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# Operating Room Efficiency and Postoperative Recovery after Major Abdominal Surgery

*The Surgical Team's Efficiency and the Early  
Postoperative Recovery of Patients with Peritoneal  
Carcinomatosis*

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## **Abstract**

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In selected patients, surgical treatments such as cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC) have enabled curative treatment options for previously incurable diseases, such as peritoneal carcinomatosis (PC). The introduction of resource demanding surgery could affect the work process, efficiency, and productivity within a surgical department and factors influencing patient postoperative recovery processes may have an impact on the efficiency of patient care after major surgery.

The aim of this thesis was to investigate operating room efficiency from the perspective of both staff and leaders' in two different settings (Papers I and II) and the early postoperative recovery of patients with peritoneal carcinomatosis (Papers III and IV).

Interviews were held with 21 people in a county hospital and 11 members of the PC team in a university hospital, and a phenomenographic approach was used to analysis the data (Papers I and II). The patients' postoperative recovery and pulmonary adverse events (AE) were determined from data retrieved from the electronic health records of 76 patients (Papers III and IV).

The concept of efficiency was understood in different ways by staff members and their leaders (Paper I). However, when working in a team, the team members had both organisation-oriented and individual-oriented understanding of efficiency at work that focused on the patients and the quality of care (Paper II).

The patients with PC regained gastrointestinal functions and could be mobilised during early postoperative recovery phase, although many patients suffered from psychological disturbances, sleep deprivation, and nausea (Paper III). Postoperative clinical and radiological pulmonary AE were common, but did not affect the early recovery process (Paper IV).

In conclusion, leaders who are aware of the variation in understanding the concept of efficiency are better able to create the same platform for staff members by defining the concept of efficiency within the organisation. In a team organisation, the team members have a wider understanding of the concept of efficiency with more focus on the patients. The factors affecting postoperative recovery and pulmonary AE should be considered when designing individualised patient care plans in order to attain a more efficient recovery.

**Keywords:** efficiency, operating room, postoperative recovery, peritoneal carcinomatosis, cytoreductive surgery, HIPEC

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*To Vahagn and Mher for sharing my life and  
to my mother and father for your unconditional love and support*

“Efficiency is doing better what is already being done.”  
Peter F. Drucker

# List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

- I     Arakelian E, Gunningberg L, Larsson J. Job satisfaction or production? Variation in how staff and leadership understand operating room efficiency: a qualitative study. *Acta Anaesthesiol Scand*. 2008; 52:1423-28.
- II    Arakelian E, Gunningberg L, Larsson J. How operating room efficiency is understood in a surgical team: a qualitative study. *Int J Qual Health Care*. 2011; 23:100-6.
- III   Arakelian E, Gunningberg L, Larsson J, Norlén K, Mahteme H. Factors influencing early postoperative recovery after cytoreductive surgery and hyperthermic intraperitoneal chemotherapy *Eur J Surg Oncol*. 2011; 37:897-903.
- IV    Arakelian E, Torkzad M, Bergman N, Rubertsson S, Mahteme H. Pulmonary influences on early postoperative recovery in patients after cytoreductive surgery and hyperthermic intraperitoneal chemotherapy treatment. (Submitted).

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# Abbreviations

AE	Adverse Event
ASA	American Society of Anaesthesiologists' physical status classification system
CC score	Completeness of Cytoreduction Score
CPAP	Continuous Positive Airway Pressure
CRC	Colorectal Cancer
CRS	Cytoreductive Surgery
EHR	Electronic Health Record
HIPEC	Hyperthermic Intra Peritoneal Chemotherapy
OR	Operating Room
MAM	Malignant Abdominal Mesothelioma
MMC	Mitomycin C
NA	Nurse Anaesthetist
PC	Peritoneal Carcinomatosis
PCI	Peritoneal Cancer Index
PEF	Peak Expiratory Flow
PMP	Pseudomyxoma Peritonei
RN	Registered Nurse



# Introduction

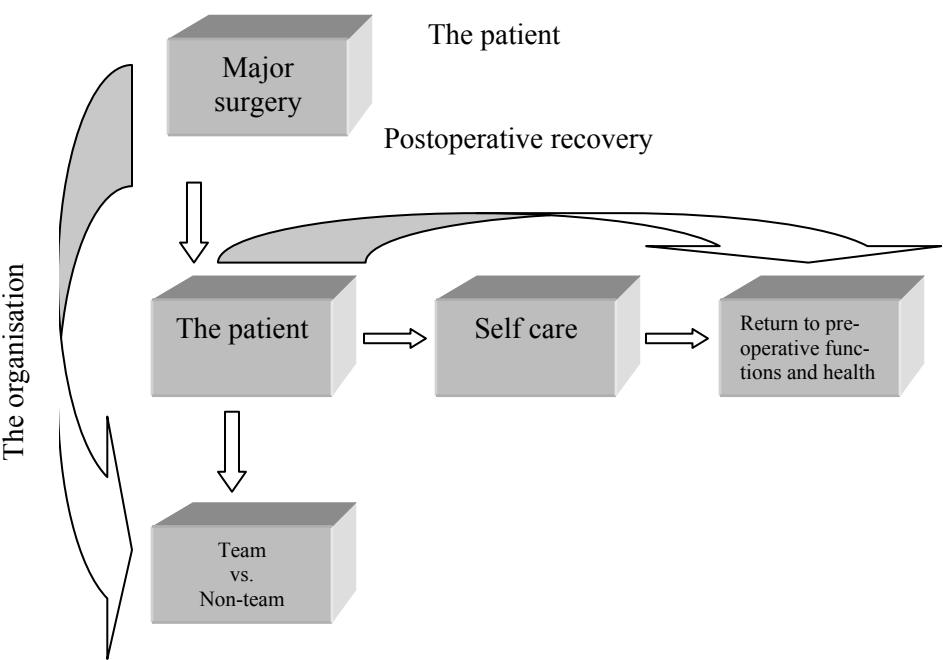
The development of new surgical techniques has given rise to new treatments for previously incurable diseases, such as peritoneal carcinomatosis (PC). The objective of current PC treatment is treated with a curative treatment, and this is achieved by complex, and time and resource consuming procedure called cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC); however, there are high rates of postoperative morbidity (1, 2). The introduction of this resource demanding (3) and extensive surgery could have an impact on the surgical department's work process, efficiency and productivity, and factors influencing the patient's postoperative recovery process may affect the efficiency of patient care after this major surgery.

In hospitals, surgical departments are accountable for a majority of hospital costs and production (4). This in turn has resulted in surgical departments struggling to find a balance between important issues: treating complicated, time consuming and resource demanding diseases, and reducing costs, while maintaining quality of care for the patients (5-7). Efficiency and productivity play a central role in managing surgical departments and with increased hospital costs, staff members constantly strive to create efficient ways of planning and processing work.

Surgical departments make continuing efforts to provide efficient patient care while preserving the quality of the care. These efforts include building multi-professional teams (8, 9) and implementing practices such as lean health care (10, 11), involving the patients in their own care (12, 13), and early discharge (14, 15). However, the concept of efficiency is defined in several different ways (16-19), and is sometimes used as a synonym for productivity (20-24). In health care, there is no common understanding of the concept of efficiency, which may constitute an unidentified obstacle to leaders' efforts for promoting efficiency. Leaders urging staff to work efficiently may sometimes face strong reactions from staff members, who consider demands for increased efficiency simply mean more stress at work.

Efficient care and the patient's role in health care are regulated in Swedish health legislation (25, 26). Laws and regulations from the Swedish National Board of Health and Welfare emphasise leadership should fulfil the demands of patient safety and quality, and work based on knowledge towards an efficient care process offering patient-focussed care within a reasonable amount of time (26). Furthermore, the foundation of health care is good communication between health care professionals and the patient, integrity, and the involvement of the patient in decision-making (25).

In this thesis, efficiency is studied from two perspectives: organisational efficiency through staff and their leaders' understanding of efficiency, and from patients' postoperative recovery (Figure 1).



*Figure 1. The two perspectives through which efficiency was studied in this thesis: the organisation and the patient.*

# Background

## The concept of efficiency

The word “efficiency” is derived from the Latin word ‘efficio’ meaning ‘to generate’ or ‘to create or produce’ (27). Efficiency can be defined in several ways, and is sometimes used as a synonym for ‘effectiveness’ and ‘productivity’. Efficiency means ‘doing things the right way’ and focuses on the work process, whereas, ‘effectiveness’ is ‘doing the right things’, which focuses on the end goal. Efficiency is achieved through mass training of the same task and reflection on how resources can be used: effectiveness is attained by re-thinking and thinking in new ways, as changes occur during work (28, 29).

Some authors (16, 17, 27) suggest the concept of efficiency consists of both productivity, which means doing things the right way, and quality. The connection between efficiency and productivity can be described as ‘the relationship between resources and production. Thus, efficiency is important for both short-term and long-term effects, whereas, productivity is a comparison of production per time unit. Efficiency is used in a long-term perspective, and is dependant on the complexity of the task (27).

However, efficiency in health care cannot be considered solely as a single item without considering the aspect of cost-efficiency (19). In health economics, ‘efficiency’ refers to obtaining the maximum benefit from the resources available (18, 30, 31). Some economists claim the meaning of the word ‘efficiency’ has changed. Earlier, it meant, ‘producing an effect’, whereas, now the meaning is ‘producing with the least waste of resources and the minimum of effort’ (18, 19). In Swedish, the same word, ‘effektivitet’, is usually used to describe both efficiency and effectiveness.

As there are different definitions of efficiency, this raises the questions of what has influenced the evolution of the different definitions of efficiency, and how efficiency is understood in ‘real- life’ settings in a surgical department.

## Efficient organisations according to management theories from Taylor to Lean Production

In the early 20<sup>th</sup> century, Frederick Taylor developed the Scientific Management Theory. A functional organisation aims to achieve the fastest way of working with staff that has the 'right' competence and qualifications in the 'right place'. The work process is supervised by leaders and the production process is standardised and managed by the staff (32). Max Weber later laid the foundation of bureaucratic organisational principles, where the leaders' position is strengthened as they become responsible for decision making; this leads to centralisation of power. Henri Fayol also believed in a bureaucratic organisation that separated management from the production units, including staff. In this case, efficiency is increased by specialisation of staff members in their tasks (32).

Discontent among staff members due to poor working conditions prompted human relations studies, led by Professor Elton Mayo between 1924 and 1932, into acknowledging staff members need for recognition or being part of a group, which increased job satisfaction and motivation. A new theory, the human relations theory, was established, which underlined the mutual relationship between efficiency and profitability of an organisation and staff members' quality of work. High job satisfaction is beneficial for both the organisation itself and the staff members (32). Decentralisation of power transfers the sense of corporate responsibility to staff members across the organisation, leading them into a closer relationship with their customers (32).

Another method of making the work process efficient while maintaining quality is lean production. Lean production originated from the Toyota Production System (TPS), designed by Sakichi Toyoda, the founder of Toyota, and his son after studying what did not work for W. Edward Deming and Henry Ford, with a goal of producing precisely the quantity needed, with the highest level of quality, when the customer wanted it. The customer plays a central role, and meeting customer needs is essential (33). The main difference between traditional and lean production management is that lean production managers empower staff members so they can actively solve problems arising during the work process. This transfer of responsibility stimulates staff members into being more efficient. Lean organisations encourage improvement in the work process and learning from it (34).

In health care, lean production is used for improving quality of care with minimum costs, and to deliver what the patients need just in time. In surgical settings, another step towards working with lean production has been taken. Multi-professional teams work with a limited number of diagnoses, which

may speed up the work process and make the course of care safer for the patients (35, 36). The team have the responsibility for deciding 'how to work and achieve goals' in order to reduce the steps in the care chain that have little or no value for the patients. Thus, team members are involved in creating a smooth patient flow, reducing patient waiting time, and improving the quality of timely care (33, 34, 36, 37).

## The Peritoneal Carcinomatosis (PC) team's work procedure

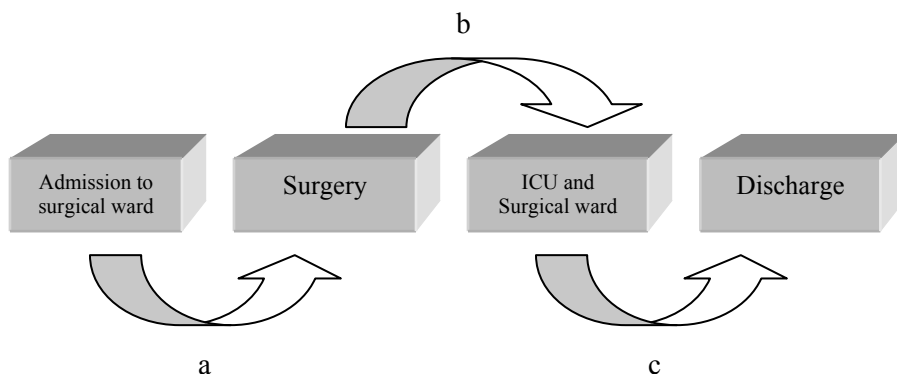
The PC team of the Main surgical department at Uppsala University Hospital, Uppsala, Sweden, was created in 2006 in an attempt to improve the quality of patient care and to make the work process more efficient.

When the study was performed, the same nurse anaesthetists, operating room nurses and assistant nurses had worked together in the PC team for two years. The PC team included anaesthesiologists and surgeons who were responsible for scheduling the patients and for teamwork. PC team members worked only with patients diagnosed with PC and were involved in deciding how to care for their patients during the entire perioperative period. The PC team's work process and the patient's path through surgery are illustrated in Figure 2, where different stages during hospital stay are marked as a, b and c (see below in text).

The perioperative nurses' (nurse anaesthetists and operating room nurses) tasks were extended into the perioperative period and they visited the patients both before and after surgery to improve patient preparation for the surgery (a, c) and to evaluate the care given during surgery (c) (38). The team starts work early in the morning (b) and leave the hospital only after surgery is finished (which could be late in the evening) and the patient has been transferred to the Intensive Care Unit (ICU). Through adopting this working procedure, the team unconsciously worked with the principles of lean production a long time before the concept was introduced at the hospital.

To strengthen the continuum of care between the outpatient clinic, surgical ward and surgical department, another step was taken. Before admitting the patients, the registered nurse responsible for the PC patients in the outpatient clinic, the team members of the PC team, the registered nurses on the surgical ward, and the surgeon responsible for the patients with PC met once a week to report on the next week's patients (a). Patients were admitted to the surgical ward two days before surgery

In this thesis, early postoperative recovery was studied during hospital stay until discharge (b, c).



*Figure 2. A flowchart of the PC patient's path through surgery and organisation of care at Uppsala University Hospital, Uppsala, Sweden.*

## Recovering from cytoreductive surgery

Postoperative recovery is a process where patients regain both physical and emotional well being through continuous information, support and encouragement from the health care staff. In the postoperative recovery process, both patients and health care staff cooperate to reach the goal of returning to the patients' preoperative 'normal' functions in everyday life (Figure 3) (39). The amount of time needed to recover from surgery is different for each individual, and during this process, setbacks that the patient needs to overcome may occur. The recovery process includes a belief in the patient and his/her ability to care for him-/herself (40, 41) and involving the patient in his/her own care (42) to ensure the postoperative care process is smooth for the patient.



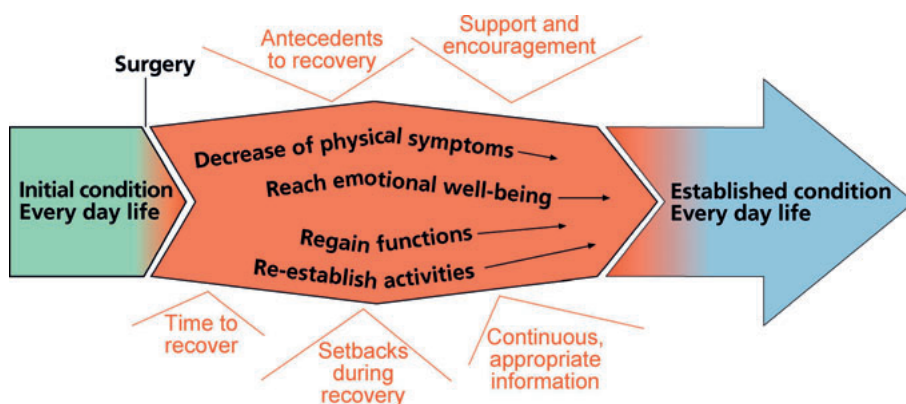


Figure 3. The process of postoperative recovery, published with permission from the originator, R. Allvin (39).

Cytoreductive surgery (CRS) is considered major surgery with a high morbidity rate (1, 2) and data about the patient's postoperative recovery process after this complex treatment is limited.

## Peritoneal Carcinomatosis (PC)

Peritoneal carcinoma (PC) means 'malignant tumour' in 'abdominal membrane', and is derived from the Greek words 'peritonaion' meaning 'parts stretched over' and 'karkinoma' or 'karkinos' meaning 'a cancer' or 'crab' (43). PC affects the second largest organ in the body, the peritoneal surface, which is almost as large as the skin (44).

PC may be a primary disease, namely peritoneal mesothelioma, or a secondary disease, originating from gynaecological (e.g. ovaries) or non-gynaecological sites such as the appendix, colo-rectal region, or stomach. Between 5-50% of all primary gastrointestinal and gynaecological cancer could result in PC (45-47). PC is regarded as a terminal disease despite treatment with systemic chemotherapy (48), and has a median survival of four to 15 months in patients with tumours of gastrointestinal origin (49, 50). PC can occur at all ages, with the mean age around 50 years (1, 51).

## Tumour spread and symptoms

The peritoneal cavity is covered by the peritoneum, a single layer of cells with an epithelial-like structure, also called mesothelium, which is supported by the tissue connected to it. Parietal peritoneum covers the abdominal wall

and visceral peritoneum lines the organs suspended in it. In the abdominal cavity, internal organs are intraperitoneal, suspended from the abdominal wall by mesenteries, or retroperitoneal, lying between the abdominal wall and parietal peritoneum and not suspended from the mesenteries (52).

Tumour cells may spread into the peritoneal cavity through exfoliation from the primary tumour before surgery, or the manipulation of the primary tumour and release from blood or lymph vessels, due to surgical trauma (53-55). All intra-abdominal organs in the peritoneal cavity, even the visceral peritoneum that lines the bladder among other organs, and the intestines can be a target for the tumour cells. Therefore, patients may suffer from intestinal obstruction (56, 57), bowel perforation with fistula formation, and nutritional deficiency (49).

## Loco-regional treatment of PC

Cytoreductive surgery (CRS) combined with hyperthermic intraperitoneal chemotherapy (HIPEC) is used as a loco-regional treatment, and has, in selected patients, resulted in a five-year survival rate of 20-40% in patients with colorectal cancer (CRC) and 75-90% in patients with pseudomyxoma peritonei (PMP) (56).

The loco-regional procedure is completed in three phases. The first phase is the CRS phase, which takes different amounts of time depending on tumour burden in the peritoneal cavity. During this phase, tumour cells are resected with a ball-tipped electrosurgical hand-piece at high voltage (200-300 Watts), which may cause a large area of burns due to carbonisation and electrovaporisation of the tissue (57). By the end of the CRS phase, the patient is prepared for the second phase, HIPEC. Finally, the third phase is reconstructive surgery and possible stoma formation, which are performed after HIPEC.

## Cytoreductive surgery (CRS)

The goal of CRS is to remove all visible tumours. The smaller the remaining microscopic cancer volume is, the better the precondition for chemotherapy and eventual post-surgical outcome (58). At Uppsala University Hospital, Uppsala, Sweden, CRS is performed as described by Sugarbaker (57). Depending on disease extent, six peritonectomy procedures may be necessary to remove cancer from the visceral intra-abdominal and parietal peritoneal surfaces. These procedures are left and right upper quadrant peritonectomy, greater and lesser omentectomy, splenectomy, cholecystectomy, pelvic peritonectomy with resection of the rectosigmoid colon, and antrectomy or total gastrectomy and reconstruction (57, 58).

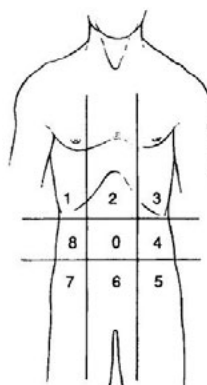
To describe the extent of tumour load, the peritoneal cancer index (PCI) is used at the same time as the abdomen is being explored during surgery. After CRS, the residual tumour is quantified by the completeness of cytoreduction score (CC score) (59).

## Peritoneal Cancer Index (PCI)

PCI is a measure of determining the peritoneal implant size and the distribution of the disease and is used in decision-making and assessment of peritoneal surface malignancy. The peritoneal cavity, from sternum to symphysis pubis (abdomino-pelvic regions), is divided into nine regions (Figure 4), and the small intestine is divided into four regions. The size of the intraperitoneal nodules in these regions is assessed by the lesion size (LS) score, which ranges from no visual malignancy (LS-0) to nodules > 5.0 cm (LS-3). Therefore, the maximum score in the peritoneal cavity is 39 (13 x 3) (59).


## Completeness of Cytoreduction (CC) Score

The Completeness of Cytoreduction (CC) Score is another measure for deciding the implant size, which is determined by the surgeon after completion of cytoreduction. The CC score helps the surgeon to decide the course of care either towards palliation or treatment. The CC score is defined as CC-0 when no visible peritoneal cancer is found, and CC-1 means nodules are <2.5 mm in diameter. Tumour nodules with a diameter between 2.5 mm and 2.5 cm indicate CC-2, and larger nodules are considered as CC-3, which means cytoreduction is incomplete (59).

	<u>Regions</u>	<u>Lesion Size</u>	<u>Lesion Size Score</u>
	0 Central	_____	LS 0 No tumor seen
	1 Right Upper	_____	LS 1 Tumor up to 0.5 cm
	2 Epigastrium	_____	LS 2 Tumor up to 5.0 cm
	3 Left Upper	_____	LS 3 Tumor > 5.0 cm
	4 Left Flank	_____	or confluence
	5 Left Lower	_____	
	6 Pelvis	_____	
	7 Right Lower	_____	
	8 Right Flank	_____	
	9 Upper Jejunum	_____	
	10 Lower Jejunum	_____	
	11 Upper Ileum	_____	
12 Lower Ileum	_____		

**PCI**



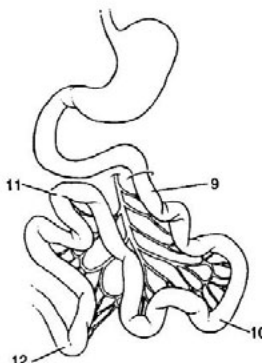


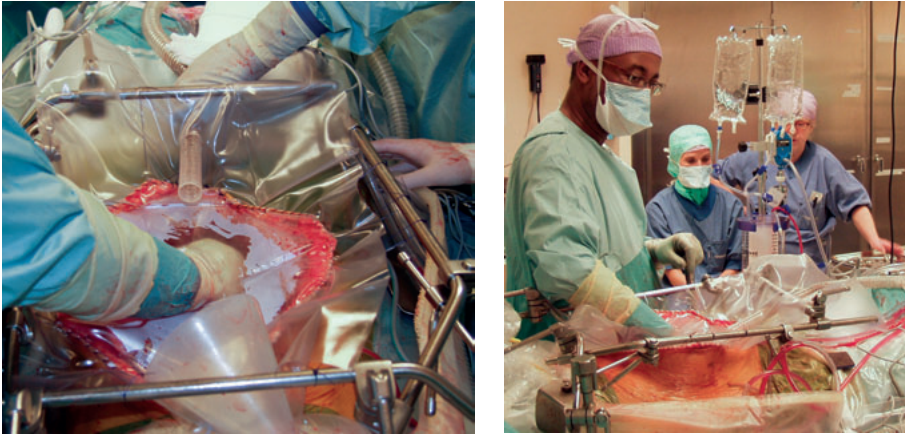
Figure 4. Peritoneal Cancer Index published with permission from the originator, Dr. Sugarbaker (59). It is used to measure the implant size and the distribution of the tumour in the abdomen.

## Hyperthermic Intraperitoneal Chemotherapy (HIPEC)

The HIPEC technique was first reported as a case report in 1980 (60). Since then, HIPEC has become part of the standard loco-regional procedure for treating PC. Once the CRS procedure is finalised, HIPEC can be through either open abdomen (coliseum) or closed abdomen techniques (Figure 5). Both procedures have advantages and disadvantages, but neither technique is superior (61).

The rationale for the HIPEC procedure is that heated chemotherapy is delivered directly loco-regionally, therefore, the plasma levels of the drugs are lower than the plasma levels in the peritoneal cavity. Hyperthermia facilitates penetration of the chemotherapy drugs into the remaining tumour cells inside the abdominal cavity after cytoreduction, as heat softens the tissue, reduces the interstitial pressure of the tumour, and increases the cytotoxicity of the chemotherapeutic agents (61). The hyperthermic drug is administered through a closed continuous circuit with a pump, a heater, a heat exchanger and a temperature monitor. The device administers the chemotherapeutic solution to the abdomen via two inflow and two outflow catheters, with a preferred intra-abdominal temperature of 41.5-43°C. In the coliseum technique (the method used at Uppsala University Hospital), the

surgeon distributes the chemotherapeutic drug uniformly within the peritoneal cavity. HIPEC is usually administered for 30 or 90 minutes depending on the origin of the tumour and drug of choice (61).



*Figure 5. The open abdomen (coliseum) technique is the method used at Uppsala University Hospital. The edges of the patient's skin are fixed to the frame of the retractor to create a space for the chemotherapeutic agent. The surgeon distributes the drugs evenly in the abdominal cavity during the HIPEC phase.*

## Anaesthesia

In one study on anaesthesia in connection with CRS and HIPEC (62), general anaesthesia was induced and maintained with propofol, starting at 10 mg/kg<sup>-1</sup>.h<sup>-1</sup> and maintained at a rate of 6 mg/kg<sup>-1</sup>.h<sup>-1</sup>, through an intravenous technique with sufentanil as the analgesic. In another study (63), anaesthesia was induced with tiopental (4mg/kg) and maintained with isoflurane and 67% nitrous oxide in oxygen, and an intermittent epidural infusion of 1% lidocaine was administered as pain management during surgery, with an additional intravenous infusion of fentanyl if epidural analgesia was insufficient.

CRS and HIPEC are best performed under general anaesthesia (62-65), and in the absence of contraindications, epidural catheter is inserted before induction of anaesthesia. Epidural analgesia is usually used for postoperative pain management (64, 65); however, there is no consensus about either the choice of drugs during anaesthesia, or whether epidural analgesia should be started before and used during surgery (64) or only started after cytoreductive surgery (65).

Throughout all three phases of the surgical procedure, monitoring of the patients is crucial. In these phases, oesophageal temperature, electrocardiogram, capnography, pulse oximetry, invasive radial arterial blood pressure, central venous pressure, airway pressure and urinary output are screened (63, 64).

Anaesthetic management aims to create a balance among the different functions in the patient's body during all three phases of the procedure. The surgical procedure is accompanied by moderate blood loss due to the extensive and open abdominal wound after many hours of surgery, especially throughout the cytoreductive phase, which causes large fluid deficit and temperature loss (66-68). The goal is to restore normovolaemia, keeping the mean arterial blood pressure above 60 mmHg and within 20% of baseline values to guarantee adequate urine production (65). The need for fluid replacement usually exceeds the typical values for major surgery (6-8 ml.kg<sup>-1</sup>), and crystalloids, colloids and blood products are used to replace the lost fluids (63, 65), although sometimes, additional infusions of dopamine, noradrenalin and/or phenylephrine are needed. The patient's body temperature is kept normal through warm infusions or warm air through blankets (in the first phase of the surgery) (65).

Before the HIPEC phase begins, core temperatures are reduced to 35°C through the application of hypothermia, usually by pre-cooled, intravenous crystalloid infusions and ice packs placed on the great vessels (62, 65, 69). Large amounts of intravenous fluids are administered due to the massive fluid shift that occurs, (65, 67, 68, 70). As the chemotherapeutic agents may be nephrotoxic (64), urine production should be kept high, and if necessary, with the help of intermittent doses of furosemid (64). After the HIPEC phase, the patient's body temperature, blood pressure, and other functions are restored to normal levels. The postoperative recovery process begins as soon as the surgery ends and anaesthesia is discontinued."

## Postoperative recovery

The concept of postoperative recovery is commonly discussed, although there is no standard definition. According to Kortilla (71), postoperative recovery occurs in three phases: awakening from anaesthesia; home readiness and discharge; and, finally, a return to normal function such as performing daily activities, for example driving and work. Recovery may be defined as the process of restoration and/or attainment of normal physiological functions (72), and is affected by the patient's illness, the extent and outcome of surgery, the patient's past and current physical condition, and the type and quality of care (72).

Many factors affect the progress and duration of postoperative recovery, such as, urinary retention, wound healing, signs of infection, pulmonary and bowel complications, time to ambulation or mobility, pain and sleep problems, medication, and postoperative days in hospital (72). Other factors include the staff members' efficiency, the complexity of treatment, for example in CRS and HIPEC, and adverse events (72). Therefore, health professionals need to understand the recovery process for different types of surgical procedures, as different procedures may have unique patterns of postoperative recovery.

The definition of postoperative recovery in this thesis was based on studies from ambulatory surgery described by Allvin (39), which includes a holistic perspective. Allvin (39) defines postoperative recovery as the process of returning to normal life, a sense of wholeness and wellbeing, and returning to the level of independence/dependence in daily activities through regaining control over physical, psychological, social and habitual functions.

A common element in all definitions of postoperative recovery is returning to normal physical functioning or a sense of 'normality' in patients' lives. Through broadening the definition of normality to include five dimensions of patients' recovery (i.e. physical symptoms, physical functions, psychological and social functions, and activity), Allvin (39) introduces a 'level of independence/dependence' into daily activities. The aim is that the patient gains control over the five dimensions of recovery by him/herself (39). Postoperative recovery is a process requiring both physical and psychological energy from the patient. The dimensions and items of postoperative recovery are presented in Figure 6 (39).

Both Allvin (39) and Kortilla (71) divide the postoperative recovery from ambulatory surgery into three periods. The early phase begins with the discontinuation of anaesthesia directly after surgery and continues until vital signs are stabilised. The intermediate phase ranges from stabilisation of vital signs until the patient is ready to be discharged, and the late phase begins with discharge and extends to the time when the patient regains his/her preoperative wellbeing (39). However, the time when a patient feels fully recovered is a subjective feeling for each individual patient.

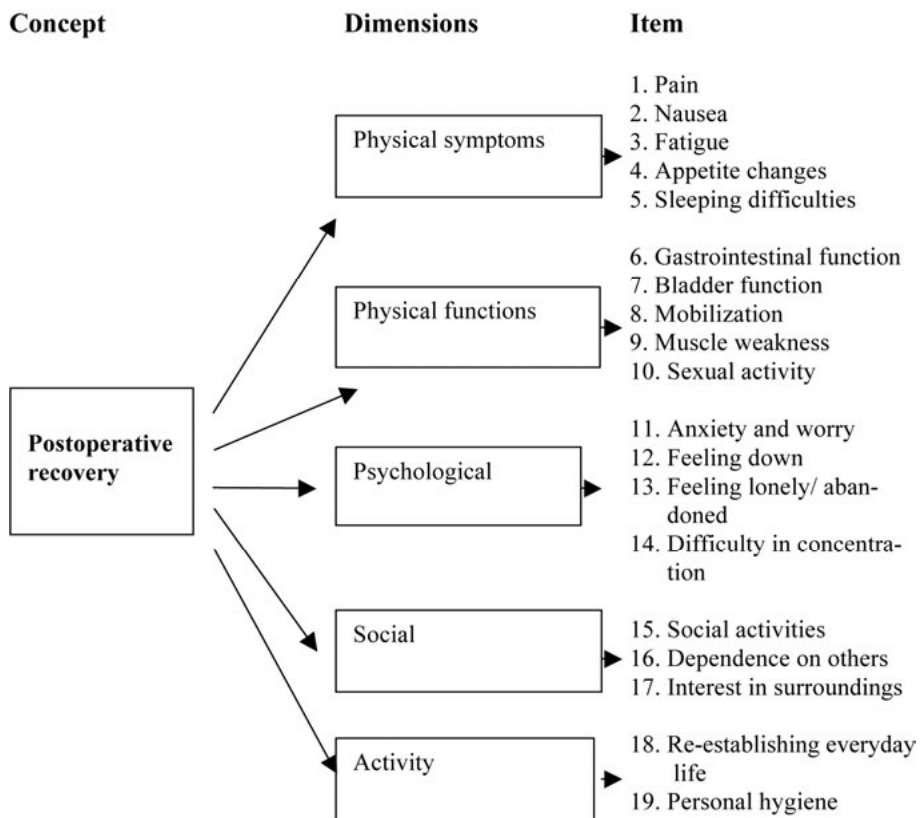


Figure 6. Diagram of the operationalisation of postoperative recovery, published with permission from the originator, R. Allvin (39).

For patients with gastrointestinal cancer, various methods, such as fast track surgery, are used to reduce postoperative recovery time after the surgical treatment. During the recovery process after surgery, patient preparation and participation are important for consolidating the patient's satisfaction with his/her own care (42). Therefore, patients should be involved in the health care team as an equal partner, and take greater responsibility in preparing for post-discharge care (73).

Reducing the length of postoperative recovery enhances an early return to normal functions while increasing the demands on post-discharge care and rehabilitation for the patients and their families at home (74). This requires the patients are informed and educated about postoperative recovery and that there is an understanding that health professionals work in multi-disciplinary teams in cooperation with the patients (74-76) in a goal-oriented manner to achieve efficiency in the patient's care (74-75).



# Overall and specific aims

The overall aim of this thesis was to investigate operating room efficiency, from both the staff's and their leaders' viewpoint, in two different settings and early postoperative recovery of patients with peritoneal carcinomatosis.

The specific aims of the four studies were:

Paper I: To explore variations in how the staff and leadership in a surgical department with a non-team organisation understood and experienced operating room efficiency.

Paper II: To investigate how organised surgical team members (PC team) and their leaders understood and experienced operating room efficiency.

Paper III: To describe the early postoperative recovery and factors related to the recovery of patients with PC who underwent CRS and HIPEC treatment.

Paper IV: To assess the occurrence of pulmonary adverse events (AE) and to investigate the relationship between pulmonary AE and the postoperative recovery process after CRS and HIPEC treatment in patients with PC.

# Methods

## Design

This thesis consists of four studies (Papers I-IV), in which both qualitative (Papers I-II) and quantitative (Papers III-IV) methods were used (Table 1).

Table 1. Overview of studies in the thesis (Papers I-IV)

<b>Paper</b>	<b>Sample</b>	<b>Setting</b>	<b>Data collection</b>	<b>Data analysis</b>
I	Surgical staff, physicians and leaders (n=21)	Non-team organisation in a county hospital	Individual interviews	Phenomenography
II	Surgical team members, physicians and leaders (n=11)	Team organisation in a university hospital	Individual interviews	Phenomenography
III	Patients with PC (n=76)	University hospital	Audit of EHR <sup>2</sup>	Univariate, multivariate, and non-parametric statistics
IV	Patients with PC (n=76). Comparison of iv <sup>1</sup> (n=12) and non-iv (n=64) groups	University hospital	Audit of EHR <sup>2</sup> and radiological assessment	Univariate, multivariate, and non-parametric statistics

<sup>1</sup>iv = intervention, <sup>2</sup>EHR = Electronic Health Records

## Qualitative research method

The data for the first two studies (Papers I and II) were analysed with the phenomenographic approach, a method originally developed for educational science (77-79), but later used in health care research to study the variation in professionals understanding of their work and to explore patients' experiences and needs (77, 80, 81).

### Phenomenography

The objective of phenomenographic research is to describe different *ways of understanding, experiencing or conceptualising* a phenomenon. The aim is to describe the qualitative *variations* in how a phenomenon is understood by a group of people (78, 82, 83). A phenomenon can be understood in a limited number of ways, and phenomenography is the relationship between a human being and the world around him/her. The phenomenon appears in the world surrounding people and comes to people's awareness: it is then understood by the person in his/her own way. A person's understanding of a phenomenon may be affected by their experiences and background.

In phenomenographic analysis, the researcher takes a *second order perspective*, focusing on how other people understand or experience a phenomenon in the world (78, 79, 82, 83). In-depth interviews with open-ended questions are usually used to capture both *how* the phenomenon of interest is described and *what* aspect of it is in focus. It is up to the person being interviewed to determine what dimension of the phenomenon he or she chooses to discuss (77-79, 82, 83).

The founder of phenomenography, Ference Marton, emphasised that there is no specific technique for a phenomenographic analysis (78), and the categories resulting from the analysis should be discovered while working with the text. The analysis has several steps. The interview is transcribed verbatim, and the relevant parts of the text, that is, the utterances about the phenomenon of interest, are selected. As the same utterance might have a different meaning in a different context, it is important to work with quotes in the text to capture the actual meaning of the utterance as stated in the interview (78). In the next step, researchers may leave individual boundaries and compare quotes and utterances from different individuals: similarities and differences between the utterances and quotes appear when working with the text. Similar quotes and utterances are grouped and a description of the group meaning, called categories, emerges. Thus, a category may be based on more than one interviewee's description. The sum of all possible ways a phenomenon is understood or experienced, or all the categories of

description, is called an *outcome space*, and is the result of the phenomenographic analysis (78).

## The context of the study and the participants

### *Paper I*

The 350-bed county hospital where this study was performed offers both emergency and elective care to 170,000 residents in two counties in central Sweden. At the time of the study, operating teams were not strictly defined in the Main surgical department. Instead, the staff in each operating room formed teams on a daily basis. Thus, a team could consist of different staff every day.

Semi-structured individual interviews (n=21, 4 men and 17 women) lasting between 20 and 66 minutes were conducted between November 2005 and January 2006. The interviewees were chosen by purposive sampling to represent a broad spectrum of experience and professional roles. The interviews followed an interview guide: to evaluate the validity of the interview guide, a first interview was held with an operating room nurse, who did not participate in the study. No corrections to the interview guide were needed.

### *Paper II*

This study was undertaken at an 1100-bed university hospital in Sweden. The hospital has six surgical departments with the Main surgical department organised into a number of teams, each working with patients with several specific diagnoses. The PC team selected for this study had well-defined goals and prerequisites for planning the work process themselves.

The 10 members of the selected team and their leaders, the nurse manager and the director of the operating department, were asked to participate in the study. Eleven people (5 men and 6 women) accepted: one of the surgeons declined participation.

Semi-structured individual interviews were held at the department during March and April 2008. The interviews lasted from 28 to 65 minutes, and the same interview guide was used as in Paper I.

## Phenomenographic analysis

The phenomenographic analysis was done in five steps:

- After reading the transcripts, the parts not pertaining to efficiency were removed from the text.

- Important descriptions on *what* aspect of efficiency was in focus and *how* it was described in each interview were identified.
- The descriptions from all interview texts were compared and similar descriptions were grouped.
- The group with similar descriptions was built into a category. Thus, the categories described different aspects of the phenomenon of interest, namely efficiency.
- Finally, the description of each category was re-formulated to express the meaning as clearly as possible (77), and the predominant and less dominant aspects of each member's understanding were described.

For Paper I, two researchers (EA, author of this thesis and JL, a senior researcher) conducted the first steps of the analysis. Another researcher (LG, a senior researcher) performed all the steps independently, except for the last one. The final categories were established after collaboration among the researchers. For Paper II, the first researcher (EA) conducted the first two steps of the analysis independently. Then all three researchers (EA, LG, and JL) analysed the remaining steps together: determination of the categories was a result of a series of discussions between the three researchers. Finally, the relationship between the categories was delineated.

## Quantitative research methods

### Study procedure and participants

#### *Papers III and IV*

Between 2005 and 2006, data were collected on 76 patients with PC (42 women, 34 men), who were treated primarily with CRS and HIPEC at Uppsala University Hospital, Uppsala, Sweden: patients with gastric cancer were not included.

The eligibility criteria for treatment were histologically confirmed diagnosis of PC; no distant metastasis; adequate renal, haematopoietic, and liver functions, and a World Health Organisation (WHO) performance status of  $\leq 3$  (84). The WHO performance status is graded into five levels. Grade 0 means the patient is as active as before illness; grade 1 is when the patient cannot carry out heavy physical work; grade 2 means the patient is able to look after him/herself, but is not well enough to work; and grades 3 and 4 mean the patient increasing needs someone to look after him/her (84).

## Anaesthesia, surgical treatments, and recovery

### *Anaesthesia*

Anaesthesia was induced by a standardised and routine procedure. In 74 patients, a thoracic epidural (Levels Th8-Th9 or Th9-Th10) was inserted before induction of anaesthesia, and two patients had continuous patient control analgesia (PCA) from the beginning of surgery. Epidural analgesia was activated with bupivacain and sufentanil before the induction of anaesthesia, and used during surgery and up to eight days postoperatively. Anaesthesia was induced by fentanyl and sodiumtiopenthal, and after an intubation dose of rocuronium, the trachea was intubated and mechanical ventilation started. Anaesthesia was maintained with isoflurane and intermittent doses of fentanyl.

Throughout anaesthesia, fluids were administered after evaluating the patient's blood pressure, pulse rate, central venous pressure, urinary output, body temperature, and skin turgor. During surgery, fluid deficit was replaced by colloids including fresh frozen plasma and erythrocyte concentrates (the most frequently used), Albumin<sup>®</sup> 200mg/ml or 50 mg/ml, Gelofusine<sup>®</sup> 60 mg/ml and Voluven<sup>®</sup> 60 mg/ml. The main crystalloid used was a solution of Ringer acetate<sup>®</sup>. Postoperative pain management was mainly based on epidural analgesia, but other analgesics were added if required.

### *Surgical treatment and HIPEC*

Peritonectomy was performed, as described by Sugarbaker (57), and the quantitative prognostic indicators for peritoneal carcinomatosis and the Peritoneal Cancer Index (PCI) were recorded immediately after surgery. The extent of tumour load in the abdominal cavity was assessed by PCI (range 1-39), which is calculated by summing the lesion size scores 0-3 in 13 different regions of the abdomen (59).

In order to assess the factors influencing the patients' postoperative recovery and pulmonary adverse events resulting from the extent of surgical trauma, the abdomen was outlined by two transverse and two sagittal planes, in a similar fashion as the abdominal-pelvic regions 0-8 and small bowel regions 9-12 of the PCI scoring system (59). All patients could then be classified as (a) regions 1-3 = upper abdomen, including the right upper quadrant, epigastrium and left upper quadrant; (b) regions 0, 4, 8-12 = middle abdomen including right flank, central, left flank and small bowel; and (c) regions 5-7 = lower abdomen, including right lower quadrant, pelvic and left lower quadrant.

HIPEC was with the coliseum technique (56, 85), and the selection of drugs for the HIPEC setting was determined by the origin of the primary tumour.

Patients with pseudomyxoma peritonei (PMP) received Mitomycin C (MMC) in a concentration of 30-35 mg/m<sup>2</sup> (86). Patients with colorectal cancer (CRC) received oxaliplatin in a dose of 460 mg/m<sup>2</sup> (87). Ovarian cancer, gastric cancer and malignant abdominal mesothelioma (MAM) patients were treated with cisplatin (50 mg/m<sup>2</sup>) combined with doxorubicin (15 mg/m<sup>2</sup>) (88). Perfusion was for 30 minutes with oxaliplatin, and 90 minutes with the other drugs. The carrier solution used for MMC, cisplatin and doxorubicin, was a low calcium peritoneal dialysis solution PD4, Dianeal 13.6 mg/ml (Baxter, Deerfield, IL, USA). For oxaliplatin, the carrier solution was 50 mg/ml glucose. The perfusate was heated to 46°C, and the temperature of the fluid at the inflow catheter was 42-43°C.

### *Postoperative recovery*

A multi-professional team of physical therapists, registered nurses, and surgeons at Uppsala University Hospital, Uppsala, Sweden, designed a special postoperative mobilisation schema (Table 2). The goal was to mobilise the patients stepwise towards becoming independent: this started 4-6 hours after extubation usually in the ICU. During the first postoperative days, the patients were assisted in performing daily activities, such as standing up, sitting down on a chair, washing themselves in the morning, taking a walk and moving freely, until they could perform these tasks without assistance from the nursing staff. Later, the patients could decide the frequency of the activity themselves.

To facilitate postoperative mobilisation through good pain management, a nurse visited the patients both when epidural analgesia (EDA) started and after the treatment with EDA ended, or whenever the patients were dissatisfied with the pain management by EDA. The specific goal of the visits was to assess the success of pain management through the patient's subjective pain evaluation. The frequency of the visits varied between different individuals.

Oral intake of fluids was recommended one to two days after surgery, except for patients with gastric resection, who were restricted up to 10-12 days. If needed, psychological support was offered by the ward nurse, a social worker, or a hospital priest. For patients with severe psychological distress, a psychologist was consulted.

Table 2. Postoperative mobilisation according to a specially-designed schema for PC patients.

Activity/Post -op day	1	2	3	4-5	6-7	8	9-10
Standing up	2-3 times	3-4 times	> 4 times	F	F	F	F
Sitting down on a chair	<10 min	10-15 min	> 15 min	F	F	F	F
Start walking	Not required	Not required	5- 10 steps	5-10 m	20-30 m	50 m	100 m

*F= Patients were free to decide the frequency of the activity and when they felt well enough to perform the activity.*

Postoperative adverse events (AE) caused by chemotherapy (neutropenia or haematological causes), the surgery, kidney functions, infections, and the restoration (at least partially) of gastrointestinal functions were monitored before the patients were discharged. Subsequently, patients were discharged to hospitals close to their homes.



In this thesis, the early postoperative recovery and in-hospital recovery, including the early phase and parts of intermediate phase of recovery, are used synonymously.

## Data collection and study variables

### *Paper III*

Postoperative recovery until discharge was studied through a retrospective audit of all medical and nursing electronic health records (EHR). All documented dimensions of postoperative recovery according to Allvin (physical symptoms, physical functions, psychological functions, and activity), except social function, were analysed (39). A special protocol was designed for data collection, which was kept in a database. Nursing documentation was according to a model (89) that contains pre-printed keywords on the patient's nursing status, interventions and outcome. Generally, medical documentation, describing medical status, intervention and diagnosis, was written longhand.

The study variables included age; gender; body mass index (BMI); American Society of Anaesthesiologists' physical status classification system (ASA); medical history; surgical procedure; duration of surgery; blood loss during surgery; pulmonary adverse events, such as development of atelectasis, pleural effusion, and pulmonary infiltrate; duration of stay in the Intensive Care Unit (ICU), and total hospital stay. Data were collected on fluid therapy (crystalloid and colloid therapy) through surgery and during the first five postoperative days, total ventilation time on respirator, and duration of oxygen therapy or treatment with Continuous Positive Airway Pressure (CPAP) after extubation. The time required for postoperative mobilisation, defined as the first postoperative attempt by the patient to stand up, sit down on a chair, wash him/herself, and walk after surgery, were also recorded. *Paper IV*

The same patient cohort was used as in Paper III. Patient EHR were studied retrospectively, with special attention on postoperative recovery: mobilisation (i.e. activity of daily life functions, restoration of gastrointestinal functions, need for psychological support), restoration of oral intake of fluids and food and bowel functions, occurrence of pulmonary adverse events during the early postoperative recovery period, and interventions in connection with pulmonary adverse events. Thus, the gastrointestinal function and mobilisation items within Allvin's (39) dimension of physical functions were investigated.

As patients with PC receive large amounts of fluids (crystalloids and colloids) during surgery and the surgical procedure may affect the

diaphragm, pulmonary adverse events and their impact on patients' postoperative recovery process were studied.

Radiological images from the first postoperative week were reviewed by two senior radiologists. The opacities or infiltrates in each lung consistent with atelectasis, pleural effusion on each side, and signs of congestive heart failure were graded according to a gradation system. Atelectasis was graded based on the extension of the opacity into no areas (0), lamellar (1), segmental (2), lobar (3) areas, or more extensive than one lobe (4). Pleural effusion was graded on the amount: none present (0), minimal amounts (1, defined as blunted pleural sinus), moderate amounts (2, defined as extension to two pleural sinuses, but not reaching the level of lung hilum), or large amounts (3, up to and higher than the level of lung hilum). Signs indicative of heart failure were noted collectively. No sign of heart failure was graded as 0. Enlargement of pulmonary vessels in the absence of other congestive signs (pleural effusion and/or cardiac enlargement) was interpreted as suggestive of congestion and graded as 1. Congestive heart failure was diagnosed if there was dilatation/congestion of pulmonary vessels combined with pleural effusion and/or cardiac enlargement: this was graded as 2.

The radiologists were blinded to the clinical postoperative course of the patients. The examinations included chest X-ray (CXR) and thoracic computerised tomography (CT).

With respect to progress in their recovery process, patients who had an invasive intervention (n=12) due to their pulmonary AE were studied closely in relation to those who received no intervention (n=64). Invasive intervention (thoracocentesis and chest tubes) was administered in presence of respiratory distress: dyspnoea, tachypnoea, or poor saturation.

## Statistical Methods

### *Paper III*

For descriptive purposes, mean, median, and range were used. To test for impact of the clinical data on postoperative recovery variables, Spearman's correlation, with a 95% confidence interval (CI), was used. When a correlation was found, there was further analysis with the Mann-Whitney U-test, regression models, general linear models, or ANOVA for continuous variables and  $\chi^2$  for categorical variables. A two-tailed P-value <0.05 was considered statistically significant for all tests. All tests were with Statistica version 10 (Statsoft Inc., Tulsa, OK, USA).

#### *Paper IV*

To test the probability of an association between the clinical data on postoperative recovery variables, the univariate analysis of each clinical and postoperative recovery variables was tested with  $\chi^2$ , and Fisher's exact test was used for categorical data and the Mann-Whitney U-test or Kruskal Wally's test were used for continuous data. To test the probability of association between the impacts of pulmonary AE on recovery variables, the Mann-Whitney U-test or Kruskal Wally's test were used. A general linear model in a multivariate analysis (with a 95% CI) was used for correlation analysis between postoperative recovery variables and pulmonary AE. Inter-rater analysis between the two radiologists' gradations of atelectasis, pleural effusion and heart failure was with Cohen's  $\kappa$ -value. A two-tailed P-value  $<0.05$  was considered statistically significant for all tests. All tests were with Statistica version 10 (Statsoft Inc., Tulsa, OK, USA).

## Ethical considerations

According to Swedish law (2003:460), the first two studies (Papers I and II) did not require approval from the Ethical Review Board at the time the studies were performed. The studies followed the principals of the Declaration of Helsinki (90). The regional ethics committee approved the studies in Papers III and IV (Dnr 2007/073).

The participants in Papers I and II received written information about the study. Participation was voluntary and the interview texts were treated confidentially. The participants had the right to refuse participation or could withdraw participation at any time, without indicating any reason. During the analysis process, personal data were excluded.

# Results

## Paper I

### Efficiency in a non-team organisation

In a non-team organisation, efficiency was experienced and understood in six different ways, and a closer analysis of the relationship between the categories revealed three different levels (Figure 7).

The first two ways of understanding efficiency (categories A and B) represented preconditions for a good work process, and these were described as *having the right qualification, knowing what to do, being able to prevent problems, and enjoying work by seeing the meaning within it*. The other two ways of understanding efficiency (categories C and D), were concerned with creating smooth work flow in the operating room. These were described as *planning and having good control and overview, creating a smooth patient flow, and each professional performing the correct task*. On a third level (categories E and F), efficiency was understood as *completing a work assignment within the given time frame and producing as much as possible per time unit*.

The nurses (nurse anaesthetists and operating room nurses) and assistant nurses working close to patients, but with little or no responsibility for productivity, stressed individual knowledge, experience and the work process as important aspects of efficiency. Leaders, surgeons and anaesthesiologists, who had greater responsibility for productivity and economy in the operating department, emphasised the importance of productivity and completing an assignment.

Most participants understood efficiency in more than one way. The individual predominant and less dominant ways of understanding efficiency are presented in Table 3. The predominant way of understanding was often expressed first, and frequently, during the interview.

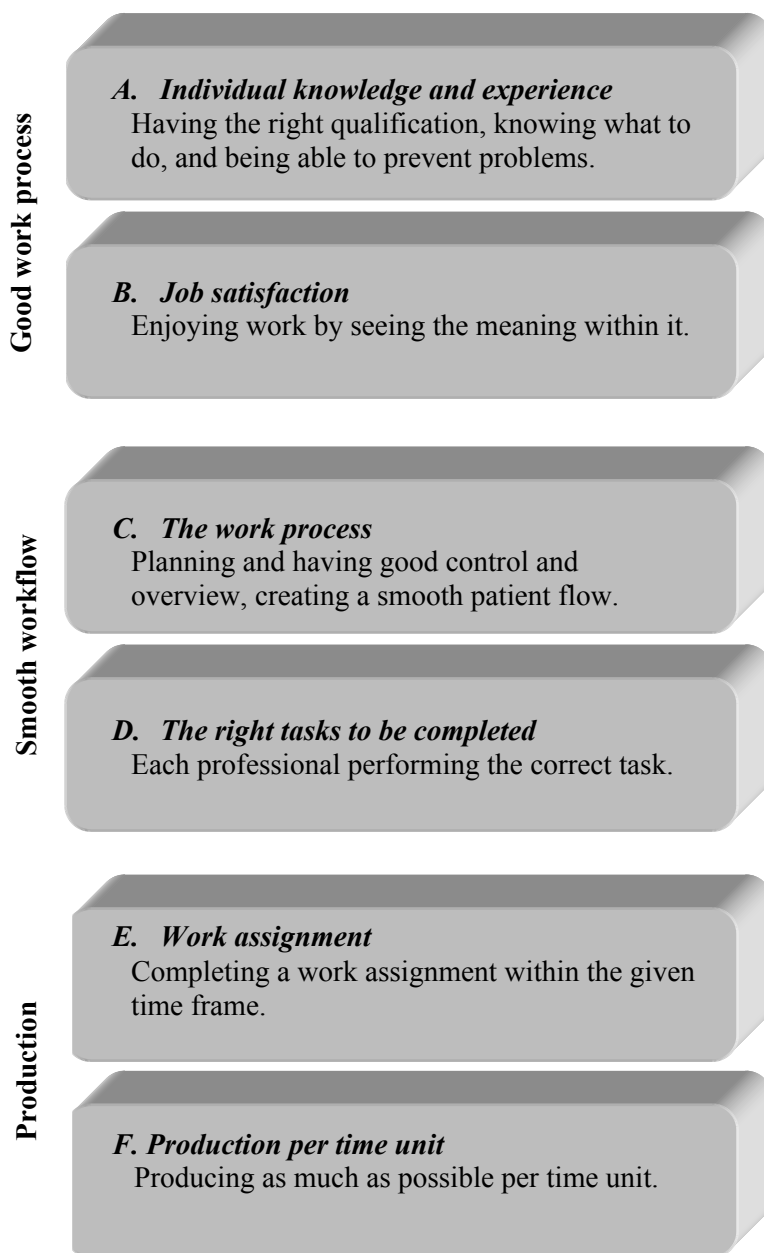


Figure 7. In a non-team organisation, efficiency was experienced and understood in six different way (categories)s.

Table 3. The individual predominant (++) and less dominant (+) ways of understanding the concept of efficiency in a non-team organisation

Category	Work exp. (years)	Good work process		Smooth work flow		Production	
		Individual knowledge and experience	Job satisfaction	The work process	The right tasks to be completed	Work assignment	Production per time unit
Staff members	NA	>10	++	+			
	NA	<5	++	+			
	NA	<5			++		
	OR nurse	>10	++			+	
	OR nurse	<10	++				+
	OR nurse	<10	++	+			
	A-NA	>10	++	+	+		
	A-NA	>10	++	+			
	A-NA	5-10	+	+			
	OR-AN	>10		++			
	OR-AN	<5	+	++	+		
	OR-AN	>10	+	+	++		
Leaders and physicians	OR-superv.	>10		++			
	OR-superv.	<10	+		++		+
	OR-superv.	>10				+	++
	OR-superv.	<5		+		+	++
	Surgeon	>10				+	++
	Surgeon	>10					++
	Anaesthes.	<5		++			
	Anaesthes.	>10	+		++	+	
	Anaesthes.	<5				++	

Eleven of twelve staff members understood efficiency predominantly in terms of having the right preconditions for a good work process and creating a good workflow, whereas, five of the nine leader, surgeons and anaesthesiologists understood efficiency in terms of production. Abbreviations: nurse anaesthetist (NA), operating room nurse (OR nurse), assistant nurse anaesthetist (A-NA), operating room assistant nurse (OR-AN), operating room supervisor (OR-superv), anaesthesiologist (Anesthes).

## Paper II

### Efficiency in a team organisation

Seven ways of understanding efficiency were identified among nine members of the PC team and their two leaders who worked with lean production principles.

In the participants' descriptions of the concept of efficiency, two levels of understanding efficiency could be distinguished. The first (categories 1-3) described the individual's own efficiency when working in close contact with the patients, and the second (categories 4-6) characterised a more complex and organisation-oriented efficiency (Figure 8).

The individual predominant and less dominant ways of understanding efficiency in a team organisation are presented in Table 4. Six of the participants had more than one way of understanding the concept of efficiency.

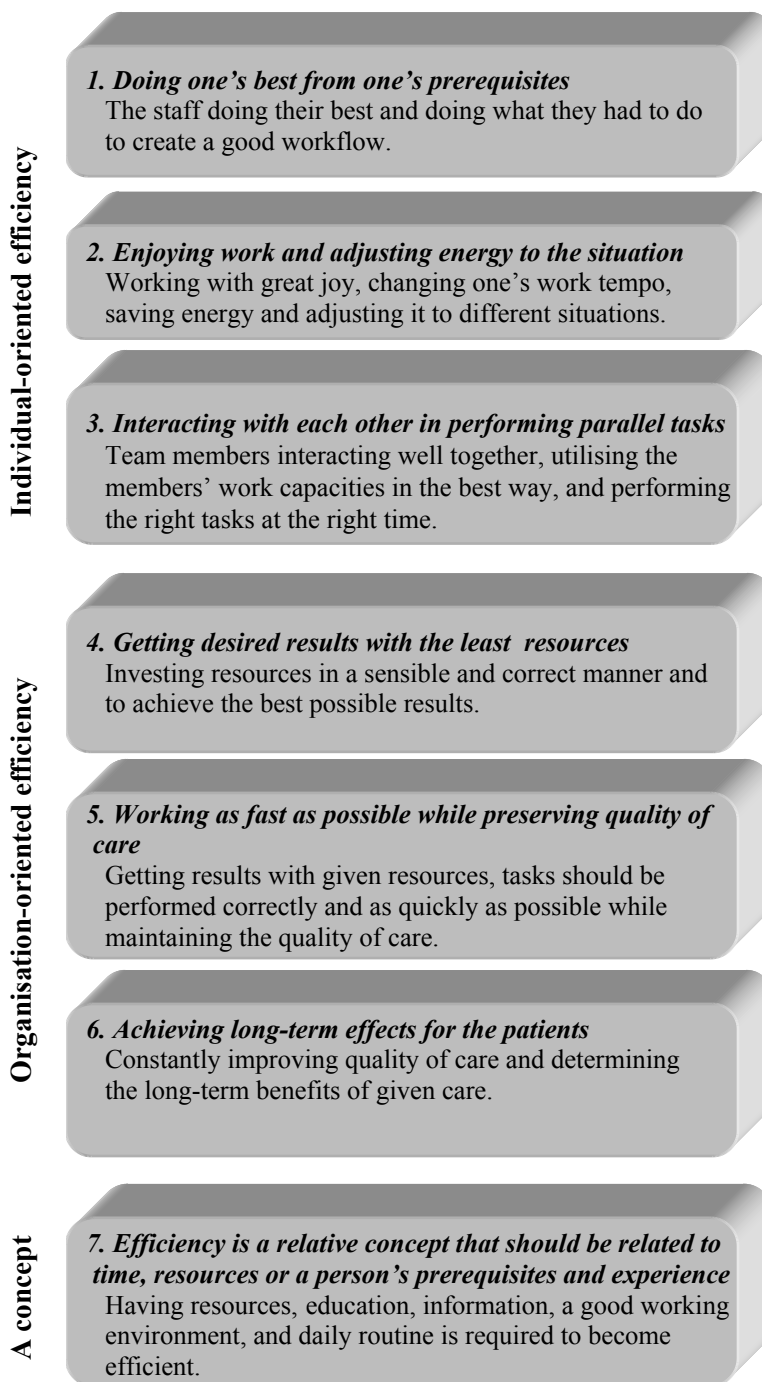


Figure 8. Seven ways of understanding efficiency (categories) were identified in a team organisation.



Table 4. The individual predominant (++) and less dominant (+) ways of understanding the concept of efficiency in a team organisation.

	Category	Work exp., years	Individual-oriented understanding			Organisation-oriented understanding			
			Doing one's best from one's pre-requisites	Enjoying work and adjusting energy to the situation	Inter-acting group performing parallel tasks	Desired results with least resources	Fast work while preserving quality	Long term effects for patients	A concept
Staff members	NA	<10			++		+	+	
	NA	<10	++	+	+				
	OR nurse	>10	+		+	+	++		
	OR nurse	<5			++		+		
	A-NA	>10	++						
	OR-AN	>10	++		+				
Leaders and physicians	Surgeon	>10					++		
	Anaesthes.	<10				++			
	Anaesthes.	<10							++
	OR-superv.	<5				+		++	
	OR-superv.	>10		++					

*The PC team members understood the concept of efficiency from both an individual-oriented and an organisation-oriented perspective. Abbreviations: nurse anaesthetist (NA), operating room nurse (OR nurse), assistant nurse anaesthetist (A-NA), operating room assistant nurse (OR-AN), operating room supervisor (OR-superv), anaesthesiologist (Anaesthes).*

In a comparison of a non-team organisation (Paper I) and a team organisation (Paper II), three categories were common to both groups: categories 1, 2 and 3 were similar to categories A, B, and C (Table 5). In a team organisation, categories 1 and 3 were considered important for an efficient team by most of the team members, and they conceptualised their team as efficient.

Table 5. A comparison of a team and a non-team organisation, illustrating how operating room efficiency is understood by different members of staff and their leaders.

Team organisation	Non-team organisation
1: The staff doing their best and doing what they have to do to achieve good workflow.	A: Having the right qualifications, know what to do, and are able to prevent problems.
2: Working with joy, changing one's work tempo, saving energy and adjusting it to different situations.	B: Enjoying work by seeing the meaning within it.
3: Team members interacting well together, utilising the members' work capacity in the best way, and performing the right tasks at the right time.	C: Planning and having good control and overview, creating smooth patient flow.
4: Getting desirable results with the least resources by investing resources in a sensible and correct manner.	D: Each professional performing the correct task.
5: Working as fast as possible while preserving quality of care by getting results with given resources.	E: Completing a work assignment within the given time frame.
6: Achieving long-term benefits for the patients by constantly improving quality of care.	F: Producing as much as possible per time unit.
7: Efficiency is a concept, which should be related to time, resources, or a person's prerequisites and experience.	

## Paper III

### Early postoperative recovery after surgery

After extubation, patients were mobilised as soon as their condition allowed (Table 6). There was a large range in postoperative recovery variables among the patients. Oral intake of fluids and food, regaining bowel function, and mobilisation usually occurred between 7 and 11 days postoperatively. Patients experienced nausea for up to 13 days postoperatively, and 42

patients were satisfied with their pain management. During the first three postoperative weeks, sleep disturbance was documented for 51 patients and psychological distress (in this thesis having anxiety or worry, and feeling down or abandoned) for 49 patients.

The total hospital stay was 22 days (mean). Postoperative mobilisation (i.e. performing daily life functions), restoration of gastrointestinal functions and the need for psychological support was the same for different age groups (<65 years and  $\geq 65$  years), for both genders, and for patients who were operated in the lower, middle, and upper abdomen.

Table 6. Postoperative recovery

Dimensions of recovery	Mean	(SD)	Median	n
<b>Physical symptoms</b>				
Nausea (days)	13.7 [1.0-48.0]	8.0	11.0	67 (9*)
EDA (days)	7.5 [2.0-39.0]	4.4	7.0	74
<b>Physical functions</b>				
Start drinking (days)	6.4 [2.0-18.0]	2.5	6.0	75 (1*)
Start eating (days)	10.5 [5.0-25.0]	4.4	10.0	67 (9*)
Flatulence occurred (days)	6.7 [1.0-18.0]	3.6	7.0	47 (29*)
Patient had bowel movement (days)	10.6 [5.0-21.0]	4.2	9.0	36 (40*)
<b>Activity (ADL functions)</b>				
Stand up (days)	2.9 [0.0-12.0]	2.0	2.0	73 (3*)
Sit up (days)	4.0 [1.0-32.0]	4.3	3.0	71 (5*)
Wash oneself (days)	5.3 [1.0-23.0]	3.4	4.0	61 (15*)
Start walking (days)	4.8 [1.0-20.0]	2.9	4.0	74 (2*)
<b>Post- op and hospital stay</b>				
Postoperative care in ICU (days:hrs:min)	01.12.44 [00:09:00-06:15:00]	01:04:26	01:03:00	75 (1*)
Total hospital stay (days)	22.0 [11.0-56.0]	7.9	20.0	76

\* *missing data*

## Factors correlated with early postoperative recovery

Tumour burden, stoma formation, use of CPAP, primary diagnosis, and the length of stay in the ICU were factors related to an early recovery process. Patients with stoma and patients with a larger tumour burden started eating later, and it took a longer time for patients with CPAP to wash themselves and stand up for the first time after surgery. Larger tumour burden also meant later mobilisation. Eating for the first time after surgery correlated with total hospital stay and length of stay in the ICU, which was also correlated with standing up for the first time after surgery (Table 7).

Table 7. Clinical factors related to postoperative recovery

Affected aspect of recovery	Clinical factor	P-value
<b>Physical functions</b>		
Eating for the first time after surgery	PCI	0.03
	Stoma formation	0.003
	Length of ICU stay	0.02
<b>Activity</b>		
Standing up for the first time after surgery	Length of ICU stay	0.003
Sitting down on a chair	PCI	0.002
Washing oneself	PCI	0.002
	CPAP	0.03
Walking for the first time after surgery	PCI	0.03
	CPAP	0.005
Sleeping difficulties	Primary diagnosis	0.003

## Paper IV

### Postoperative recovery after pulmonary AE in the intervention and non-intervention group

Twelve of the 76 patients needed invasive intervention due to postoperative pulmonary AE: thoracocentesis was performed on six patients and six others had chest tubes. None of the 76 patients was re-intubated due to the pulmonary AE.

Mobilisation, restoring gastrointestinal functions, the length of ICU stay and overall hospital stay was the same for the entire study population, regardless of intervention or not.

The patients in the intervention group received approximately four litres of perioperative crystalloids (p=0.02) and five litres of combined crystalloids and colloids (p=0.02) more than patients in the non-intervention group. Four patients in the intervention group required CPAP approximately four days after surgery (median), which was longer (p=0.02) than the 11 patients in the non-intervention group (Table 8).

### Pulmonary adverse events

Sixty-two patients had post-operative thoracic imaging due to clinical signs. Sixty of these were chest X-rays and two were computed tomography (CT). Both atelectasis and pleural effusion in grades 1-4 were seen in 55% of the patients, and 12% had enlargement, dilatation or congestion of pulmonary vessels. Among 76 patients, extensive atelectasis ( $\geq$  grade 3) was observed in six patients, major pleural effusion (grade 3) was found in seven patients, and signs of heart failure (grade 1-2) developed in nine patients (Table 9). Two patients had pneumonia, one had empyema, and another patient developed respiratory insufficiency.

There were no differences in the occurrence of atelectasis and pleural effusion between gender or age ( $<65$  years and  $\geq 65$  years). The presence of atelectasis, pleural effusion and heart failure did not correlate with body mass index (BMI), patients with different primary tumours, operating time, stoma formation, preoperative chemotherapy, and the presence of surgical, infectious or medical AE. Upper-, middle-, or lower abdominal surgical procedures did not correlate with pulmonary AE, nor was there a correlation between diaphragm stripping and pulmonary AE.

Table 8. Comparison of the recovery process in patients with pulmonary AE subjected for intervention and non-intervention groups.

Parameter	Intervention group Mean (CI) n=12	Non-intervention group Mean (CI) n=64	P-value
Use of CPAP (days)	6.8 (3.2-10.3)	3.1(1.4-4.8)	0.02
Perioperative crystalloids (ml)	14842 (12100-17582)	11671 (10677-12665)	0.02
Sum of perioperative crystalloids and colloids (ml)	20629 (16790-24469)	16255 (14702-17808)	0.02

Table 9. Pulmonary adverse events in 76 patients' thoracic organs during 1 week post-surgery, and comparison between gradations performed by radiologists 1 and 2

Images (n)	62		
Thoracic computerised tomography CT (n)	2		
Chest X-ray (n)	60		
	<b>Radiologist 1</b>	<b>Radiologist 2</b>	<b>Cohen's weighed kappa</b> $\kappa = 0.45$
<b>Atelectasis (n)</b>			
None (grade 0)	19	13	
Grades 1 to 4 atelectasis	42	48	
No images*	15	15	
<b>Pleural effusion (n)</b>			$\kappa = 0.41$
None (grade 0)	20	10	
Grades 1-3 pleural effusion	42	51	
No images*	14	15	
<b>Congestive heart failure (n)</b>			$\kappa = 0.41$
None	53	46	
Grades 1-2 heart failure	9	14	
No images*	14	16	
<b>Pneumonia</b>	2		
<b>Empyema</b>	1		
<b>Respiratory insufficiency</b>	1		

*No images\*= no images of thoracic organs were taken during the first postoperative week. Pulmonary adverse events are common after CRS and HIPEC. Cohen's weighed kappa,  $\kappa$ , indicated a moderate level of agreement between the two radiologists.*

## Factors correlated with pulmonary adverse events

Total mechanical ventilation, the length of ICU stay, total hospital stay, tumour burden, and ASA were correlated with the occurrence of atelectasis and pleural effusion (Table 10).

Patients with segmental or larger atelectasis ( $\geq$  grade 2) were extubated 1.2 days (mean) later than patients who had atelectasis grades 0-1. Length of ICU stay and total hospital stay correlated with the occurrence of atelectasis. Pleural effusion correlated with tumour burden i.e. PCI, ASA, and duration of stay in the ICU. The patients with grades 1 and 2 pleural effusion had greater tumour load ( $PCI > 24$ ) and higher ASA grade than patients who had no pleural effusion. Patients with a moderate amount of pleural effusion

(grade 2) had an approximately 23 hours (mean) longer stay in the ICU than the patients with no effusion.

The occurrence of heart failure (grade 1-2) in nine patients correlated with oral intake ( $p=0.02$ ), bowel movement ( $p=0.03$ ), the length of ICU stay ( $p=0.03$ ), and total hospital stay ( $p=0.02$ ).

Table 10. Influence on recovery and clinical parameters by the presence of atelectasis and pleural effusion.

Affected aspect of recovery	Pulmonary adverse events	P-value
<b>Post- op and hospital stay</b>		
ICU stay	Atelectasis	0.03
	Pleural effusion	0.02
Total hospital stay	Atelectasis	0.02
<b>Clinical factors</b>		
Mechanical ventilation	Atelectasis	0.02
PCI	Pleural effusion	0.02
ASA	Pleural effusion	0.02

*Total mechanical ventilation, the length of ICU stay, total hospital stay, tumour burden, and ASA were correlated with occurrence of atelectasis and pleural effusion.*

# Discussion

This thesis presents staff members and their leaders' understanding of efficiency in two different settings, and the early recovery process of patients with peritoneal carcinomatosis.

The findings indicated efficiency was understood in different ways by staff members and their leaders, and that in a team organisation, staff members had a wider understanding of the concept of efficiency, with a focus on the patient and the quality of care. Patients with PC regained their gastrointestinal functions and could be mobilised during the early postoperative recovery phase, and clinical and radiological pulmonary AE did not affect this early recovery process.

## The concept of efficiency in different organisational settings

The concept of operating room efficiency was understood in different ways by staff members and their leaders in a non-team organisation, which might reflect different definitions of efficiency, where efficiency was defined as 'doing things the right way', 'obtaining the maximum benefits from the resources available', or efficiency being a product of productivity and quality (16-19, 27- 31). The development of management theories might have influenced the evolution of these different definitions.

Throughout the 20<sup>th</sup> century, several management theories laid the foundation for increasing efficiency at work (32). While the first theories of Taylor, Weber and Fayol highlight the importance of centralisation of power and standardisation of the work process, the development of human relations (32) emphasises employees' need to be recognised by their leadership and to build groups to which they can belong. Human relation studies and the subsequent fusion theory are based on the existence of a relationship between efficiency, quality and profitability in an organisation (32): it is important to have employees who are satisfied with their work performance.



This led to, decentralisation of power, which was later included in lean production (32).

This continued development in management history might support the concept of efficiency being too complex a phenomenon to be described in just a few ways. During the interviews in a non-team organisation, neither the staff members nor their leaders discussed the quality of care, even though every organisation should be measured by both the volume produced (whether physical products or services) and the quality of the product.

Moreover, the way a person understands a phenomenon (e.g. efficiency) is linked to how the person deals with that phenomenon (78, 79, 82, 83). This may explain why it is difficult to achieve efficiency at work, as efficiency is understood differently by staff members and leaders.

Leaders who are aware of the variation in understanding between staff members and the leaders are more capable of defining the concept of efficiency and creating the same platform for everyone within the organisation to increase efficiency. Another step is to increase staff members' competence (91). Studies on competence at work by Larsson et al (84), Lindberg (92, 93), and Sandberg (91) emphasise that understanding more than one aspect of work leads to improved ability in dealing with problems at work, which in turn, improves competence (91). Competence does not develop solely from knowledge and skills, but reflections about one's work and a broader understanding are important in becoming competent in a profession (91-93). Thus, a wider understanding of efficiency improves the ability to act efficiently in the workplace.

With the aim of increasing efficiency in the care of patients with PC in the surgical department, a team of operating room nurses, nurse anaesthetists, assistant nurses, surgeons, and anaesthesiologists was created at Uppsala University Hospital, where patients with PC have been treated since 2003. The PC team members had a wider understanding of the concept of efficiency, which meant their understanding included several aspects of efficiency than staff members in a non-team organisation. The PC team members described efficiency as maintaining quality of care and measuring the benefits of care for patients. The involvement of the PC team in organising patient care broadened the perception of efficiency from the individual's own efficiency to an organisation-oriented understanding of efficiency. However, the non-team and team organisations were in different settings, which might have had an impact on the results from the two studies.

To improve teamwork and quality of care, the team members aimed to develop new methods actively and systematically, through evaluating old methods and focusing on patients' needs. Although the PC team had not

consciously chosen to work under lean production, during the interviews, the team members described their work process in terms of lean production.

In health care, lean production is directed towards meeting patient needs by reducing all steps not of value to the patient and not wasting the patient's time (33). Teambuilding plays a crucial role in making the work process efficient for the patient (35, 36). Preparing a patient for surgery requires cooperation between several different units and professionals, and to increase efficiency in care, efforts should be made in several directions, both towards the staff members and the patient, for example in patients' postoperative recovery after surgery.

## Early postoperative recovery from CRS and HIPEC

The postoperative process, according to Allvin (39), is defined as an energy-requiring *process*, which extends to the post-discharge period. Only the early phase of postoperative recovery was studied in this thesis and before the overall postoperative recovery process after any kind of cancer surgery, especially for PC, can be understood for patients, further study is needed.

## Physiological dimension of early postoperative recovery and activity in patients with PC

In the early phase of recovery after surgery, patients with PC struggled with several physiological symptoms, such as nausea and sleep disturbances (67% of the patients). Despite the extent of the surgery, oral intake of fluids and food, bowel function, and mobilisation were restored within 7-11 days of surgery. Due to the complexity of the CRS and HIPEC treatment, it is difficult to compare the results with other surgical procedures where the hospital stay is shorter because of, for example, fast track surgery (94, 95). In fast track surgery, early oral feeding starts a few hours after surgery to prevent nausea and postoperative ileus, and pain is managed through epidural analgesia and Non Steroid Anti-inflammatory Drugs (NSAIDs) (94, 95). For patients with PC, it may be difficult to follow an early oral feeding regimen due to gastric retention and postoperative fatigue, and NSAIDs are not a part of pain management.

The majority of the PC patients had epidural analgesia, and 42 of 57 patients were satisfied with their pain management. However, the subjective evaluation of pain management was missing for 19 of the patients, which rendered it difficult to comment on the success of the pain management: a

prospective study would limit this missing data. Although the patients did not have tunnelled epidural catheters, the use of an epidural was extended until eight days postoperatively. This was an exception to general recommendation at the Uppsala University Hospital, which only uses non-tunnelled epidural catheter for 3-5 days due to the risk of infection; however, no infections were documented due to the epidural catheter. Pain management is crucial for surgical patients, especially those undergoing major surgery, and patient satisfaction with pain management can enhance both the progress of mobilisation (96) and wound healing (97).

## Psychological health

As the documentation of patients' psychological health consisted of short descriptions, it was difficult to determine the real reason behind the patients' reactions. This was a shortcoming of this study. Psychological distress (anxiety, worry, feeling down or abandoned) were documented in 64% of the patients' EHR and 18% of the patients required psychological support (anti-anxiety medication, and/or a contact with a priest, a social worker, or a psychologist), but this number might be underestimated. The patients' psychological distress could last for the entire hospital stay, a period of three weeks.

In a study by Nordin and Glimelius (98) reactions in newly diagnosed patients with gastrointestinal cancer reveal patients with colon and rectal cancer, who potentially were cured, have more confrontational attitudes toward their diagnosis, whereas, non-cured patients (patients with pancreatic/biliary or gastric cancer) have higher levels of anxiety and depression. Studies on quality of life in patients with PC by McQuellon (99) and Hansson (1) indicate an initial decrease in physical, functional and wellbeing scores directly after surgery, recover to baseline levels three, six and 12 months postoperatively (1, 99). At the time of surgery, about 32% of patients may suffer symptoms of depression, which may remain for up to one year after surgery in 24% of patients (99).

The results from studies on quality of life are not readily comparable with the results from this thesis on patients' psychological health during early postoperative recovery because longitudinal studies on patients' quality of life may not include the patients' early postoperative recovery. On the other hand, the patients themselves did not describe their early postoperative recovery, as is the case in other studies on quality of life (99, 1).

Nevertheless, the importance of rigorously documenting patients' reactions both before and after surgery is required, as reactions may persist long after discharge (99) and have an impact on postoperative recovery. Therefore,

preparing patients through psychological support and physical activity before surgery (13) is important.

## Factors to consider when planning postoperative recovery

According to Hansson (1) and van Leween (48) several factors, such as diagnosis, duration of surgery, PCI score, number of organs removed, perioperative blood loss, and chemotherapeutic agent given during surgery may affect postoperative AE (1, 48) and thus, postoperative recovery. In the studies for this thesis tumour burden, stoma formation, the use of CPAP, primary diagnosis, and the length of ICU stay correlated with an early postoperative recovery process. Stoma formation has an impact on patients' social life (1), and the policy of the PC centre at Uppsala University Hospital is to create protective stoma only when low colorectal anastomosis has been performed, as anastomotic dehiscence from this site can cause major morbidity. This policy is in line with previously reported data (100, 101).

## Pulmonary AE and related factors

Over half of the patients (55%) developed atelectasis and pleural effusion grades 1-4, and 12% had enlargement of pulmonary vessels or signs of congestion. However, no correlations were found between the administered fluids and the occurrence of pulmonary AE (i atelectasis, pulmonary effusions, signs suggestive of congestion or congestive heart failure and pneumonia). Although it can be speculated the operating site close to the diaphragm (upper abdominal), the large amount of fluids administered during surgery (102, 103), and the length of mechanical ventilation time (104-106) has an impact on the development of pulmonary AE, this was not found in the studies for this thesis.

The postoperative recovery parameters (mobilisation, i.e. activity of daily life functions, restoration of gastrointestinal functions, and the need for psychological support) did not correlate with the presence of atelectasis, pleural effusion or heart failure. However, further prospective studies are needed to distinguish which grades of atelectasis or pleural effusion are important for treating more aggressively during the postoperative period: not all grades of pulmonary AE are clinically important or have an impact on the patient's postoperative care.

There was a correlation between tumour burden, total mechanical ventilation time, total hospital stay, ASA and atelectasis and pleural effusion. Patients with larger atelectasis ( $\geq$  grade 2) were extubated 1.2 days later than patients

who had less atelectasis, and patients with moderate amounts of pleural effusion (grade 2) stayed approximately 23 hours longer in the hospital, as is suggested earlier (104). There were only six patients with atelectasis larger than segmental ( $\geq$  grade 2), and one possible explanation for the relationship between atelectasis and extubation might be the extension of surgery. However, a larger number of patients are required in order to confirm this.

There was a correlation between the nine patients with signs of heart failure (grades 1-2) and regaining gastrointestinal functions, ICU stay, and total hospital stay. Although this may appear logical, as patients with heart failure or signs suggestive of congestion need longer time to regain their functions, it was difficult to draw reliable conclusions due to the limited number of patients. However, this finding warrants further study.

There is limited information on grading the occurrence of atelectasis, pleural effusion or heart failure clinically and radiologically. Therefore, as this grading was a first attempt, it needs validating in further studies.

### Invasive intervention does not affect postoperative recovery

Twelve patients needed invasive intervention due to the pulmonary AE: six patients had thoracocentesis and six received a chest tube. None of the patients was re-intubated due to the pulmonary AE. However, restoration of gastrointestinal functions and mobilisation was the same for patients in both the intervention and non-intervention groups.

There was a difference between the intervention and non-intervention groups with regard to perioperative crystalloids and the total sum of crystalloids and colloids, which might explain the occurrence of atelectasis. However, there was no correlation between perioperative fluids and the occurrence of atelectasis.

Van Leeuwen et al (48) argue strict selection of patients for surgery may have an impact on the limitations in surgical outcomes. For example, it may have led to a limited number of patients with pulmonary AE requiring an intervention. None of the patients had any signs of congestive heart failure, and only four patients had co-morbidities, such as chronic obstructive disease, asthma, cardiovascular disease or diabetes, prior to surgery. These results, combined with the limited number of the patients in the intervention group warrant further study with a larger numbers of patients before any reliable conclusions can be drawn.

## Organised surgical teams and preoperative patient preparation-steps to increase efficiency in the care of patients

At Uppsala University Hospital, the PC team cooperated with both the outpatient clinic and surgical wards in preparing patients for surgery and with perioperative visits; consequently, the team members began to work in terms of lean production. A team of registered nurses responsible for the patients' pain management and many other professionals were engaged in the postoperative care of the patients.

The building of a team to work only with patients with the same diagnosis might have had an impact on the team's understanding of efficiency. For the patients, several steps should be taken to involve them in their care in order to make postoperative care a more efficient process. Patients with PC followed a postoperative mobilisation schema designed by physical therapists, nurses, and surgeons. Although the impact of this schema on postoperative recovery was not studied, the effect of such a schema should be evaluated as a further step in making the care of the patients more efficient.

Fast track surgery (74, 75) is another example where patients are prepared preoperatively, and this is combined with perioperative measures such as restrictive perioperative fluid therapy, good pain management, and early postoperative oral feeding. Accelerated recovery requires patient preparation (13, 74, 75), both physically and psychologically (13), and the commitment of a multi-disciplinary team (58). Although fast track regimens might not be suitable for patients with PC who go through major surgery, such as CRS and HIPEC, patient preparation, good pain control, and passing greater responsibility to the patients postoperatively are aspects of fast track surgery that could be applied to patients with PC. These aspects may be in line with the principles of lean production and creating value for the patients. Thus, for patients with PC, the purpose should be to make the recovery process as easy as possible for the patients rather than aim for fast recovery.

There are many benefits of early postoperative recovery for the patient (107), and early discharge puts the responsibility of post-discharge care onto the patients and their families. Different theories are utilized for the concept of recovery (40, 41, 76). Dorothea Orem's theory of self-care advocates individuals are able to practice self-care, that is, patients performing activities on their own behalf for maintaining life, health, and wellbeing (40-42).

A belief in a patient's ability to care for him/herself increases the patient's sense of personal control (40-42). The nurse's role in this self-care is to

strengthen the patient's self-care skills when and where the patient needs it (40-42). Patients may be involved by receiving information about postoperative care or being more active in performing activities before surgery that will enhance the postoperative recovery process (108, 109). This results in the patient gradually reaching a level of postoperative independence, and may decrease psychological symptoms (110, 111). Age, state of health, environment, and family affect the patient's ability to exercise self-care (41), and in order to increase the patient's self-care skills, patient participation and education is required (112).

In a study by Arving and colleagues, individual cognitive behavioural therapy, such as relaxation and distraction, activity scheduling, and ways of improving communication are used with breast cancer patients after the start of chemotherapy treatment (113). Over time, individual cognitive behavioural therapy improves insomnia and dyspnoea for the patients. However, it is recommended that specially trained nurses, as an alternative to the psychologists, provide patients with this kind of psychological support (113), as nurses are in close contact with patients and can be successfully educated for this task (114). Individual cognitive behavioural therapy sessions are usually given after the start of chemotherapy treatment, and a further step may be needed for patients with PC, such as preparing the patients preoperatively with this cognitive behavioural therapy.

## Methodological considerations

The strength of this thesis is that it contains both qualitative and quantitative research designs. Efficiency in care was studied from both the staff members' and their leaders' perspective and in terms of patient postoperative recovery. Although the patients' postoperative recovery process was described, their voice was not heard, and the patients were actively not involved preoperatively in the postoperative care.

One challenge was to identify a correct translation of the words efficiency and effectiveness, which in Swedish are both translated as 'effektivitet'. However, as the interviews were conducted in Swedish, 'effektivitet' meaning 'efficiency' was the word used throughout the whole thesis. If the studies had been performed in English, the starting point would be to decide whether the same phenomena (efficiency) or a different phenomenon (efficiency, productivity, or effectiveness) were the focus of the study.

The concept of efficiency was studied in two different settings, which may have influenced the understanding of efficiency in the organisation. As there were both similarities and differences in the understanding of efficiency between the two organisations, this warrants further investigation.

Another difficulty was deciding the period that constituted ‘early’ postoperative recovery. The concept of early postoperative recovery stems from ambulatory surgery, and there may be differences between the recovery process between ambulatory and major surgeries. As CRS and HIPEC are deemed major surgery, it was difficult to compare the postoperative recovery process after major surgery with that after ambulatory surgery. However, patients may follow the same pattern but in several steps and at different times. Therefore, the early and a part of the intermediate postoperative recovery process, according to Allvin (39), were used synonymously for the recovery process until discharge from the university hospital. After discharge from the University Hospital, PC patients may need care in a local hospital close to their homes. The recovery process in the local hospital, and the social dimension of the postoperative recovery process that may occur after discharge, were not included in this thesis.

## Paper I

The strength of the study presented in Paper I is that it is one of the few studies examining the concept of efficiency as it is understood by the operating room staff members and their leaders. As the aim was to investigate variations in understanding a phenomenon, this decided the choice of analytical method. A phenomenographical approach was used to analyse the interviews and describe variations in how people understand a phenomenon.

A familiarity with the study context was a benefit for analysing the interview texts and understanding the content of the interviews. However, working in a similar environment can affect the interpretation of the interviews due to researcher bias. To minimise this risk and increase confirmability (objectivity) and credibility (internal validity), three researchers, one of who did not work in a surgical setting, independently performed the analysis (two working together and one working separately).

Individual interviews were conducted with 21 informants chosen by purposive sampling to represent a broad spectrum of experience and professional roles. This is important in phenomenographic analysis for describing the variations in understanding: 20 informants are considered sufficient for identifying the variation (83).



## Paper II

This study qualitatively analysed the concept of efficiency in a team organisation working with lean production principles.

A limitation is that only one team was included in this study. However, in contrast to non-organised teams, this team presented a new working method that followed lean production principles and had an unusually narrow focus on one patient group. Eleven participants were interviewed; this was less than ideal but proved sufficient to allow a variation to be discerned.

In phenomenographic research, the number of interviews must ensure a variation in how the phenomenon being study is considered, but unmanageably large numbers of interviews should be avoided (115-117). The ideal number is 20-30, with 10-15 interviews being a minimum, although patterns of variations in understanding can be discerned even after 5-10 interviews (117).

Another limitation was that two of the researchers involved in the study had previously worked with some of the study participants. As this might introduce researcher bias, another author working in a different setting was involved (to guarantee confirmability and credibility). In addition, confirmability (objectivity) of the findings was guaranteed by presenting citations from the interviewees' descriptions (118, 119) within each category.

To retain dependability (reliability), the interview guide was used in a first interview with an operating room nurse, who did not participate in the study. As no further corrections to the interview guide were needed, all participants were asked the same questions.

To assure credibility (internal validity) of the methodological procedures in Papers I and II, both study procedures are described thoroughly, and the reader has the possibility to decide whether the results are relevant in other situations (transferability or external validity).

## Paper III

The study in Paper III was a retrospective study that provided insight into the postoperative recovery for patients with PC. One limitation of this study was that the recovery process was described by a third party, that is, it was recorded in the patient's electronic health record (EHR) by a registered nurse or a surgeon, and not described by the patients themselves. This created a further limitation in that there was lack of documentation in both medical

and nursing records. In order to retain all information, the entire documentation for the whole hospital stay was examined; therefore, data collection and analysis were rigorous.

A prospective study may reduce shortcomings in documentation, and the study of the postoperative recovery process must include all dimensions of postoperative recovery and through all phases, even after discharge. This would include both auditing health records and interviewing patients. Patients' descriptions of their psychological health, how they cope with difficulties during different phases of the postoperative recovery, and the recovery process in general could be improved through further qualitative work.

During surgery, the abdomen was divided purposely into three different regions in an attempt to classify the factors influencing patient postoperative recovery and pulmonary adverse events resulting from extensive surgical trauma. The study design presented both strengths and weaknesses to the study, as it was the first time that both postoperative recovery after CRS and HIPEC has been described and this kind of classification attempted. The impact of the classification has not validated, but warrants further study.

## Paper IV

The number of patients requiring invasive intervention was limited, which rendered it difficult to draw reliable conclusions. However, the study was unique in that it investigated pulmonary AE after CRS and HIPEC, and their impact on patients' postoperative recovery: in effect, this described the "true life situation". If a patient presented clinical signs of pulmonary AE, a radiological image (bedside chest X-ray and/or CT scan) was taken. Although radiological images are not routinely taken, images were taken for 62 of 76 patients. Even so, there might be a lack of some data and the use of bedside chest X-rays and CT scans might be incomparable. Further prospective studies with radiological examinations scheduled for predetermined dates and with larger numbers of patients could provide better information from which to draw reliable conclusions.

Although the gradation of atelectasis, pleural effusion and heart failure were not established, similar findings are reported (104). The inter-rater reliability ( $\kappa$  value) between the radiologists' only had moderate agreement, but even though this was a weakness, it demonstrated the grading process was rigorous.

# Conclusions

This thesis focussed on operating room efficiency from both the staff and their leader's perspectives and the early postoperative recovery for the patients with peritoneal carcinomatosis.

- The concept of efficiency was understood in different ways by staff members and leadership in an organisation without organised surgical teams. Leaders who were aware of this variation are able to create a common platform for increasing efficiency at work. To lead staff members towards the same goals, the leaders need to define the concept of efficiency and understand the staff members' way of conceptualising efficiency.
- In a team organisation that treated patients with PC through a loco-regional approach and worked with the principles of lean production, seven ways of understanding efficiency were identified. The ways of understanding operating room efficiency appeared to represent both individual-oriented and organisation-oriented understanding of the concept. Being patient-focussed, efficiency was understood as maintaining quality of care and measuring benefits of care for the patients.
- Evaluation of the early postoperative recovery highlighted oral intake, regaining bowel functions, and mobilisation were re-established within 11 days of CRS and HIPEC. Tumour burden, stoma formation, use of CPAP, primary diagnosis, and the length of stay in the ICU had an impact on postoperative recovery. In order to attain a more efficient recovery, these factors should be discussed with the patients preoperatively and taken into consideration when designing an individualised patient care plan.
- Clinical and radiological postoperative pulmonary adverse events were common after CRS and HIPEC. However, few pulmonary adverse events affected postoperative recovery. Total mechanical ventilation, the length of ICU stay, total hospital stay, tumour burden, and ASA were correlated with the occurrence of atelectasis and pleural effusion.

# Clinical implications and future research

This research began with questions about efficiency in the care of patients with PC who undergo complex treatment with CRS and HIPEC. In the Main surgical department at Uppsala University Hospital, a team was created to work only with patients diagnosed with PC. This raised the questions of what staff members considered 'efficiency' was, whether there was confusion about the concepts of 'efficiency' and 'productivity' among staff members and their leaders, and whether a team could become efficient without engaging the patients in their own care.

It is possible patients can do more to positively influence their postoperative recovery process, not just after surgery but while awaiting surgery. Therefore, the focus of this thesis was to study the patients' postoperative recovery, as this has not been studied in patients diagnosed with PC.

The study in Paper I highlighted the concept of efficiency could be understood in several ways by staff members and their leaders, and leaders who were aware of this variation were better able to create the same platform for staff members within the organisation. Although it is not possible to ask staff members to adopt the same understanding of efficiency, a first step for leadership is to define efficiency in their units/organisations. In this way, staff members and their leaders will speak a common language and be able to follow and work towards the same goal.

In the study in Paper II, team members reached a more organisation-oriented understanding of efficiency at work that focussed on the patients and quality of care. Thus, a second step to implementing the results from this thesis would be to give the teams the freedom to assume responsibility for being creative and deciding their own work methods, for example adopting the principles of lean production, as long as this abided by the guidelines and regulations of the organisation.

For patients with PC, many steps could be taken to implement the knowledge gained from studies about postoperative recovery and pulmonary AE after CRS and HIPEC. However, the factors affecting the recovery process and pulmonary AE need to be considered when caring for these

patients. These factors should be studied closely in both larger numbers of patients and in patients undergoing other major surgical procedures.

The patients' psychological health and sleeping difficulties warrant special attention. This means the impact of postoperative nausea and vomiting, pain management, and intraoperative fluids on pulmonary AE should be studied prospectively.

The knowledge gained from the studies in this thesis could be used both for evaluating patient care in hospital and as the basis of information that is distributed to the patients and their caregivers. In this way, there is an opportunity for improving care for patients with PC and for other patients scheduled for major surgery. Patients should become more actively involved in, and prepared for, their own care, both physiologically and psychologically. This could be achieved through individual psychosocial support administered by surgical ward nurses, both after surgery and while waiting for the surgical procedure.

This thesis attempted to describe the early postoperative recovery process for patients with PC. However, further investigation into engaging patients with PC in their own care is warranted. The work presented in this thesis presents a foundation that in the future may not just help one group of patients to improve their postoperative care process and efficiency in care, but even patients with other diagnoses requiring major surgery.

## Svensk sammanfattning (Swedish summary)

Dagens sjukvård står inför en stor fråga. Hur ska de befintliga resurserna användas på ett effektivt sätt med bibehållen kvalitet för patienten? Den medicinska och tekniska utvecklingen har lett till att patienter med svår cancersjukdom, som var omöjliga att behandla tidigare, idag behandlas med framgång.

CRS och HIPEC är ett exempel på stor kirurgi som utförs på patienter med peritoneal carcinomatos (PC) med framgång idag. CRS eller peritonektomi betyder borttagande av synlig tumörvävnad från bukhålan och bukhinnan, och genomförs i kombination med uppvärmd cellgiftsbehandling i bukhålan under pågående operation, dvs. HIPEC. Patienter med PC har modertumörer som kan utgå ifrån magsäcken, blindtarmen, tjocktarmen, ändtarmen, äggstockarna eller bukhinnan. Trots konventionell behandling med borttagande av modertumören och intravenös cellgiftsbehandling har PC mycket dålig prognos (oftast 4-15 månader). Rapporter från några få centra i världen har visat att man med omfattande tumörreducerande kirurgi, dvs. CRS och HIPEC, har kunnat förbättra fem-årsöverlevnaden (ca 20-90%) för patienter med PC. Denna behandling är resurskrävande både för patienten och vården och har tillämpats vid Akademiska sjukhuset sedan 2003, vilket är Sveriges och Nordens enda etablerade centrum för PC behandling.

För att effektivisera vården av patienter med PC på Akademiska sjukhuset har ett team av kirurger, anestesiologer, operations- och anestesijuksköterskor samt undersköterskor bildats (PC-teamet). Vidare har vårdkedjan stärkts mellan mottagning, operation och avdelning. Teamet på operationsavdelningen arbetar målmedvetet med ständiga förbättringar av vårdprocessen för patienten enligt 'lean production-principerna'.

Kunskapen om att behandla PC ökar ständigt, men lite är känt om patienternas återhämtning efter operationen i både tidig och sen fas samt om vilken betydelse teamet har för effektivisering av vården.

Effektivitet och produktivitet är centrala begrepp som används inom sjukvården och i synnerhet vid opererande enheter. Dessa begrepp definieras på flera sätt och används ibland som synonymer, vilket kan skapa en förvirring hos personalen och göra det svårt för ledningen som försöker effektivisera arbetet på sin enhet.

I denna avhandling studerades effektivitet från två utgångspunkter: personalens uppfattning om effektivitet och patientens återhämtning efter operationen.

Det övergripande syftet med avhandlingen var att undersöka hur effektivitet uppfattades av personal och ledning i en icke-teamorganisation samt i en teamorganisation. Ett annat syfte var att beskriva hur patienter med PC återhämtar sig under tidig postoperativ fas (under sjukhusvistelsen före utskrivning) efter operationen.

Delarbete I och II har kvalitativ metodologi och i delarbete III och IV har kvantitativa metoder använts. I de två första delarbetena har fenomenografisk analysmetod tillämpats, vilken syftar till att undersöka variation i människors uppfattningar. Metoden utvecklades inom pedagogiken, men kom även att användas inom studier gällande kompetens i arbetet. Utgångspunkten är att människor uppfattar olika fenomen i sin värld på ett begränsat antal sätt. Människors tankar kan påverka deras handlande i olika situationer genom att de får möjlighet till att reflektera över sitt eget förhållningssätt till dessa fenomen. Om man förstår hur människor tänker, kan man i slutändan även ha en inverkan på hur dessa agerar/handlar.

## Delarbete I

Syftet i delarbete I var att studera variationen i uppfattningar hos ledning och personal om begreppet ”effektivitet” i en icke-teamorganisation. Tjugoen personer (17 kvinnor) intervjuades: kirurger, anestesiloger, anestesioch operationssjuksköterskor och undersköterskor samt avdelningschefer och verksamhetschefen på en operationsavdelning på ett medelstort sjukhus i centrala Sverige där man inte arbetar i något specifikt team. Frågorna handlade om ”flyt och hinder i arbetet” och vad ordet ”effektivitet” betydde för deltagarna.

Resultatet visade att effektivitet kunde uppfattas på sex olika sätt: 1) att ha rätt kvalifikationer, veta vad man ska göra och hur man kan förebygga problem, 2) att vara tillfredsställd med sitt arbete genom att se meningen med det, 3) att planera och ha kontroll över arbetsprocessen och skapa bra patientflöde, 4) att arbeta med rätt arbetsuppgifter, 5) att slutföra en given uppgift inom given tidsram och 6) att producera så mycket som möjligt per tidsenhet.

Ledningen och personalen uppfattade effektivitet på olika sätt. Ledningen och läkarna med större ansvar för patienten och produktionen uppfattade

effektivitet i produktionstermer medan personalen som har mindre ansvar för produktionen uppfattade effektivitet som att ha kompetens/kunskap och erfarenhet.

## Delarbete II

Syftet i delarbete II var att undersöka hur effektivitet uppfattades av medlemmarna i ett team (PC- teamet) och deras ledare. PC teamets nio av tio medlemmar, avdelningschefen och verksamhetschefen (fem män, sex kvinnor) intervjuades.

I en teamorganisation uppfattades effektivitet på sju olika sätt: 1) att göra sitt bästa och göra vad man ska göra för att få bra 'flyt' i arbetet, 2) att arbeta med stor glädje, ändra arbetstempo för att spara energi och anpassa den till olika situationer, 3) att samarbeta med teamets medlemmar och använda varje persons kapacitet på bästa sätt och arbeta med rätt saker vid rätt tidpunkt, 4) att få de önskade resultaten med minsta möjliga resurser, 5) att arbeta på ett kvalitetsbevarande sätt så fort som möjligt, 6) att uppnå långsiktig patientnytta, 7) att effektivitet är ett begrepp som måste relateras till en individs förutsättningar och erfarenhet och en grupps resurser.

Att arbeta i teamorganisation ledde till att det fanns både individuella och organisations-orienterade uppfattningar om effektivitet. Patienten och kvaliteten i vården var i fokus, och ansvarskänslan mot patienten att operationen skulle äga rum som planerat var stark bland teamets medlemmar. Att samarbeta i teamet, att arbeta mot samma mål och att göra sitt bästa för att skapa bra "flyt" omnämndes av flera medlemmar. PC-teamets medlemmar tyckte att de hade ett effektivt team.

## Delarbete III

I delarbete III var syftet att studera återhämtningsprocessen för patienter med PC och de faktorer som påverkar återhämtningen under den tidiga fasen av återhämtningen (under sjukhusvistelsen före utskrivning). En journalgranskning genomfördes på 76 patienter (42 kvinnor, 34 män) som opererades på ett universitetssjukhus för första gången pga. PC.

Resultatet visade att patienterna började äta och dricka och återfick tarmfunktionen efter ca elva dagar efter operationen. Illamåendet varade i ca två veckor postoperativt. Sjuttiofyra procent av patienterna var nöjda med



smärtlindringen, vilken hos de flesta genomfördes via epiduralanalogi före operationsstarten och fortsatte till en vecka efter operationen. Sömnsvårigheter förekom hos mer än hälften (67%) av patienterna, 64% upplevde oro, ångest, en känsla av övergivenhet under de tre postoperativa veckorna, och 18% behövde någon form av lugnande och antidepressiva läkemedel, eller psykologisk stöd av en kurator, en sjukhuspräst eller en psykolog. Tumörbörda, stomi, användande av CPAP, primär diagnos och längden på vistelsen på intensivvårdsenheten var faktorer som var korrelerade med tidig postoperativ återhämtning.

## Delarbete IV

I delarbete IV var målet att beskriva lungpåverkan och dess relaterade faktorer efter CRS och HIPEC behandlingen samt lungpåverkans effekt på den postoperativa återhämtningsprocessen.

Resultatet visade att 55% av patienterna hade atelektas<sup>1</sup> och pleuralvätska<sup>2</sup> båda i graderna 1-4 och att tolv procent av patienter hade tecken på hjärtsvikt. Bland 76 patienter, sex patienter (8%) utvecklade extensiva atelektaser ( $\geq$  grad 3). Stora mängder pleuravätska (grad 3) fanns hos sju patienter (9%) och nio andra patienter fick tecken på hjärtsvikt (grad 1-2). Tolv patienter (16%) behövde någon form av intervention<sup>3</sup> pga. lungpåverkan. Sex av 76 patienter fick thoraxdränage<sup>4</sup> för att dränera vätska från lungorna och sex andra fick genomgå pleuratappning<sup>5</sup>. Ingen patient reintuberades pga postoperativa atelektaser eller pleuravätska. Dessa tolv patienters återhämtning var samma som för övriga patienter i gruppen när det gäller oralt intag, normaliserad tarmfunktion och mobilisering<sup>6</sup> efter operationen.

Den totala tiden i respirator, längden på vistelsen på intensivvårdsenheten och den totala vårdtiden var relaterade till förekomsten av atelektaser, och det fanns en korrelation mellan tumörbörda, ASA-klass och längden på vistelsen på intensivvårdsenheten med förekomsten av pleuravätska. Förekomsten av atelektaser, pleuravätska och hjärtsvikt korrelerade varken

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<sup>1</sup> Sammanfall av en del av lungan som förlorat sitt luftinnehåll

<sup>2</sup> Vätska i lungsäcken

<sup>3</sup> Kirurgisk/medicinsk åtgärd

<sup>4</sup> Lungsäcksdränage

<sup>5</sup> Tappning av vätska från lungsäcken

<sup>6</sup> Att stå upp, att sitta, att tvätta sig, och att gå för första gången efter operationen

<sup>7</sup> Injicerat i en ven

med den postoperativa mobiliseringen eller med de normaliserade gastrointestinala funktionerna. De stora intravenösa<sup>7</sup> vätskemängder som patienterna fick under operationen påverkade inte förekomsten av postoperativa atelektaser, pleuravätska eller hjärtsvikt.

## Slutsats

- Effektivitet uppfattades på olika sätt av såväl ledarskapet och läkarna som personalen i en icke-teamorganisation.
- I en teamorganisation hade teamets medlemmar både individorienterade och organisationsorienterade uppfattningar om effektivitet med fokus på patienten och kvaliteten i vården.
- Patienter med PC återfick sina gastrointestinala funktioner och kunde mobiliseras under sjukhusvistelsen, före utskrivning från sjukhuset. Sömnsvårigheter, känsla av oro, ångest och övergivenhet förekom hos mer än hälften av patienterna.
- Lungpåverkan var vanlig efter CRS- och HIPEC-behandling. De postoperativa lungproblemen påverkade varken patienternas återhämtning av gastrointestinala funktioner eller mobilisering.

## Förslag till framtida forskning

För att öka effektiviteten i vården och för att skapa gemensamma mål inom organisationen bör begreppet effektivitet definieras inom organisationen. Ett annat steg är att ge ansvar till teamen att inom organisationens ramar planera och genomföra sin arbetsprocess självständigt med fokus på patienten, vårdkvaliteten och förbättring i teamets arbetsprocess t.ex. i enlighet med principerna i 'lean production'. Som nästa steg i patientens återhämtning bör patienten förberedas psykiskt och fysiskt redan före operationen, vilket kan underlätta den postoperativa återhämtningen.

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