on the challenges for the anaesthetist in further improving postoperative recovery and to integrate these advances with developments in surgical care. We believe that further major improvements in perioperative care can only be achieved by a multidisciplinary collaboration within the context of fast-track surgery.[2] We do not discuss specific aspects of intensive care, trauma, or operations with specific problems, but focus instead on issues shared by most common operations.

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## Preoperative assessment and optimisation

Postoperative morbidity is related to preoperative comorbidity, and the anaesthetist (together with the surgeon) has to assess the risks before the operation and institute treatment to optimise the patient's condition thereby reducing postoperative complications.[3]

Additionally, psychological preparation of patients undergoing surgery has been shown to shorten hospital stay and to reduce the need for postoperative analgesics.[4] Carefully presented information from surgeons, anaesthetists, and nurses about the surgical procedure, anticipated sensory experiences, analgesic treatment, and the recovery period is expected to reduce anxiety and promote recovery.[1,4]

## Recovery and morbidity from general anaesthetics

The introduction of short-acting volatile anaesthetics (desflurane and sevoflurane), intravenous anaesthetics (propofol), and opioids (remifentanil) permits earlier recovery from anaesthesia. Comparisons between short-acting volatile anaesthetics and total intravenous anaesthetic techniques have not shown major clinically relevant differences in recovery profiles.[5,6] However, the occurrence of postoperative nausea and vomiting (PONV) during the first 6 h after surgery is reduced with propofol compared with volatile anaesthetics.[7,8] Furthermore, three meta-analyses have shown a reduction in PONV if nitrous oxide is omitted from a general anaesthetic,[9–11] but such an omission might increase the risk of awareness.[10] The newer short-acting anaesthetics have the potential to shorten the stay in the recovery unit and reduce costs.[12]

### Search strategy

Due to the many aspects of perioperative care covered in the review a formal literature search was not done. We based the review on work published mostly within the past 5 years from the major anaesthesiological, surgical, and pain journals, and systematic and Cochrane Reviews where appropriate. Recent review articles that provided comprehensive overviews were included where appropriate instead of multiple references of original work.

## Prevention of surgical stress and postoperative organ dysfunction

Surgical injury induces a complex and orchestrated stress response characterised by profound endocrine-metabolic changes with hypermetabolism and catabolism, as well as an inflammatory response with activation of humoral cascade systems leading to malaise, hyperthermia, and immunosuppression.[13] This stress response to surgery puts the patient at risk, especially if organ functions were already impaired before the operation. Modern anaesthetic and surgical care aims to reduce surgical stress responses, although the best way to modify such a natural evolutionary response has not been found.[13]

Various techniques are available to reduce the surgical stress responses (figure 1), several of which can be used by the anaesthetist. Prevention of intraoperative hypothermia reduces cardiac morbidity, bleeding, and infectious complications.[1,14] High inspired fraction of oxygen (80%) reduces the risk of wound infection after colorectal surgery, compared with 30% oxygen.[15] Most importantly, blockade of afferent neural stimuli from the surgical area by infiltration anaesthesia, peripheral nerve blocks, and spinal or epidural anaesthesia in major operations reduces endocrine-metabolic responses but not inflammation.[16] By contrast, opioids, non-specific anti-inflammatory drugs (NSAIDs), and other commonly used analgesics have little or no stress-reducing effect when used in recommended dosages.[16] The metabolic effects of afferent blockade with local anaesthetics are further enhanced if the block is maintained postoperatively for pain treatment.[16] Central neuraxial blockade has been shown to reduce morbidity (cardiac, pulmonary, thromboembolic) and mortality by 30–50% in lower-body procedures.[17] However, the effects of continuous epidural analgesia as a single intervention in major operations are still uncertain,[18–21] probably because overall perioperative care was not adjusted to take advantage of the beneficial physiological effects of the continuous postoperative epidural analgesia.

Other ways to reduce surgical stress include glucocorticoids given as a single dose preoperatively.[22] Such treatment has been shown to reduce PONV, pain, and pulmonary dysfunction, apparently without side-effects.[22] Administration of β blockers to reduce sympathetic stimulation of the heart has improved cardiac outcome in several randomised trials,[23] and has been recommended as a routine treatment for patients at cardiac risk.[23] β blockers might also have beneficial metabolic effects, since they reduce injury-induced catabolism in patients with burns.[24] The use of anabolic agents such as growth hormone and insulin leads to reduced catabolism, but other clinical benefits remain to be shown.[13,25] Provision of nutrients also reduces catabolism, and the use of specific substrates such as omega-3-fatty-acids and glutamine may provide additional benefits in high-risk patients,[25] although further data are needed in patients at moderate risk. Preoperative administration of carbohydrate might reduce postoperative catabolism,[26] but other clinical benefits for recovery remain to be explored. However, it is rational to avoid starvation-related sequelae to surgical injury by providing carbohydrates before the operation.[26]

Minimally invasive surgery also reduces surgical stress via inflammatory responses but endocrine-metabolic responses are less affected.[27,28] The choice of incision could have implications for postoperative pain and organ function; abdominal horizontal incisions including only a few nerve segments lead to reduced pain and pulmonary dysfunction compared with longitudinal incisions.[29]

## Prevention and treatment of pain

The alleviation of postoperative pain is central to the role of the anaesthetist, and can include interventional as well as pharmacological techniques—provided before, during, and after surgery. Pain treatment should also reduce anxiety and provide subjective comfort. Furthermore, effective analgesia might help to blunt autonomic and somatic reflex responses and thus restore organ functions and enable mobilisation and food intake, thereby helping to improve postoperative outcome.

In the past few years, much knowledge has been systematically gathered on effects and side-effects of postoperative analgesic techniques. We do not intend to review all evidence, but only some key topics.

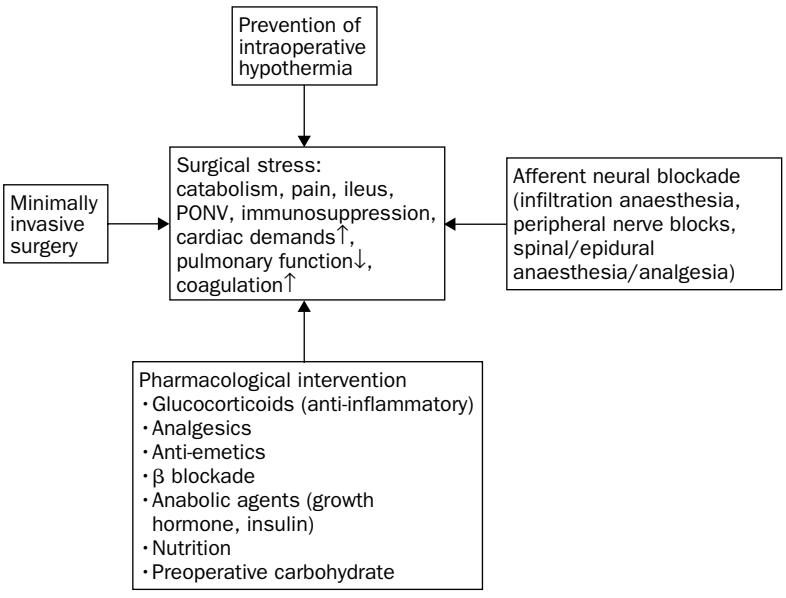


Figure 1: **Measures to investigate surgical stress responses and organ dysfunction**

### Pre-emptive analgesia

Laboratory studies suggest that prevention of pain and the neurophysiological and biochemical consequences of a noxious input to the CNS might be preferable to treatment of pain when these consequences are already established.[4] However, a systematic review, including an analysis of more than 80 randomised controlled clinical trials, showed that the timing of analgesia did not affect postoperative pain control, whatever the type of pre-emptive analgesia.[30]

This conclusion does not rule out a possible beneficial effect of aggressive, continuous perioperative analgesia on pain after surgery, because most studies of pre-emptive analgesia have used short-term interventions, which might be insufficient to prevent subsequent development of central pain hypersensitivity.[30] Finally, pain treatment should be initiated early to ensure a pain-free emergence from anaesthesia. The concept of pre-emptive analgesia therefore remains an important research topic, despite initial negative clinical studies.

### Opioids

Opioid analgesics are often given routinely despite their well-known side-effects. Administration of these drugs by patient-controlled analgesia, epidural, or continuous intravenous methods might allow lower total doses and fewer side-effects compared with traditional administration on request.[31] Use of opioids may be restricted to situations where suitable alternatives are not available.[32,33] The gastrointestinal side-effects of opioids mean that these drugs are less than ideal after abdominal surgery and should possibly only be allowed when non-opioid drugs provide insufficient analgesia.[32,33] Also, in ambulatory procedures long-acting opioids may retard recovery and discharge.[32,33] In major operations, patient-controlled opioid analgesia does not reduce postoperative morbidity and hospital stay, compared with traditional intermittent opioids on request.[31]

### Paracetamol, NSAIDs, and COX-2 inhibitors

Paracetamol,[34,35] NSAIDs,[33,36] and cyclo-oxygenase (COX)-2 inhibitors[37–39] have been robustly documented as effective for postoperative analgesia, with few side-effects during short-term treatment. The analgesic effect of paracetamol is possibly weaker (20–30%) than that of NSAIDs and COX-2 inhibitors,[34,35] but the drug has almost no side-effects at recommended doses.[34,35] By contrast, the potential side-effects of conventional NSAIDs (gastrointestinal and surgical-site haemorrhage, renal failure) could restrict their usefulness in high-risk patients (those with pre-existing gastric ulceration or renal dysfunction)[33] or operative procedures (tonsillectomy,[40] cosmetic surgery, and eye surgery, and immediately after administration of heparin during cardiovascular procedures). Recent evidence suggests that conventional NSAIDs could be replaced by COX-2 inhibitors in some situations where short-term treatment is indicated.[38] COX-2 inhibitors seem to have similar analgesic potency but a better safety profile than NSAIDs with respect to the gastrointestinal tract[41] and platelet function,[42] but their effect on renal function is unclear.[38] Consequently, the indications for this class of drugs may be broadened in the future to include patients for whom conventional NSAIDs are contraindicated.

### Epidural local anaesthetics

Epidural local anaesthetics result in effective pain relief and improved gastrointestinal function compared with opioid-based analgesia after abdominal surgery.[43,44] Addition of opioids to epidural local anaesthetics relieves pain more effectively than local anaesthetics alone.[43] However, the potential deleterious effects of even small doses of epidural opioids on gastrointestinal motility have not been clarified, although an ileus-reducing effect can be maintained by the combination of local anaesthetics and opioids.[43,44] Results from major prospective and retrospective studies have shown that postoperative epidural infusions are safe and effective, and can be managed readily in general postsurgical wards with few complications, provided that patients are observed systematically by staff who are competent to detect possible problems.[45,46] Continuous balanced low-dose epidural analgesia is therefore recommended for pain treatment in major surgery, and is a prerequisite for enhanced recovery in such procedures (see below).

### Incisional and intraperitoneal local anaesthetics

Administration of local anaesthetic in the surgical wound is effective after minor surgical procedures (eg herniotomy), but has not been shown to be effective after major surgery.[47] The effect of continuous wound infusion with local anaesthetic shows promise, but is still controversial.[48] Intraperitoneal application of local anaesthetics has only a short-lasting and weak analgesic effect after laparoscopic procedures.[49]

### Peripheral nerve blocks

Peripheral nerve blocks provide excellent pain relief after several orthopaedic procedures, and preliminary studies suggest that continuous infusion of local anaesthetics for peripheral nerve blockade is very efficient and safe, even in outpatients.[50,51]

### Other drugs and techniques

Many other methods have been investigated or reviewed in recent years: transcutaneous electrical nervous stimulation,[52] intra-articular opioids,[53] intrathecal opioids,[54] clonidine,[55] neostigmine,[56] N-methyl-D-aspartate (NMDA)-receptor antagonists (ketamine and dextromethorphan),[57,58] and gabapentin.[59,60] However, only intrathecal opioids (in moderate-sized procedures) and to some extent intra-articular opioids have found a place for common use outside centres with special interest in pain. In particular, recent interest has focused on various antihyperalgesic drugs, since experimental evidence suggests that sensitisation and hyperalgesia of the peripheral and central nervous system plays a major role in postoperative pain.[4,61] The mechanism of action of antihyperalgesic drugs differs from that of classic analgesics, since they have no effect on the nociceptive input, but reduce the injury-induced hyperexcitability of the CNS.[4,61] Hence, NMDA-receptor antagonists and other antihyperalgesics are expected to present their effects only after tissue damage, for example surgery, where the surgical injury has induced hyperexcitability of dorsal horn neurons.

Ketamine and dextromethorphan are both well-known NMDA-receptor antagonists, and both have shown some analgesic or antihyperalgesic potential in clinical trials of postoperative pain.[57,58] The anticonvulsant gabapentin is widely used for treatment of chronic pain, but despite intensive investigation, the molecular mechanism of action remains unsettled. Experimental studies have shown

Panel 1: **The process of postoperative recovery**

**Preoperative period**
Preoperative assessment
Preoperative optimisation

**Perioperative period**
Anaesthesia
Surgery
Organ dysfunction

**Early postoperative period**
Surgical stress response
Pain
Nausea, vomiting, ileus
Fluid management
Mobilisation
Nutrition
Fatigue and sleep disturbances

**Late postoperative period**
Pain
Fatigue and sleep disturbances
Convalescence

All stages can be improved by interventions from the anaesthetist (except surgery) and the surgeon (except anaesthesia).

antihyperalgesic effects of gabapentin in animal models involving central neuronal sensitisation, without affecting acute pain transmission. Results of two recent clinical trials showed that gabapentin relieved pain and reduced the need for opiods in patients with acute postoperative pain.[59,60]

### Multimodal analgesia

Pain in the perioperative period represents operation of several nociceptive mechanisms. These include encoding of nociceptive stimuli at the surgical wound, injury-induced inflammation and sensitisation of peripheral somatic and visceral nociceptive nerve terminals and central neurons, and loss of local and descending inhibition of neurons in the brainstem and spinal cord.[4] A rational approach to the treatment of postoperative pain is therefore to combine different treatment modalities, working at different pain mechanisms, in order to improve analgesia and potentially, to reduce side-effects.[62,63,64] So far, the combinations of epidural local anaesthetics plus opioids, opioids and NSAIDs, and paracetamol and NSAIDs have been shown to improve analgesia in several randomised studies.[34,35,62–64] Although positive results have been achieved by combination with other analgesics (ketamine, clonidine, tramadol, etc) more information is needed about different combinations to define the best analgesic technique in individual procedures.

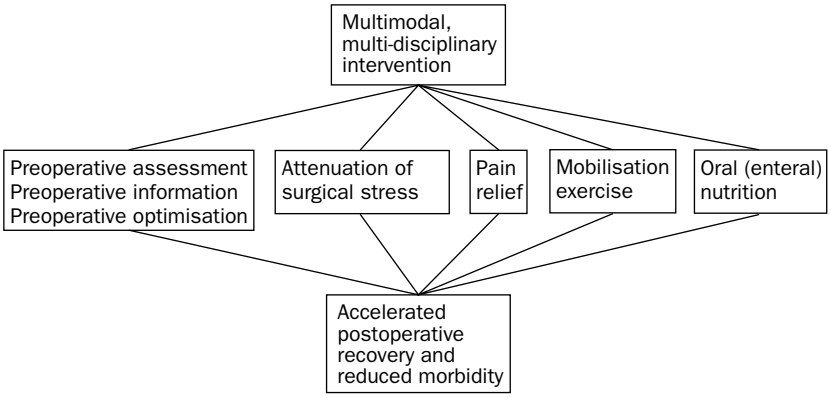


Figure 2: **Multimodal concept of early postoperative rehabilitation**
Modified from reference 1.

## Fluid management

Replacement of appropriate amounts of fluid is obviously important when normal intake is prohibited, and also has a role in preoperative optimisation of cardiovascular function. Postoperative fluid management has varied from "wet" to "dry" regimens, but evidence-based procedure-specific regimens for fluid administration are not available.[65] For minor procedures, preoperative and intraoperative administration of 1–1·5 L fluid is important to enhance recovery by compensating for preoperative dehydration.[66] In major procedures, administration of excess fluid can increase the risk of cardiac and pulmonary complications, prolong duration of ileus, and probably contribute to thromboembolic complications.[65,67] Perioperative management of fluids is therefore a major task for the anaesthetist, in collaboration with the surgeon. Administration of large amounts of fluid to treat hypotension during sympathetic blockade with regional anaesthesia should be avoided and managed by sympatomimetics instead.[65]

## PONV and ileus

Anaesthetists can enhance recovery by administering effective anti-emetics such as serotonin antagonists, glucocorticoids, and droperidol,[22,68–70] and combination therapy can further improve the effects. Additionally, provision of opioid-free or opioid-reduced anaesthesia and analgesia can facilitate recovery by reducing PONV.

Postoperative ileus is a paradoxical response to abdominal surgery, which can increase patients' discomfort and delay recovery and nutritional intake. So far, a useful purpose of postoperative paralytic ileus has not been found,[44] and since early enteral nutrition has been shown to reduce postoperative morbidity[71] every effort should be made to reduce ileus to allow early normal oral intake. The pathogenic factors of ileus include inhibitory sympathetic reflexes initiated from the site of injury, local intestinal inflammatory responses, and opioids.[44] The anaesthetist can help to alleviate ileus by provision of opioid-reduced analgesia,[33,44] administration of peripheral opioid antagonists,[72] and, most importantly, provision of continuous epidural local anaesthetic analgesia, which effectively reduces ileus.[43,44] The surgeon can also contribute with minimally invasive (laparoscopic) surgery, which reduces duration of ileus.[44]

### Other perioperative care principles

Modern perioperative care often includes a high degree of monitoring, with the use of nasogastric tubes, drains, catheters, etc. Although such techniques may be indicated in specific procedures, their routine use should be adjusted in view of data suggesting that nasogastric tubes should not be used routinely in most elective procedures, and drains in only a few operations.[1] Similarly, the use of bladder catheters should be reconsidered and investigated further, since prolonged use may contribute to morbidity.[1] Revision of common perioperative care principles could have important implications for early recovery, since in the past such routines have often been based on traditions without scientific evidence.[1]

## Fatigue and convalescence

Major operations are commonly followed by fatigue and convalescence. The pathogenesis of early postoperative fatigue can include sleep disturbances induced by cytokines and opioids in the early period,[1,73] while the late fatigue persisting for up to several weeks can depend on loss of muscle tissue and function and deconditioning of cardiovascular response to exercise,[1,73] as well as level of preoperative fatigue.[74] Strategies that can reduce postoperative fatigue include a combined anaesthetic and surgical effort to reduce inflammatory responses (minimally invasive surgery, steroids, and opioid-reduced anaesthesia and analgesia) as well as techniques to reduce catabolism (regional anaesthetic techniques, dynamic pain relief, and early oral nutrition and mobilisation). Convalescence is dependent on pain, fatigue, and traditional recommendations of a long convalescence period,[1,75,76] and the anaesthetist can therefore have an important role by providing the best anaesthetic and analgesic treatment. Reduction of the convalescence period is also highly dependent on advice from surgeons and general practitioners, but in the past such information has mostly been restrictive and based on traditions.[75] Short convalescence recommendations are followed by a pronounced reduction in duration of convalescence without compromising safety.[76,77]

## Combined anaesthetic and surgical care to improve outcome

Advances in our understanding of perioperative pathophysiology and care suggest that several factors contribute to postoperative morbidity, length of hospital stay, and convalescence (figure 1, panel 1). Subsequently, the concept of accelerated postoperative recovery programmes, or fast-track surgery, has been developed, which involves a coordinated effort to combine preoperative education of patients, preoperative optimisation, attenuation of surgical stress, optimised dynamic pain relief, and enforced mobilisation and oral (enteral) nutritional support (figure 2).[1,2] The concept also includes an up-to-date approach for use of general principles of postoperative care (eg tubes, drains, catheters, monitoring, and rehabilitation recommendations) and takes into account the revisions of traditional practise indicated by current scientific data.[1,2] These measures are intended to shorten the time needed for full recovery.[1,2] Although the same principles have already been introduced within ambulatory surgery in minor procedures, the concept is expected to have its largest effect on care in major operations and in patients at high risk. The primary aim is to improve surgical management by reducing complications and providing better outcomes, and, if successful, subsequently to improve the cost-effectiveness of perioperative care.

So far, most outcome data come from non-randomised studies from single institutions, but a few randomised studies have also been done.[1,2] The multimodal approach to enhance postoperative recovery seems very promising, and some examples are presented in the table.

### Perioperative care and the role of the anaesthetist

The basic needs in a successful fast-track rehabilitation programme are provision of anaesthetic agents that allow quick recovery of vital organ functions[1,12,105] and provide stress-reducing effects to alleviate or prevent organ dysfunction after major procedures.[1,13] A concept of minimally invasive anaesthesia, similar to that of minimally invasive surgery, might be desirable. Such a programme consists of combined use of short-acting general anaesthetics, neuromuscular blocking agents only if necessary, minimally invasive monitoring and airway handling, multimodal systemic analgesic and anti-emetic therapy, and local anaesthetic neural blockade to enhance recovery.

Provision of effective dynamic pain-relief is a prerequisite for enhanced recovery, again emphasising the important role of the anaesthetist. Additionally, a multidisciplinary collaboration between the anaesthetist, the surgeon, the physiotherapist, and the surgical nurse must be established to obtain a successful recovery programme. In this context, education of the patient and preoperative optimisation of organ functions are essential. Finally, the individual constituent elements need to be integrated (figure 1, panel 1) to take full advantage of the scientific and clinical advances made within each specialty.[1]

Successful accelerated recovery programmes (table)[1,2] need a detailed care map, including an outline of postoperative nursing care.[105] Such care maps should include sections where the occurrence of factors or events that could preclude early recovery and discharge are recorded, to facilitate interpretation of the care maps and to provide data for future areas that need development. In this context, the anaesthetic and surgical professionals need to understand the potential that each can have to enhance recovery. An example might be the tolerance needed from the surgeons for the short extra time it may take to establish sufficient epidural anaesthesia and analgesia. However, the anaesthetist's work will have little effect on overall morbidity[18–21] unless the surgeons understand the potential for epidural analgesia to enhance postoperative recovery, and change postoperative care accordingly to fully obtain the beneficial effects.[1,16]

| Type of surgery | Postoperative hospital stay | Comments |
|---|---|---|
| Inguinal hernia repair[78,79] | 1·5–6 h | Large consecutive series (n=1000–3000) using local infiltration anaesthesia in >95%, documented low morbidity with unmonitored[79] or monitored[78] anaesthesia with no urinary retention, cost reduction >US$250 with local anaesthesia, patient satisfaction about 90%, series include repair of recurrent hernia.[79] |
| Cholecystectomy[77,80–83] | Same-day discharge in >80% | Large consecutive series with documented safety and high patient satisfaction, large cost reduction compared with non-ambulatory setup,[81] similar results with open mini-incision surgery?[83] Physical activity, fatigue, and pain returned to normal after 2 days.[77] |
| Hysteroscopy[84] | Outpatient | Day-case hysteroscopy with faster recovery than day-case setup, similar satisfaction. |
| Hysterectomy[85,86] | Ambulatory (vaginal hysterectomy) 2 days (abdominal hysterectomy) | Laparoscopic or standard vaginal hysterectomy with 12-h stay,[85] open transabdominal hysterectomy with epidural analgesia, early oral feeding and mobilisation at 2 days.[86] |
| Colonic resection[87–90] | 2–3 days | Consecutive series including high-risk patients show normal gastrointestinal function at <48 h in 90% of patients[87] with improved postoperative body composition, pulmonary function, and cardiovascular response to exercise.[88] Similar results with open and laparoscopic procedures,[89,90] continuous epidural analgesia and early oral feeding and mobilisation with no use of nasogastric tubes. |
| Colostomy closure after Hartmann's procedure[91] | 2–3 days | Open surgery, epidural analgesia, and early oral feeding and mobilisation. |
| Complex pelvic colorectal procedures[92] | 3–6 days | Results achieved without epidural analgesia and with preoperative stoma care education, low readmission rate (7%). |
| Rectal prolapse[93] | <24 h in 80% | Consecutive series (n=63) with Altemeier repair, safety documented. |
| Pulmonary resection[94] | About 1 day | Fast-track protocol with cryoanalgesia, reduced opioids, and revision of drainage principles (n=65) |
| Radical prostatectomy[95] | 1 day in 75% | Epidural analgesia, reduced opioids, large consecutive series (n=252), documented safety and patient satisfaction. |
| Donor nephrectomy[96,97] | 1–2 days | Shortest stay (23 h) with laparoscopic approach,[96] and 2 days with open surgery and opioid-reduced analgesia.[97] |
| Abdominal aortic aneurysmectomy[98] | 3 days | Consecutive series (n=50) with revised criteria for intensive care stay, epidural analgesia not used. |
| Mastectomy[99–102] | <1 day in 90% | Large cumulative series with documented safety, patient satisfaction, and cost reduction, improved pain relief with paravertebral blockade.[100] |
| Craniotomy[103] | <24 h in about 40% | Consecutive series (n=240), use of local anaesthesia, includes tumour surgery, low readmission rate and safety suggested. |
| Parathyroid surgery[104] | 90% ambulatory | Consecutive series (n=100) with regional anaesthesia and intraoperative adenoma localisation, safety documented. |

**Results from selected fast-track surgical programmes**

Panel 2: **Future directions and strategies for anaesthetists to enhance postoperative recovery**

- Preoperative information, risk assessment, and optimisation
- Minimally invasive anaesthesia
- Pharmacological reduction of surgical stress
- Opioid-free, multimodal analgesia
- Block transition from acute to chronic pain
- Multidisciplinary collaboration with procedure-specific management protocols
- Implementation of evidence-based care principles
- Assessment of economic implications of postdischarge symptoms
- Logistics, planning, co-ordination, responsibility shared between anaesthetists and surgeons in perioperative medicine

### What outcomes should be measured after anaesthesia?

In the past, anaesthetists have mostly focused on assessment of anaesthetic-related complications and traditional measures of postoperative morbidity and hospital stay. Because of cost constraints in modern health care, there is now also demand for assessment of other outcomes such as need for stay in the recovery room, anticipated admissions to intensive care units, readmissions after discharge, patients' expectations, and costs of care.[12,105,107] Additionally, a more detailed assessment of the quality of recovery provided by anaesthetic (and surgical) care may be needed in accelerated recovery programmes.[1,2] PONV, pain, awareness, patients' satisfaction, and quality of recovery after anaesthesia are relevant outcomes; valid and reliable questionnaires to measure quality of recovery after anaesthesia are available[105,108,109] and should be used in accelerated recovery programmes. Also, simple measures such as the 6-min walking test and validated quality of life scores (SF-36) have been used successfully to show advantages of epidural anaesthesia after colonic surgery compared with patient-controlled opioid analgesia.[110] The use of computerised monitoring to automatically assess ambulation and sleep[111] is a simple way to monitor outcomes and has been used to show early recovery after laparoscopic cholecystectomy[77] in conjunction with assessment of pain, PONV, and fatigue. Finally, assessment of individual organ functions, such as body composition, oxygenation, mobilisation, and cardiovascular response to exercise might be clinically relevant outcomes.[88]

Procedure-specific anaesthetic regimens are needed, since each operation may have specific problems that require specific interventions to enhance recovery. Finally, the effects of anaesthetic and analgesic techniques on postdischarge outcomes such as fatigue, sleep disturbances, convalescence, and persisting pain[112] need to be assessed, along with the potential risk that early discharge could increase the burden on general practitioners or other aspects of the non-hospital health-care system because of persistent problems. The available data from fast-track surgery have so far not shown an increase in use of health services after discharge, in line with the hypothesis that accelerated recovery programmes should alleviate the complaints and organ dysfunctions noted in traditional practice.[1,2]

## Future directions

The forthcoming years will, as before, pose several challenges for anaesthetists to improve perioperative care and to take part in the multidisciplinary collaboration of fast-track surgery (panel 2). Thus, the anaesthetist will have a major role in the improvement of postoperative outcome, thanks to the expertise within the specialty in anaesthesia and analgesia, pathophysiology of perioperative organ dysfunctions, respiratory care, fluid management, and other supportive treatment.[113] It has been proposed that "anaesthetists should take the lead in studying the impact of post-discharge symptoms and advocating for our patients best care, even if it involves care beyond our traditional period of involvement".[113] However, anaesthetists should consider the development of "perioperative medicine" as a multidisciplinary effort that should not involve conflict between the anaesthetic and surgical specialities, but rather serve as a mutual platform for improvement of peri-operative care.[114] A more specific task is the need to optimise perioperative pain management[115,116] with improvement of multimodal analgesic regimens and integration of acute pain services into perioperative rehabilitation, since the overall effects of acute pain services on postoperative outcome have previously been rather restricted.[117] Preventive methods to avoid the transition from acute postoperative pain to chronic persistent pain[112] are also needed. Finally, the anaesthetist will have an important role in the progress of stress-free anaesthesia and surgery by further development of minimally invasive anaesthetic techniques and pharmacological modification of stress responses.

*Conflict of interest statement*

H Kehlet is serving as a consultant for Pharmacia, Pfizer, and GlaxoSmithKline, and J Dahl as a consultant for Pfizer.

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