Improvement in perioperative care of the day case patient; logistics and quality of care

Anaesthesia impact in Day Surgery

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Cover illustration: “Vattenfallet” by Nils von Dardel (Sweden, 1888-1943)

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To Lars, Mercedes and Siri

"An expert is a person who has made all the mistakes that possibly can be made in a very narrow field."

NIELS BOHR, 1885-1962

"What you have learned to understand, one no longer fears."

MARIE CURIE, 1867-1934

ABSTRACT

Background: The "Day surgery concept" is increasing and nowadays numerous of surgical procedures in patients of all ages, with different comorbidities are performed as day case surgery. Day surgery (DS) is a process; not a procedure. Anaesthetic method, multi-modal analgesia, new surgical minimally invasive techniques and a mind-set to facilitate a rapid recovery are all of importance. Thus, multiple factors influence a safe, effective and successful perioperative course combining high quality of care with rapid recovery, enabling patients to be safely discharged on the day of surgery.

Aim: To investigate how different parts of the perioperative care *per se* affects resource utilisation, logistics and quality of recovery in three common DS procedures.

Methods: *Paper I*; A retrospective observational study in patients scheduled for pelvic organ prolapse (POP) surgery assessing discharge on day of surgery, impact of "annual changes" (2012-14) and anaesthetic techniques in 4 different hospitals. *Paper II;* A prospective randomised study in male patients scheduled for open hernia repair assessing the impact of surgical scrub/sterile covering before *vs.* after induction of general anaesthesia on haemodynamic changes, medication, logistics and quality of care. *Paper III;* A prospective randomised study performed on patients scheduled for surgery

of distal radial fractures (DRF) investigating the impact of 3 different anaesthetic methods on postoperative pain, postoperative opioid consumption and logistics the first postoperative week. *Paper IV*; A subgroup of study III patients, prospectively randomised to 2 different immobilisation methods, brace vs cast, assessing patients self-assessed Quality of recovery (QoR-15), postoperative opioid use and logistics the first postoperative week.

Results: *Paper I;* The use of local anaesthesia and sedation (LAS) significantly increased the by-passing of PACU to a step-down unit and discharge day of surgery during the study period. *Paper II;* No differences in vasoactive medications was found between groups, but there was a significant decrease in PACU-time in awake patients. Both patients and surgical nurses found the awake procedure acceptable. *Paper III*; The pain scores and postoperative opioid consumption were significantly higher in the supraclavicular block (SCB) group with long-acting local anaesthetic agent (long-LA) compared to short-acting (short-LA) 24-hours post-surgery and during the first 3 postoperative days. The long-LA-group also had most unplanned healthcare contacts postoperatively. Most SCB-patients could by-pass PACU. *Paper IV;* The median QoR-15 score increased over time from baseline to 1 week post-surgery with no significant differences between brace/cast-groups of patients.

Conclusion: The use of LAS in POP-surgery improved both theatre and PACU efficacy and increased discharge on day of surgery. Surgical scrub/sterile covering before induction can be performed without jeopardizing patient´ quality of care and probably improve the perioperative care. SCB with long-LA for surgical repair of DRF provide effective analgesia during early postoperative course, but the patients that received SCB with short-LA had less pain at 24-hours post-surgery, a better pain profile and consumed less opioids during the first 72 hours postoperatively. An immobilisation with brace instead of cast directly after DRF-surgery appears to be a feasible and attractive option.

Keywords: Day surgery, POP surgery, open hernia repair, distal radial fracture, anaesthetic technique, supraclavicular block, local anaesthesia, long/short-acting local anaesthetic agent, logistics, pain, postoperative opioid consumption, quality of care, QoR-15

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SAMMANFATTNING PÅ SVENSKA

Med ”Dagkirurgi” menas oftast att patienten kommer till och går hem från sjukhuset samma dag som hen blivit opererad. Denna form av logistik vid kirurgiska ingrepp blir allt vanligare och idag genomförs många ingrepp av varierande storlek på patienter i alla åldrar, och med olika grad av samsjuklighet, på detta sätt. Detta innebär att största delen av återhämtningen efter operationen/anestesin kommer att ske som egenvård i hemmet med hjälp av anhöriga. Dagkirurgi är idag en säker vårdform och allvarliga komplikationer är inte vanligare efter dagkirurgi än efter slutenvårdskirurgi. För att bibehålla god vårdkvalité när patienten skrivs ut på operationsdagen ställs stora krav på att såväl anestesin som kirurgin planeras och genomförs så att bieffekterna blir så små som möjligt efter hemgång. Uppföljning efter dagkirurgi har dock visat att patienterna upplever olika grader av påverkan från såväl operationen som anestesin. Olika anestesitekniker och logistiska faktorer kan påverka återhämtningen; smärta, illamående, kognitiv återhämtning samt behov av akuta och/eller planerade vårdkontakter efter hemgång. Anestesimetod och smärtbehandling kan således påverka både vårdkvaliteten och kostnaderna för den dagkirurgiska vården. Denna avhandling har fokuserat på 3 mycket vanliga dagkirurgiska ingrepp, vilka undersökts med avseende på ovannämnda faktorer.

Delarbete I är en journalgenomgång av 440 patientjournaler efter gynekologisk framfallsoperation under åren 2012-14. Vi fann att förändringen av anestesimetod från ryggbedövning och narkos till användning av lokalbedövning kombinerat med lugnande/sedering, förbättrade utnyttjandet av operationssalen samt ökade påtagligt andelen patienter som kunde gå hem samma dag som operationen.

Delarbete II är en randomiserad studie på män som genomgick ljumskbråcksoperation i narkos under åren 2015-16. Patienterna randomiserades till att vara vakna eller sövda under tvättning och inklädning med sterilt material innan operationen påbörjades. Vi fann som förväntat att anestesitiden blev kortare i gruppen med vakna patienter men vi kunde inte verifiera några signifikanta hemodynamiska effekter. Dock var tiden för att tvätt/klä kort (ca 6 min). De sövda patienterna låg längre på UVA efter operationen jämfört med de vakna patienterna. I en postoperativ enkät framkom att både de patienter som varit vakna samt operationssköterskorna fördrog den logistiska proceduren ”vaken patient under tvättning/inklädning” som rutin.

Delarbete III är en randomiserad studie där 3 olika anestesimetoder för operation av en handledsfraktur jämfördes. Studien genomfördes under åren 2018-20. Patienterna randomiserades till supraclavikulär plexusblockad med 1) lång-, respektive 2) kortverkande lokalbedövningsmedel och lugnande/sederande läkemedel, alternativt 3) en kontrollgrupp som sövdes (narkos). Vi studerade smärta och smärtlindringsbehov samt återhämtning under dag 1 - 3 efter operationen samt behov av akuta vårdkontakter och möjligheten till hemgång operationsdagen.

Patienterna som fick kortverkande blockad uppvisade en bättre återhämtning avseende smärta och mindre behov av värktabletter med morfinpreparat jämfört med patienterna som fick långverkande blockad. Patienterna som fick narkos hade bättre återhämtning än de som fick långverkande blockad men sämre än de som fick kortverkande blockad.

Delarbete IV är en randomiserad studie där patienterna lottades till immobilisering med gips eller ortos efter avslutad operation av handledsfraktur. Båda grupperna hade samma anestesiform dvs en kortverkande supraclavikulär plexusblockad. Det primära utfallet var skillnaden i patienternas egenskattning av återhämtningen mätt i en validerad självskattningsskala, QoR-15, före operation samt vid 24 och 72 timmar och 1 vecka efter anestesi/operation.

Faktorer vi också undersökte var skillnaden i postoperativ opiat konsumtion samt tidsutnyttjandet av sjukvårdsresursen. Studien visar att ortos-användning som primärt förbandsmaterial, efter operation av handledsfraktur, medförde samma återhämtning som traditionell gipsskena.

Både delarbete III och IV gjordes i samarbete med Arbetsterapeuter som följde patienterna upp till 1 år efter operation med avseende på rehabilitering av handledsfunktion.

Avhandlingsarbetet visar att valet av anestesimetod har stor betydelse för hela den dagkirurgiska processen, såväl patienternas smärta och smärtlindrings-behov, övrig återhämtning, nöjdhet med vården, utnyttjandegraden av operationsenheten/teamet och möjligheten att kunna gå hem samma dag som operationen gjorts. Arbetet kan användas som del i ett nationellt Vårdprogram kring effektiv och säker dagkirurgisk anestesi.

LIST OF PAPERS

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

I. Sellbrant I, Pedroletti C, Jakobsson JG
Pelvic organ prolapse surgery: changes in perioperative management improving hospital pathway.
Minerva Ginecol. 2017 Feb;69(1):18-22.
doi: 10.23736/S0026-4784.16.03901-0.

II. Sellbrandt I, Brattwall M, Jildenstål P, Warrén Stomberg M, Jakobsson J.
The choice between surgical scrubbing and sterile covering before or after induction of anaesthesia: A prospective study.
F1000Res. 2017 Jun 28 [revised 2017 Jan 1];6:1019.
doi: 10.12688/f1000research.11965.2.

III. Sellbrant I, Karlsson J, Jakobsson JG, Nellgard B.
Supraclavicular block with Mepivacaine vs Ropivacaine, their impact on postoperative pain: A prospective randomised study.
BMC Anesthesiol. 2021 Nov 9;21(1):273. doi:10.1186/s12871-021-01499-z.

IV. Sellbrant I, Blomstrand J, Karlsson J, Nellgard B, Jakobsson JG.
Brace versus cast following surgical treatment of distal radial fracture; a prospective randomised study comparing quality of recovery.
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ABBREVIATIONS

AAAHC	Accreditation Association for Ambulatory Health Care
AGC	Automatic Gas Control
AI	Artificial Intelligence
ASA	American Society of Anesthesiologists
ANOVA	Analysis of Variance
CROM	Clinic Reported Outcome Measures
DRF	Distal Radius Fracture
DS	Day Surgery
ERAS	Enhanced Recovery After Surgery
ERSA	European Regional Science Association
GA	General Anaesthesia
HR	Heart Rate
IAA	International Association for Ambulatory Surgery
ICU	Intensive Care Unit
IQR	Inter Quartile Range
i.v.	intravenously
LMA	Laryngeal Mask Airway
LA	Local Anaesthetic agent
LAS	Local Anaesthesia with Sedation

Long-LA	Long acting Local Anaesthetic agent
MAP	Mean Arterial Pressure
MMA	Multi Modal Analgesia
NRS	Numeric Rating Scale
PACU	Post Anaesthesia Care Unit
PARS	Post Anesthesia Recovery Score
PC6	Pericardium 6 or Nei Guan
PDNV	Post Discharge Nausea and Vomiting
PONV	Postoperative Nausea and Vomiting
POP	Pelvic Organ Prolapse
PQRS	Postoperative Quality of Recovery Scale
PROM	Patient Reported Outcome Measures
PREM	Patient Reported Experience Measures
PROSPECT	Providing evidence-based and procedure-specific recommendations and clinical decision support for the management of postoperative pain
QoR	Quality of Recovery
QoL	Quality of Life
OR	Odds Ratio
OSA	Obstructive Sleep Apnoea
RA	Regional Anaesthesia
SAMBA	Society for Ambulatory Anesthesia
SCB	Supraclavicular plexus block
SFAI	Svensk Förening för Anestesi & Intensivvård
SF-36	The MOS (Medical Outcomes Study). 36-items Short-Form Health Survey
Short-LA	Short acting Anaesthetic agent
SPOR	Svenskt Perioperativt Register
SSI	Surgical Site Infections
TENS	Transcutaneous Electric Nerve Stimulation
TIVA	Total Intravenous Anaesthesia
TCI	Target Controlled Infusion
VAS	Visual Analogue Scale
VGR	Västra Götalandsregionen
WHO	World Health Organization

DEFINITIONS IN SHORT

Day Surgery

An operation/procedure (excluding an office or outpatient operation/procedure) where the patient is discharged on the same working day. (IAAS, *http://iaas-med.com*). This term is used more frequently in British English literature.

Ambulatory Surgery

The same definition as Day Surgery but used more frequently in American English literature.

Bottleneck

A station whose maximum capacity controls how much it is possible to produce.

ERAS

The ERAS definition refers to a multimodal perioperative care pathway or protocol designed to achieve early recovery for patients undergoing major surgery. *(https://encare.net)*

Outpatient

A patient, whose treatment does not require an overnight stay in a hospital or clinic.

Office-based surgery

Any surgical or invasive procedure, utilizing minimal to moderate anaesthetics, performed by a licensed physician in a location other than a hospital or ambulatory surgery centre. These procedures are typically performed in a suite located within the physician's office.

Value in health care

Value = Benefits/Cost
"Value is defined by the customer perception of benefit"[1].

1

INTRODUCTION

This thesis is devoted to how anaesthesia care can further improve day surgery logistics and quality of recovery. Three high volume day surgical procedures have been studied. The impact of anaesthesia on logistics, time events, discharge, pain and subsequent need for analgesics, postoperative nausea and vomiting and self-assessed recovery has been the focus in the present studies.

It is important to understand that Day Surgery (DS) is a process, not a procedure. It is a planned elective pathway, which starts with the first patient contact and ends with the final discharge/follow-up. It demands a DS concept mind-set among all healthcare staff that provides an effective care with the target to allow safe patient discharge on the same day as surgery. It is thus a change in paradigm, with patients being awake during the surgery and having early discharge post-surgery instead of the traditional surgical care where patients are allowed to stay in bed and recover slowly at the hospital.

DS has increased in both Sweden and the rest of the world. There is today an increased interest in its implementation. In 2008 about 60% of all surgery in Sweden was performed as day surgery according to the Swedish National Board of Health and Welfare (*Socialstyrelsen, http://www.socialstyrelsen.se), being increased to 75%* in 2019 and 2020 (less performed number of surgery procedures 2020, most likely due to the Covid-19 pandemic, but the same

amount of DS). In the near future, more extensive procedures, such as hip and knee replacements as well as abdominal robotic surgery may be performed as DS since both new anaesthetic methods and minimally-invasive surgery make it possible[2].

The Scandinavian countries are in the front in terms of DS, while its most extensive implementation is probably seen in the US (*https://sambahq.org*). The amount of procedures as well as the number of different procedures performed as DS varies however considerably between countries.

The goal of DS, *i.e.* decreasing hospital stay, is associated with several benefits, such as early mobilisation and discharge, which will reduce the risk of thromboembolic complications, improve wound healing and reduce the risk of postoperative nosocomial infections[3]. Early hospital discharge may also reduce health care cost[2]. The implementation of DS is therefore important for both the patients and society.

DS is most efficient when being arranged as a self-reliant unit both functionally and structurally separated from inpatient operating theatres and wards[4].

Thus, DS enhances the demands on patient selection, optimisation of routines and logistics, in order to avoid jeopardising the safety and quality of care. It consists of multiple interventions and a dedicated mind-set with protocols, guidelines and careful handling of the patient's expectations.

"The father of Day Surgery"

Figure 1. "The Father of Day Surgery". James Henderson Nicoll, 1863-1921, was a Scottish paediatric surgeon and professor of surgery at Anderson´s University in Glasgow, Scotland, UK. (Picture from Wikipedia, *https://en.m.wikipedia.org*)

1.1 HISTORY, DEFINITION AND TERMINOLOGY

Day Surgery is certainly not a new concept. James Henderson Nicoll is considered as the "Father of Day Surgery" and in 1909 he reported his experience, in the British Medical Journal, of performing nearly 9000 paediatric DS cases at the Sick Children's Hospital and Dispensary in Glasgow. The cases he included were elective procedures for hernias, harelip and cleft palate, and clubfeet but also emergency DS procedures for congenital pyloric stenosis and depressed birth fractures of skull.

The modern DS, however, has its roots in the 1980's initiated by the possibility of cost reduction *vs*. traditional inpatient surgery. The IAAS* (International Association for Ambulatory Surgery, *(http://iaas-med.com)* define day surgery as:

"An operation/procedure (excluding an office or outpatient operation/procedure) where the patient is discharged on the same working day".

While there are variability worldwide with some countries accepting a 23 hour stay as day surgery, the IAAS defines this as Extended Recovery or Short Stay Surgery as it fails to guarantee the full benefit for the hospital and the patient, see Table 1.

Table 1. Terminology as suggested by IAAS.

Terminology	Synonyms and Definitions
Day Surgery	Ambulatory surgery, Same-day surgery. Day care only.
Extended recovery	23 hours, overnight stay. Treatments requiring overnight stay.
Short stay	Treatments requiring 24-72 hours before discharge
Outpatient	A patient treated at a hospital who is not admitted for a stay of 24 hours

*The International Association for Ambulatory Surgery (IAAS) was founded in 1995 and is a registered charity in Belgium. Its main aim is to promote the worldwide development of high quality ambulatory surgery (aka: day surgery).

Friend of the Association: Accreditation Association for Ambulatory Health Care (AAAHC, USA).

1.2 PERIOPERATIVE CARE LOGISTICS

Logistics is the knowledge of managing and controlling a material- or production flow as well as the associated resource-, information- and monetary flows. It is about achieving the highest possible efficiency through good service and low costs. The principles of "lean management" is today spread through many areas of the business world, resultant to the success of the Toyota Production System[5].

Logistics as a topic originate from military needs to control the supply of fuel, food, ammunition in large quantities to meet specific needs at different front sections. One of the first to realize this is said to be Napoleon, who in the 19:th century instituted a post as *Générale de Logistique,* so-called logistics-general. However, this became even more evident during the World War II on the Allied side where the production apparatus was located in the United States and the needs were on different fronts far away, with very long transport lines across the Atlantic and Pacific Oceans.

In today´s society and the world around us, logistics have become an area that most companies take into account, as logistics in many ways improve the profitability of a business. In a review from 2009 Casey *et al* marked; "These lean management principles can be applied to health care as well. Their implementation within the day surgery setting is predicated on the continuous identification and elimination of waste within the process. The key concepts of flow time, inventory and throughput are utilized to improve the flow of patients through the clinic, and to identify points that slow this process -- so-called bottlenecks. Finally, application of the lean management principle of "just-in-time" management can eliminate excess clinic inventory, better synchronize office supply with patient demand, and reduce costs" [5, 6].

Patient´s perioperative care should be effective and likewise patient-centred, e.g. avoiding unnecessary waiting time and delays, shortening duration of anaesthesia; optimising the surgical anaesthesia time quota and thus optimising total amount of anaesthesia delivered all with the goal to facilitate recovery and secure a minimum of side effects. The perioperative anaesthesia care should also include procedures minimising side effects, residual sedation, fatigue, postoperative nausea and vomiting as well as postoperative pain. The surgical outcome is of course of extreme importance and all complications should be avoided.

Grocott et al. told us in 2015; “Value is delivered by perioperative medicine through the efficient practice of patient-centred, multidisciplinary, and integrated medical care of patients undergoing surgery from the moment of contemplation of surgery until full recovery”, see Figure 2 and “value is defined by the customers perception of benefit” [1].

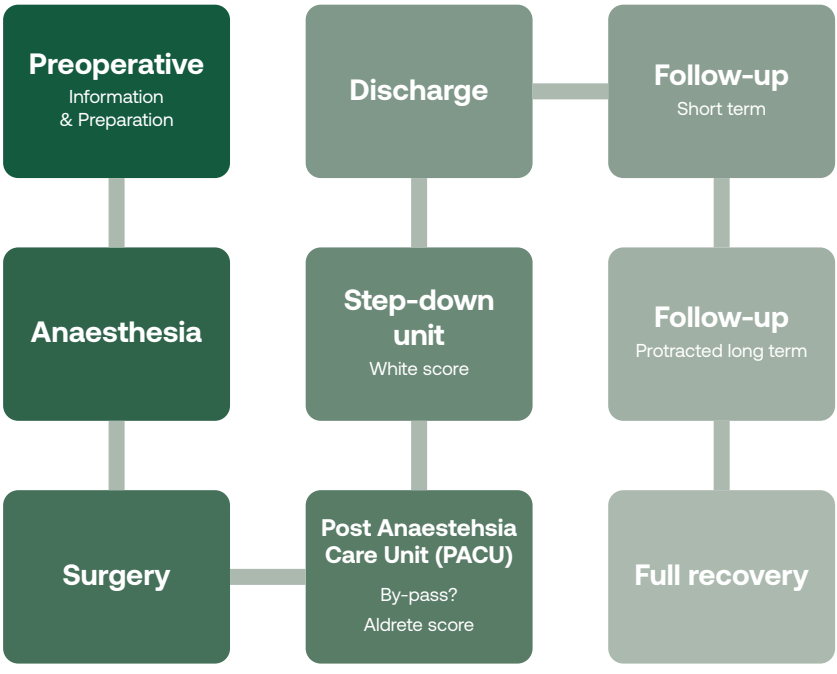

Figure 2. Day surgery logistic flow.

1.2.1 COMMON *"BOTTLENECKS"*

The day surgery concept is closely related to a high volume flow of patients. At the same time the amount of elderly and fragile in the population will increase significantly the coming 20-40 years. The elderly will be the DS patients of the future. In addition, a recent review by Warnakulasuriya *et al*. declared "the recent COVID-19 pandemic has stressed inpatient bed resources further and it is anticipated that there will be further appetite by both clinicians and patients to avoid inpatient stays"[7].

When a value flow analysis has been made, a "station" in the flow may be discovered where the production stops or is minimised, in other words a "station" whose maximum capacity controls how much it is possible to produce. These are called "*Bottlenecks*".

All activities are destined to omit bottlenecks since they reduce production and are therefore costly e.g. preoperative anxiety is important to reduce since it can cause more postoperative pain and decrease post-surgical recovery and wound healing[6, 8].

To omit bottlenecks one has to find them. Post Anaesthesia Care Units (PACU) with Intensive Care Unit (ICU)-staff and technical monitoring is a typical bottleneck. Availability of the operation theatre is another one. Patients waiting for the surgeon information before discharge is a third bottleneck. A huge one is staffing of healthcare professionals.

To avoid bottlenecks, it is important to adopt the multimodal analgesia (MMA) care concept to avoid long PACU-times and by-pass the PACU whenever possible and thereby shorten the hospital stay. Further, by using another room than the operation theatre for preparation of the surgical instruments and performing peripheral blocks makes the theatre more available for surgical time[9]. Staffing of healthcare in the future demands a thesis on its own.

In 2016, a scientific project called "TagOn" was constructed at the University hospital in Lund together with the Technical University and MAPCI (Mobile and Pervasive Computing Institute at Lund University), where the patients were given a bracelet with a Bluetooth-transmitter at the emergency department. The information related to where the patient was positioned and for how long during the hospital stay. This was an interesting attempt to capture "bottlenecks".

Conclusively, by focusing on “the flow” and the patient-journey through the hospital stay appears to enhance patient satisfaction and work environment for the staff and at the end of the day, result in the best cost-effectiveness.

1.3 COMMON PROCEDURES PERFORMED AS DAY SURGERY

There is no definitive list of surgical procedures appropriate for day surgery. There are different national laws and regulations that must be adhered to and service must be safe and follow national association’s recommendations. One example of a list of suitable procedures has been developed in the UK, where the Directory of Procedures, published by the British Association of Day Surgery, provides useful information [(4)].

Type of surgery, minimising invasiveness and the length of procedure, reducing the surgical trauma and impact on homeostasis are of importance. Surgical procedure, postoperative wound care and rehabilitation should be communicated during the preoperative consultation with the surgeon. The surgical outcome is thus of outmost importance.

Huge number of elderly and more fragile patients requiring surgery will be a major challenge in the future.

However, DS is suitable for patients in all ages. Some DS procedures are more prominent in older patients like cataract and inguinal hernia surgery, while others are more frequent in children like ear-nose-throat-procedures. Children and persons with intellectual disabilities may need anaesthesia for non-surgical procedures as well.

According to the *Guidlines for day-surgery 2019, British Association of Day Surgery and Association of Aneasthestists,* “Many children require day-stay anaesthesia for non-surgical procedures such as radiological imaging, endoscopy, laser treatment of skin lesions, radiotherapy and oncology investigations and treatments. These children should have the same standards of care as those undergoing surgical procedures”[(4)].

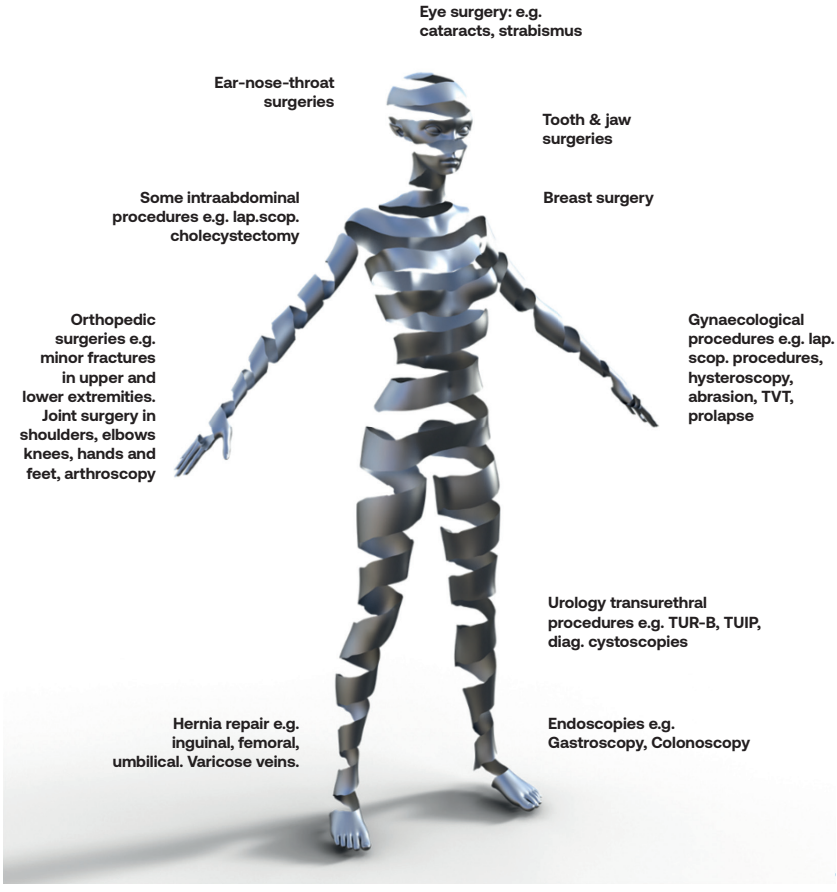

Figure 3. Common procedures in Day Surgery.

Quality Registers

National Quality Registers gives us knowledge about how the Swedish healthcare works and how it can be improved. Some of the quality register include information related to changes of DS management over time.

❶ Inguinal hernia repair is one of the most common procedures. In 2019 almost 16 000 procedures were made in Sweden, 90% males/10% females. *(www.svensktbrackregister.se)*. In 1992, 33% of inguinal hernia repairs were performed in DS settings, while in 2019 this number had increased to 80%. The patients had the mean age of 63 years.

❷ In 2019, 6181 pelvic organ prolapse procedures were performed in Sweden. *(www.gynop.se)*. In 2010, 30% of the organ prolapse procedures were performed in DS settings, increased to > 60% in 2019. The amount of patients leaving the hospital the day after surgery increased at the same time from 70% to 90%. 60% of the patients were between 55-74 years old.

❸ Data from the Swedish Fracture Register (*https://sfr.registercentrum.se)* shows that an acute DRF (Distal Radial Fracture) is a very common fracture with 25000/year. Of these 21% undergo primary surgical fixation and 6% secondary.

❹ Swedish Perioperative Register (SPOR) *(www.spor.se)* is a quality register collecting patients- and process-data related to perioperative care and linked to operations. At the end of 2019 almost 80 hospitals in Sweden were connected to this register.

1.4 ANAESTHESIA IN DAY SURGERY

With modern MMA, surgical time is not as critical as it once was, although most DS procedures require less than 2 hours of anaesthesia time. All anaesthetic techniques used today are safe and efficacious. Anaesthesia should be patient targeted and goal directed. Optimizing of patient care and tailored anaesthesia are of major importance for successful and effective DS.

Even though general anaesthesia (GA) techniques like total intravenous anaesthesia (TIVA/TCI) or inhalation anaesthesia with Automatic Gas Control (AGC) is the most frequently used anaesthetic techniques in day surgery settings.

The laryngeal mask airway (LMA) presents a suitable alternative to endotracheal intubation, even for oral surgery, in most DS-patients as this will omit the use of muscle relaxants and its side effects[22]

Spinal anaesthesia (SPA) has become more accepted for use in DS, according to a recent review; “with the introduction of low-dose local anaesthetic (LA) techniques and newer shorter acting LA such as hyperbaric prilocaine 2% and 2-chloroprocaine 1%”[21], (British Association of Day Surgery. Spinal anaesthesia for day surgery patients, 3rd edn. London, UK: BADS, 2013.)

Ultrasound guided regional anaesthesia (RA) are commonly used as either an alternative or complement to GA. Nerve blocks can offer superb anaesthesia

and pain relief after surgery and patients may safely be discharged home with residual motor or sensory blockade, as long as the limb is protected and suitable support is available for the patient at home. The expected duration of the blockade should be explained, likewise the risk for rebound pain [10-18]. The patient should receive written information about how the anaesthetised body part will function until normal power and sensation return. Infusions of local anaesthetics may also be an alternative path to provide pain relief [4, 19, 20].

Local anaesthesia with sedation (LAS) is also a feasible option of DS. This technique reduces the amount of anaesthetic drug used and thus minimise the residual effects on the central nervous system [4].

Anaesthesia and pre-anaesthetic preparations must likewise to be addressed prior to patient arrival to the hospital as is common for in-hospital surgery [4], see 1.5.1.

1.5 DISCHARGE PROCESS

Since DS is performed on various patient groups and includes a wide variety of surgical procedures it appears reasonable that the time to full restitution after DS may be variable within wide time limits. The majority of patients are appropriate for DS, but it is important to evaluate the possible risk factors that can jeopardize patient safety both preoperatively or during the perioperative process before discharge.

1.5.1 DISCHARGE CRITERIA

Discharge criteria are used when deciding when the patient is ready to leave the PACU to a step-down unit and then further when to leave the hospital [23].

There are 3 phases of recovery following anaesthesia according to IAAS, see below, (*https://.iaas-med.com*):

❶ Early recovery - awakening and recovery of airway reflexes. Pain is under control. The majority of patients who undergo surgery with a local or regional anaesthetic block can be fast-tracked in this manner.

❷ Intermediate recovery - recovery to the point of home readiness.

❸ Late recovery - recovery to the point of street fitness.

Patients are fit for discharge from the DS setting when they have completed the intermediate phase of recovery.

The Aldrete's scoring system is a commonly used scale for deciding when people can be safely discharged from PACU to the step-down ward or for use in ambulatory surgery[24]. Jorge Antonio Aldrete, a Mexican anaesthesiologist, while working at the Denver´s Veterans Affairs Hospital, developed it in 1970 and modified it in 1995[25, 26]. The scale was a variant of the Apgar score, used to evaluate newborn infants, developed by Virginia Apgar in 1953.

Table 2. Classical Aldrete score. Maximum total score is 10; a score of ≥ 8 is required for discharge. It was called Post Anesthesia Recovery Score (PARS) by Aldrete & Kroulik.

Parameter	Description of patient	Score
Activity level	• Moves all 4 extremities voluntarily/on command • Moves 2 extremities • Cannot move extremities	2 1 0
Respirations	• Breathes deeply and coughs freely • Is dyspneic, with shallow, limited breathing • Is apneic	2 1 0
Circulations (Blood pressure)	• Is 20 mmHg > preanaesthetic level • Is 20-50 mm Hg > preanaesthetic level • Is 50 mm Hg > preanaesthetic level	2 1 0
Consciousness	• Is fully awake • Is arousable on calling • Is not responding	2 1 0
Oxygen saturation (SpO_2) as determined by pulse oximetry	• Maintains SpO_2 > 92% when breathing room air • Maintains SpO_2 > 90% with O_2 • Maintains < 90% with O_2	2 1 0

Additional criteria were added e.g. pain, surgical bleeding, nausea and vomiting, by Marshall and Chung in 1999 for ambulatory surgery[27].

There are other similar scores for discharge criteria, see below. All are based on traditional basic concepts like stable vital signs, orientated to proper stage, stand/walk un-aided, micturition, acceptable control of pain and PONV and no noteworthy bleeding from the surgical site. However, the ability to drink and keep oral fluids before discharge is increasingly disputed as it may in fact incite nausea and vomiting. Also, voiding is also not always necessary, although it is important to detect the patients who are at a certain risk, as

those with extended surgery or having manipulation of the bladder. A recent review showed that a bladder scan check is advisable to add to the discharge criteria[23]. *Soong et al.* presented a safe discharge checklist that includes five domains in 2013[28].

Other scoring scales:

- *White et al,* in 1999 proposed "*fast-track criteria*" to determine if patients can be transferred straight from theatre to phase II recovery. They proposed a minimum overall score of 12 with no score <1 in any category. Their score included consciousness, activity, circulation, respiration, oxygen saturations, pain and emesis. However, it did not include bleeding or urine output[29-31].

- Post anaesthetic discharge scoring system (PADSS) used by *Chung et al.* 1995[32, 33].

- Discharge criteria tool from PACU used by *Brown et al.* 2008[34].

Non-medical criteria to be met prior to discharge from the day unit, according to IAAS, see below, (*https://.iaas-med.com*):

- An adult to accompany the patient home and to be with her/him at home for the first 24-hours following surgery is now being re-evaluated. Twenty-four hours may be excessive for a patient having undergone a minor procedure, whereas it may be insufficient for a patient having undergone a major one[4, 35].

- Access to a telephone.

Patient to be given

- Printed post-operative instructions
- Printed information about whom to contact in case of emergency.
- Appropriate discharge drugs like analgesics.
- Follow-up information.
- A summary of the treatment the patient has received.

Who should assess fitness for discharge?

- Surgeon and/or anaesthetist?
- Senior nurse following a medical approved protocol?
- Surgeon and/or anaesthetist only involved in cases of doubt or when there is a problem?

1.5.2 FACTORS IMPACTING DISCHARGE AND SAFETY

Preoperative preparation

Preoperative preparation of the patient is to identify medical risk factors, promote health and optimize the patient's condition prior to surgery[36, 37]. Pre-anaesthetic assessment questionnaire (and/or a visit) with a targeted survey to a pre-anaesthetic reception and the World Health Organization (WHO) checklist are good tools, according to a lot of studies and review, to identify risk factors[37, 38].

According to the *Guidelines day-case surgery 2019 by Baileys et al;"* Fitness for a procedure should relate to the patient's functional status and not by ASA physical status, age or body mass index[39-41]. Patients with a stable chronic disease such as diabetes are often better managed as day cases because there is minimal disruption to their daily routine (British Association of Day Surgery. Managing diabetes in patients having day and short stay surgery, 4th edn. London, Uk: BADS, 2016)[4]. The only patients routinely not included in DS are those with unstable medical conditions. In these circumstances, the question should be asked as to whether it is safe to go ahead with the procedure or whether it should be delayed until the patient's condition has been optimized"[4].

Obesity itself is not a contraindication to DS, but the incidence of complications during the operation or in the early recovery phase is elevated. Therefore, appropriate resources must be available including additional time for anaesthesia and surgery as well as the attendance of skilled assistants and equipment[4, 42].

Surgical factors

The procedure should be as "minimally-invasive" as possible and not bring a significant risk of severe postoperative complications demanding immediate medical attention, e.g. haemorrhage or cardiovascular instability.

Pain and PONV should be controllable with oral medication and/or local anaesthetics, with the ability to resume oral intake within hours from end-of-surgery, as well as the ability to mobilize before discharge[4]. Earlier research on procedure specific postoperative recommendations can be helpful, e.g. PROSPECT (Providing evidence-based and procedure-specific recommendations and clinical decision support for the management of postoperative pain; *www.postoppain.org*)[43].

Anaesthetic and Analgesic factors

In order to select the suitable anaesthesia method, the most important factor to consider is the surgical procedure planned as well as the patient´s condition.

Morbidly obese patients (obese 3) have an increased risk for obstructive sleep apnoea (OSA) and can thus be at greater risk when undergoing DS. However, with comorbidities optimized and careful monitoring peri- and post-operatively, these patients can safely undergo day surgery procedures, according to several studies and review[44-46]. Avoidance of postoperative opioid prescription to these patients is advised and the optimal technique, if possible, is RA (Regional anaesthesia)[44].

The most common complication after ambulatory surgery is postoperative pain after discharge. The concept of MMA has become the new gold standard including several analgesic agents working synergistically and/or additively to obtain pain relief. Additionally, this approach decreases the prescription of opioids, giving less opioid-related side effects e.g. sedation and PONV[47], as well as reducing the prescription of opioids[48].

Information

On discharge from hospital, all patients should receive oral and written instructions and be informed about symptoms and side effects of the procedure and medication *per se* and where to turn. If possible, these instructions should be presented in the presence of the person escorting the patient home.

DS has verified itself to be a high-quality, safe and cost-effective concept to surgical health care [49-51] and a 30-day follow-up of recovery after DS is the standard recommendation by IAAS and most quality registers. As modern DS includes more extensive procedures and more patients with risk factors, it is also important to focus on late outcomes/complications, e.g. postoperative infections, cardiovascular complications, etc [51]. Advances in technology will simplify the remote collection of patient-reported data and the use of video, telephone or web-based tools will preserve social distancing during the postoperative period [7].

1.6 THE RECOVERY PROCESS

Outcome of perioperative care is primarily the surgical outcome. However, recovery after surgery and anaesthesia is commonly analysed also by dedicated protocols for the assessment of the recovery process by multi-dimensional tools such as Postoperative Quality of Recovery scale (PQRS) and the Quality of Recovery scale 9, 40 and 15 (QoR-15). The tools are validated questionnaires including queries around e.g. pain, PONV, fatigue, cognition and wellbeing[52-59].

Recovery from anaesthesia and surgery can be divided into three phases, as briefly described in chapter 1.5.1., and below according to IAAS. (*https://.iaas-med.com*)

❶ **First-stage recovery** – emergence - lasts until the patient is awake, protective vital reflexes have returned and pain is controlled. This should be performed in the PACU with appropriate facilities and staffing[4]. Most patients who undergo surgery with a local or regional anaesthetic block can bypass this first stage.

❷ **Second-stage recovery** is from when the patient steps off the trolley and ends when the patient is ready for discharge from the hospital. This should take place in a step-down unit area equipped and staffed to deal with common postoperative problems (e.g. pain, PONV) as well as emergencies (haemorrhage, cardiovascular events).
Nurse-led discharge using agreed protocols is usually the standard pathway but the anaesthesiologist and surgeon should be available if necessary.
Protocols may be adapted to allow low-risk patients to be discharged without fulfilling traditional criteria. Patients and their care-takers should be provided with written information including warning signs of possible complications and when and how to seek help.

❸ **Late recovery** ends when the patient has made a full physiological and psychological recovery from the procedure. This may take several weeks or months. The IAAS suggests that follow-up of recovery after DS should cover 30 days after surgery.

1.6.1 ERAS & QUALITY OF RECOVERY

Today, there is a continuous search for effective perioperative handling also after intermediate and major surgery. The ERAS-concept (Enhanced Recovery After Surgery) developed at ERSA (European Regional Science Association) in 1990s had the goal to optimize perioperative care with a multidisciplinary model in order to reduce complications especially reducing metabolic and surgical stress, enhance recovery and to shorten the in-hospital stay. The Danish and the Swedish surgeons Henrik Kehlet and Olle Ljungqvist were two of the initiators[60]. *

The ERAS-protocol was introduced about a decade later (2010), focusing on the quality of recovery, rather than speed and that the surgical outcome is determined by the perioperative care, rather than the actual operation.[61]. In addition, it has been shown, in a meta-analysis by *Wang et al.* in 2014, to decrease complications after major surgery[62].

Peri- and postoperative ERAS-recommendations includes identifying frailty, correction of preoperative anemia, smoking cessation, optimizing nutrition (reducing insulin resistance), aggressive PONV-prevention strategies, maintaining euvolemia, prevention of perioperative hypothermia, minimally-invasive surgical techniques whenever possible, pain management through a multimodal opioid-sparing regimen and early mobilization. It´s important to inform the patients that the time before the operation is *"preparation time"* and not *"waiting time"*. Implementation of the ERAS protocols have been shown to reduce patient mortality, morbidity and length of hospitalization and to save cost and resources[1, 61, 63, 64]. Today the ERAS principals are implemented in more than 25 countries and there are more than 40 000 ERAS related publications[64]. ERAS has indeed improved perioperative care worldwide[65].

Ljungqvist et al. declared in a review in JAMA 2017: *"Enhanced Recovery After Surgery (ERAS) is a paradigm shift in perioperative care, resulting in substantial improvements in clinical outcomes and cost savings"*[61]

** The ERAS-guidelines are developed by the "ERAS Society", which is an international, professional non-profit organization. It was founded in 2010 with the mission to "develop perioperative care and to improve recovery through research, audit, education, and implementation of evidence-based practice. http://erassociety.org. A Swedish national ERAS Society was developed 2016, "SwERAS", www.sweras.se.*

Further;
Ljungqvist et al. declared in a review in JAMA 2021: "During this time of global crisis, the ERAS method of delivering care is required to take surgery and anesthesia to the next level and bring improvements in outcomes to both patients and health systems. The COVID-19 pandemic poses both a challenge and an opportunity for ERAS"[64].

The ERAS protocol was initially developed for colorectal surgery but today the study areas includes liver resections, gastric/pancreatic & esophageal surgery, urologic/gynecologic surgery, thoracic and orthopedic surgery[66].
The extremes of the ERAS-concept is discharge on the day of surgery or the day after [67, 68].

Recovery after surgery and anaesthesia is a composite process dependent on patient, surgical and anaesthetic methods, as well as the presence of any of several possible adverse sequelae[57, 69].

The quality of recovery is usually divided into 5 dimensions: pain, physical comfort (e.g. PONV), physical independence, psychological support and emotional state (Figure 4)[57].

Pain	• Moderate pain • Severe pain
Physical comfort	• Able to breathe easy • Have a good sleep • Being able to enjoy food • Feeling rested • Nausea and vomiting
Physical independence	• Able to wash, brush teeth or shave • Able to return to work, or usual home activities
Psychological support	• Able to communicate with family or friends • Getting support from hospital nurses/doctors
Emotional state	• Having a general feeling of well-being • Feel in control and comfortable • Feel anxious • Feeling depressed

Figure 4. The five different domains assessed with Quality of Recovery -15 (QoR-15) questionnaire. Each question can give a max of 10 points, totally 150 points. For a more detailed explanation, see chapter 1.6.4. The QoR-15 questionnaire is found in its entirety in the Appendix.

It is important that the patients feel safe and is listened to. An empathic patient-centred intervention can decrease the preoperative anxiety and improve surgical recovery, wound healing and patient satisfaction[8, 70].
A mild postoperative confusion in the elderly patient post-surgery is common. This is usually transient and should not effects discharge as long as social circumstances permit. In fact, the prevention of hospitalization after minor surgery is favoured[71].

1.6.2 PAIN

The management of postoperative pain in the day surgical setting can be challenging. The use of RA techniques, along with MMA and pain risk stratification, can be of significant benefit when providing postoperative analgesia. There are several studies investigating peripheral blocks with different adjuvants added to the block, either intravenously or locally at surgical site with different results[72-75].

Patient experienced pain is the most common problem after DS and studies have found that as many as 30% of the patients had moderate to severe pain 24 hours post-surgery [76]. Further, recent reviews and a meta-analyse showed that this is a common problem and as many as 40% of patients may experience rebound pain when the peripheral block wears off at home(10, 16, [17]. Age, gender, surgical site and preoperative pain are known risk factors for severe postoperative pain[73].

Kehlet et al. declared in a review in Lancet 2006, “In 10-50% of patients with acute postoperative pain a persistent pain will follow after common operations, as breast-surgery and groin hernia repair”[77].

Pain is usually measured using the Numeric Rating Scale (NRS) or Visual Analogue Scale (VAS). It was introduced in the late 1960s as a psychiatric tool to measure degrees of depression and is today often used to measure many types of phenomena besides pain. Using the NRS, the patient chooses a number between 0 (no pain at all) and 10 (worst possible pain). The patient can enter the number verbally or mark a number on a ruler, Figure 5. Using VAS, the patient does not have to express a number, just put a mark on a numberless line. The numbers are visible on the backside for the staff. It is also important to report if the assessment is done in rest or in movement.

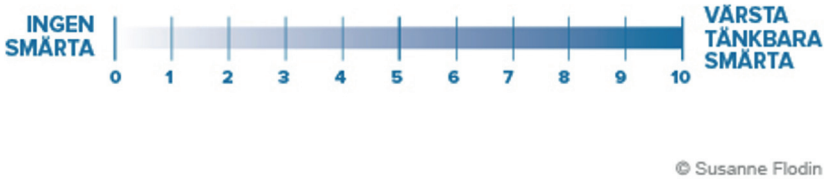

Figure 5. Numeric Rating Scale (NRS). Scoring from No pain = 0 to Worst possible pain = 10. (Picture from *vardhandboken.se*)

VAS and NRS results are often categorized into 3 categories (0-3=mild, 4-6=moderate, 7-10=severe)[78]. In terms of categorization the most difficult cut-off is found to be 4 and 7.

The concept of MMA is an important approach to pain treatment in DS[79]. Pain should be treated with 3 or more analgesics with different modes of action. Opioid-sparing adequate pain control, avoiding pain rebound and pain peaks needs to be implemented as a part of the DS routines[80].

Prediction of pain intensity is important in order to identify patients at risk for severe postoperative pain. Preoperative pain, opioid use and fear of pain are important risk factors[8, 81, 82]. In the future machine learning models could be used to calculate postoperative opioid needs in DS patients and could potentially contribute to a better management of their postoperative acute pain [83]. The PROSPECT-recommendations is a bank of knowledge that sometimes can be helpful.[43]

Pharmacological interventions in DS
- Acetaminophen 1000 mg
- NSAID/ Etoricoxib
- Betametason[72, 73, 84]
- Oxycodone/Codein
- Clonidine
- Esketamin[85]
- Local anaestetics (infiltation, periferal blocks, RA, infusions).

Non-pharmacological interventions
- Preoperative empathic patient-centered interview[8]
- Transcutaneous Electric Nerve Stimulation (TENS)[86-90]
- Cryotherapy and compression[47, 91, 92]
- Music and calming sounds[48, 93, 94]
- Hypnosis[70]
- Prayers[95, 96]

1.6.3 PONV AND PDNV

What is Post-Operative Nausea and Vomiting? (PONV):
The physiology of PONV is complex and not completely understood. The reason for PONV is probably multifactorial, involving anaesthetic, surgical and individual risk factors.

Incidence:
In the recent updated version from 2020, "*Fourth Consensus Guidelines for Management of Postoperative Nausea and Vomiting*", the authors declare; "Nausea and vomiting are two of the most common adverse events in the postoperative period with an estimated incidence of 30% in the general surgical population and as high as 80% in high-risk cohorts".[97, 98]

Postoperative outcomes:
In a study by *Macario el al.* where patients were asked to rank 10 undesirable postoperative outcomes, the majority of patients consider the most unwanted outcome being nausea and vomiting[99]. PONV can become the limiting factor that may increase patients' discomfort, make them stay longer in PACU, with an unplanned hospital admission and increase health care

costs[98]. This can be a highly stressful experience and is related to significant patient dissatisfaction.[100, 101]

Triggers:
Several perioperative stimuli like opioids, volatile anaesthetics, anxiety, adverse drug reactions and motion are common triggers for PONV. It is especially a problem after some surgical types as laparoscopic, bariatric, gynaecological, breast, eye surgery, ear/nose and throat surgery, major orthopaedic surgery and cholecystectomy[102].

Even with prophylactic medications the overall risk for PONV after general anaesthesia, using volatile anaesthetics, is approximately 30% but there is a risk associated with other forms of anaesthesia as well. A recent study by *Moraitis et al.* found that there is a high risk for PONV after spinal anaesthesia with intrathecal morphine even when given antiemetic prophylactic after knee/hip arthroplasty[103].

Risk scoring by Apfel in adults:
Apfel´s model for assessing PONV risk is commonly used and was developed for GA[97].

Table 3. Apfel score for PONV. 0, 1, 2, 3, and 4 risk factors correspond to PONV risks of approximately 10%, 20%, 40%, 60%, and 80%, respectively, as presented in "Fourth Consensus Guidelines for Management of Postoperative Nausea and Vomiting",[98].

Risk factors	Points
Female gender	1
Non-smoker	1
Postoperative opioid	1
History of PONV and/or Motion sickness	1
Sum of points	0-4

If all factors are present in the Apfels´model, the risk of PONV can be as high as 80%[97]. Koivuranata score includes the 4 Apfel risk predictors as well as length of surgery over 60 minutes[104]. Risk scores characterise an objective method to predict the incidence of PONV or PDNV, with sensitivity and specificity of between 65% and 70%, and should be used as a transformer for prophylaxis[98].

The fact that regular nicotine use, both smoking and snuffing, decreases the risk for PONV has previously been demonstrated by several authors. However, this is apart from its many negative effects[97, 105, 106].

What is Post-Discharge Nausea and Vomiting? (PDNV):
PDNV is usually defined as the period from 24 h to 48 h after discharge. In DS it has been recognised as a major problem occurring in more than one-third of patients[107]. In a multi-centre cohort study by Apfel et al. a simplified score was developed and validated to predict the risk for PDNV[108, 109].

Table 4. Apfel score for PDNV. 0, 1, 2, 3, 4, and 5 risk factors correspond to PDNV risks of approximately 10%, 20%, 30%, 50%, 60%, and 80%, respectively, as presented in "Fourth Consensus Guidelines for Management of Postoperative Nausea and Vomiting"[98]

Risk factors	Points
Female gender	1
Age < 50	1
History of PONV	1
Use of opioids in PACU	1
Nausea in PACU	1
Sum of points	0-5

This simplified PDNV score has been validated in 2016 for Swedish DS patients[109].

PONV prophylactic, rescue treatment and reducing the risk:
Fourth Consensus Guidelines for the management of PONV in adults and children were published in 2020. This up-to-dated guideline was created by an international panel of experts under the auspices of the American Society of Enhanced Recovery and Society for Ambulatory Anaesthesia, and based on a systematic review published in September 2019[98].

The main change is a more generous attitude to PONV-prophylaxis with a recommendation to give two agents to patients with 1–2 risk factors and three or four agents when there are more than two risk factors identified. If

generalized, the new guidelines recommend that patients with any risk factors for PONV should be given 1–2 additional prophylactic interventions[98].

According to Fourth Consensus Guidelines for the management of PONV; "Optimal management of PONV is a complex process. There are numerous antiemetic medical treatments with varying pharmacokinetics, efficacy, and side-effect profiles, thus the choice of an antiemetic will depend on the clinical context. The benefit of PONV prophylaxis also needs to be balanced against the risk of adverse effects"[98].

General prophylactic treatments:
Total IntraVenous Anaesthesia (TIVA) with preferential use of propofol infusion, to avoid volatile anaesthesia, is a good choice for patients that scores high on the Apfel score.

MMA regime given as a preoperative medical cocktail and perioperative use of LA/RA are important tools in minimization of perioperative opioids.

Perioperative adequate hydration.

***Pharmaceutical recommendations from*;**
The current Fourth Consensus Guidelines for the management of PONV in adults and children,2020.

Perioperative corticosteroids:
Dexamethasone is a perioperative glucocorticoid that has been used for many years. Additionally, it reduces the need for analgesics and improves respiratory parameters, reduces fatigue, provides a better quality of recovery and reduces the length of stay in hospital[98, 110]. Methylprednisolone have also been proved to be effective in reducing PONV and pain. However, betamethasone, that is commonly used, has a lesser effect compared with the others in reducing PONV[98].

5-HT3 Receptor Antagonists:
Ondansetron, the most commonly used 5-HT3 receptor antagonist is well studied and today considered the "golden standard" for PONV treatment, but a second-generation is now on the market being more frequently used in oncology (palonosetron).

Other pharmaceutical treatments:
Antihistamines, NK1 Receptor Antagonists, Antidopaminergics and anticholinergics.

Rescue treatment:
Use anti-emetic from a different class than the prophylactic drug.

Non-pharmaceuticals methods:
Chewing Gum:
In a pilot trial by *Darvall et al*. chewing gum had similar effects as ondansetron for the treatment of PONV after general anaesthesia for laparoscopic or breast surgery in female patients[111].

Transcutaneous Electric Nerve Stimulation (TENS):
TENS is a non-needle electrical stimulation on the Pericardium 6 (PC6) acupuncture point. Best effect is received if the treatment starts 30 minutes before induction of anaesthesia continuing to the end of surgery[112, 113]. According to the Fourth Consensus Guidelines for the management of PONV; "An updated Cochrane review including 59 trials with 7667 subjects reported that PC6 stimulation was associated with a significant reduction in the risk of PONV and the need for rescue anti-emetics compared with sham treatment" [98, 114]. This method is already commonly used for motion sickness as seasickness and nausea and vomiting during pregnancy with special acupressure-bracelets[115].

Hypnosis:
Preoperative Hypnosis has also been studied and published in JAMA, 2020 but with doubtful results[70].

1.6.4 TOOLS FOR ASSESSMENT OF QUALITY OF RECOVERY

Studies assessing recovery after surgery and anaesthesia have usually focused on physiological outcomes like recovery times and incidence of adverse events e.g. major morbidity and mortality. Quality of recovery (QoR) from the patient's perspective are often forgotten. Thus, multiple tools for measuring QoR have been developed [7, 57, 69, 116].

❶ **QoR-9, QoR-40 and QoR-15.** The 15-item Quality of Recovery scoring (QoR-15) is developed as a short-form of the QoR-40 that was published by

Myles et al. in 2000[117]. QoR-40 originates from QoR-9. QoR-15 was published in 2013 by *Stark et al.*[57]. It has been tested for its validity, reliability, responsiveness and clinical acceptability and feasibility in five domains, see Figure 4. It is an important measurement of the early postoperative health status of patients. It is used both in clinical practice and in research and it´s found suitable for both in a systematic review by *Gornall et al.*[7, 55-58]. It´s validated into Swedish and it was recently incorporated into SPOR 4.0[7, 54].

❷ **PQRS** - Postoperative Quality of Recovery Scale was developed in 2010 by *Royse et al.*[59]. It assesses recovery in six domains including physiological, nociceptive, emotive, cognitive, activities of daily living and patient satisfaction[53, 59, 118, 119].

❸ **FRI** – Functional Recovery Index was published to assess post-discharge functional recovery for ambulatory surgical patients by *Wong et al.* in 2009[120]. This questionnaire includes 14 items grouped under three factors; 1) pain and social activity, 2) lower limb activity and 3) general physical activity.

❹ **SF- 36** – 36 health survey questionnaire is an instrument for measuring health perception in a general population (QoL) and has been used since the early 1990s.[121-124]

❺ **EQ-5D** - Quality of life (QoL). Assesses five domains; pain, mobility, depression, self-care and normal activities. Convenient and often used for following longitudinal changes over time[125, 126].

❻ **PROM** – (Patient Reported Outcome Measures), **PREM** – (Patient Reported Experience Measures), **CROM** – (Clinic Reported Outcome Measures) are all Quality Performance Indicators (QPI) often used by the healthcare systems to evaluate the value of a treatment for the patients[7, 127].

2

AIM

THE OVERALL AIM:

The overall aim of this thesis was to investigate improvement factors in perioperative resource utilisation, logistics and quality of recovery for three common day case surgery procedures.
The specific aims of the individual studies were as follows:

PAPER I:

To investigate the implementation of a new anaesthetic technique – local anaesthesia and sedation (LAS) and its impact on the logistical changes, especially discharge day of surgery, during the period 2012 - 2014 in four different hospitals in the Västra Götalandsregionen (VGR) in Sweden for pelvic organ prolapse surgery (POP).

PAPER II:

To investigate if avoiding prolonged general anaesthesia (GA), by inducing surgical scrubbing and sterile covering with the patient awake, could reduce the need for vasoactive medication, in male patients scheduled for unilateral open hernia repair. Additionally, we investigated if this awake vs asleep preparation *per se* affected anaesthetic drug doses, PACU-time and quality of care.

PAPER III:

To investigate the impact of anaesthetic techniques; using supraclavicular plexus block (SCB) with 1) long- or 2) short-acting local anaesthetic agents or 3) GA (as control) on postoperative pain, postoperative opioid consumption, PONV/PDNV and time events following surgical treatment of displaced distal radial fractures (DRF).

PAPER IV:

To investigate the impact of immobilization methods; brace vs dorsal cast splint placed at the end of surgical treatment of a displaced DRF, on the postoperative quality of recovery and perioperative management.

3

PATIENTS AND METHODS

This thesis is based on data from four studies with various methodological approaches.

The first study is a retrospective patient record review of a large number of patients, who were electively scheduled for a high-volume gynaecological procedure at four different hospitals in VGR.

The second study is a prospective randomised study of male patients electively scheduled for a common surgical procedure in a small, private hospital with follow-up until discharge.

The third and the forth studies, both prospective and randomised, share some patients (n=27). These studies were performed at a University hospital and investigated a common subacute orthopaedic procedure and follow-up until one week after discharge from the hospital.

A brief overview of the study design, samples, pre-study preparations, aims/focus, interventions and objectives is given in Table 5 + 6 in chapter 3.1.

3.1 DESIGN

Table 5. Overview of study design, samples, preparation and aim/focus. Local Anaesthesia with Sedation (LAS).

Overview of study design	Study I	Study II	Study III	Study IV
Study design	Retrospective observational design	Prospective randomised design	Prospective randomised design with one week follow-up	Prospective randomised design with one week follow-up
Study samples	n = 440	n = 60	n = 90	n = 60
Study period	2012 - 2014	2016 - 2017	2018 - 2020	2018 - 2020
Preparation	Quality improve-ment project *Sahlgrenska Quality First price 2016*	Pilot study *Poster SFAI 2016*	Mini review Sellbrant et al, *F1000Reaserch, 2017*	Mini review Sellbrant et al, *F1000Reaserch, 2017*
Aim and focus	LAS´ impact on changes in perioperative management 2012-14 in 4 hospitals.	Surgical scrub/ sterile cover awake vs anaes-thetized. Does it matter? Haemodynamic, quality of care	Compare 3 anaesthetic methods. Pain and post-operative opioid consumption.	Compare 2 immobilisation methods. Postoperative quality of recovery.
Day surgery settings	• University hospital • Regional hospital • Local hospital • Private hospital	Private hospital	University hospital	University hospital
Status	Published 2017	Published 2017	Published 2021	Accepted Feb 2022

3.1.1 PROTOCOL OF THE STUDY INTERVENTIONS AND OBJECTIVES

Table 6. Interventions and Outcomes in this thesis. Local Anaesthesia with Sedation (LAS). Spinal Anaesthesia (SPA). General Anaesthesia (GA). Supraclavicular plexus block. Local Anaesthesia (LA). Laryngeal Mask Airway (LMA). Post Anaesthetic Care Unit (PACU). Postoperative Nausea and Vomiting (PONV). Post Discharge Nausea and Vomiting (PDNV). Patient Reported Experience Measure (PREM). Quality of Recovery -15 (QoR-15).

Sketch	Study I	Study II	Study III	Study IV
Intervention/ Observational variables	POP-surgery in: • LAS/SPA/GA • 2012-2014 • 4 types of hospitals	Scrub and sterile dressing, awake vs anaesthetised	SCB short-acting LA vs SCB long-acting LA and GA (control)	Brace vs Cast
Outcomes	**Change in anaesthetics technique** - Time events	**Vasoactive medications** • Anaesthetic drug consumption • Pain, PONV - Time events - Quality of care	**Rebound Pain** • Postoperative opioid consumption • PONV/PDNV - Time events	**Quality of Recovery** - Postoperative opioid consumption - Time events
Logistic aspects addressed	• Theatre time • Surgery time • Surgery/theatre quota • By-pass PACU • Discharge day of surgery	• Theatre time • Surgery time • LMA time • PACU-time • Discharge time	• Theatre time • Surgery time • Anaesthesia nurse time • By-pass PACU • SCB duration • Discharge time • Unplanned admissions • Unplanned contacts	• Theatre time • Surgery time • Anaesthesia nurse time • By-pass PACU • SCB duration • Discharge time • Unplanned admissions • Unplanned contacts
Patients/ nurses self-assessment	-	PREM/ Anonymous nurse survey	NRS	QoR-15

3.2 PATIENTS

All patients in the four studies were ≥ 18 years old. Patients in the three randomised studies, Studies II – IV, were all opiod naïve and scheduled for a day surgery-consept. Exclusion criteria were dementia, cognitive dysfunction, ongoing drug and alcohol abuse, known local anaesthetic allergy, pregnancy and finally not being able to communicate fluently in Swedish.

Study I
A total of 440 random patient records of patients that had undergone elective vaginal surgery for correction of pelvic organ prolapse in 2012 - 2014 at one of four hospitals in VGR was reviewed. One university, one regional, one local and one private hospital were included.

Study II
This study was conducted at Capio Lundby Hospital, (a private elective surgical centre), in Gothenburg, November 2016 – February 2017. Male patients scheduled for elective open unilateral hernia repair with a modified Lichtenstein technique under general anaesthesia were included. Patients were randomised into two groups with 30 patients in each group.

Study III
Patients undergoing surgical repair of a DRF using a volar plate fixation between September 2018 - June 2020 at the Sahlgrenska University hospital/Mölndal hospital were included. Patients were randomised to one of three groups with 30 patients in each group. One of these groups of patients is shared with Study IV.

Study IV
Patients undergoing surgical repair of a distal radial fracture with a volar plate fixation between September 2018 - June 2020 at the Sahlgrenska University hospital/Mölndal hospital were included. Patients were randomised to one of two groups with 30 patients in each group. One of these groups is shared with Study III.

3.2.1 DROP-OUTS

Study I

This was a retrospective study based on patient record review. Only patients that met the defined inclusion criteria (see chapter 3.4.1) were included.

Study II

Sixty patients were included in the study. In the anaesthetised group of patients, one stayed overnight at the hospital because of social reasons. In the awake/sedated group of patients, one stayed overnight because of social reasons and one patient had a more extensive surgery than planned. For those three patients some data is used as "intension to treat", see Tables 10, 11.

Study III

142 patients were eligible for study enclosure. Twenty-two patients declined study participation because of different reasons, leaving 120 patients to be included. 90 patients were assessed to Study III. 30 of those 90 patients were shared with Study IV.

In the GA-group one patient was excluded because of prolonged surgery-time > 90 min. In the SCB-group with long-acting LA two patients were excluded due to failed blockade and therefore received GA. In the SCB-group with short-acting LA three patients were excluded due to failed blockade and these received GA.

Study IV

142 patients were eligible for study enclosure. Twenty-two patients rejected to participate in the study because of different reasons, leaving 120 patients to be included. 60 patients were assessed to Study IV. 30 of those 60 patient were shared with Study III.

In the Cast-group three patients were excluded due to failed blockade and received GA. (The shared patients with Study III). In the Brace-group two patients were excluded due to failed blockade and received GA and one patient were excluded because of anatomic anomaly that could cause extra pain.

3.3 ETHICS AND APPROVALS

All the studies were approved by the Regional Ethical Review Board in Gothenburg, Sweden.

Study I, Dnr 518-14 approved on 27:th of August 2014 by the Ethical Review Board secretary Mr Lennart Andren.

Study II, Dnr 751-16 approved on 24:th of October 2016 by the Ethical Review Board secretary Mr Sven Wallerstedt.

Study III + IV, Dnr 214-18 Study III+IV approved on 31:t of May 2018 by Ethical Review Board secretary Mr Gunnar Göthberg.

They were registrated in the Sahlgrenska University Hospital GDPR (General Data Protection Regulation) database August 28, 2018.

The initial registration of these studies in ClinicalTrials.gov. (NCT03749174) was done in August 2018, but was not finally approved and registered until November 21, 2018. The registration was later updated to comply with the ethical application.

All the studies were conducted in accordance with the tenets of the 1964 Declaration of Helsinki. The patients in Studies II – IV had oral and written information about the study and a written consent was obtained from all the participants prior to the start of the studies.

3.4 METHODS FOR THE SPECIFIC PAPERS

The papers in this thesis range from a retrospective observation study (Paper I) via a smaller prospective randomised study with follow-up until discharge (Paper II) to a larger prospective randomised study with follow-up one week after discharge and with cooperation together with an Occupational therapist and PhD-student (Paper III + IV).

A specified description of the methods that are used can be found in the Methods section of the respective papers, chapter 3.4.1-4.

3.4.1 PAPER I

Subjects: All 440 patients included in the study had undergone anterior colporrhaphy because of cystocele, posterior colporrhaphy because of rectocele and/or combined procedures. Combined procedures also included a low number of cervix amputations and/or perineorraphy. Only primary standard prolapse procedures including midline plication where included in the analysis. No patients having biological graphs, mesh or surgery for apical support where included.

Design: This was a retrospective observation study. 440 consecutive patient records of procedures performed during 2012-2014 in four different hospitals in VGR were reviewed; one University hospital, one Regional, one Local and one Private hospital (Table 7).

Table 7. Description of the 4 hospitals in the study. The total number of patients who underwent POP surgery each year is shown in Table 15.

Hospitals	Description
University hospital	Sahlgrenska University hospital/East hospital, Gothenburg
Regional hospital	Norra Älvsborgs Länssjukhus (NÄL), Trollhättan
Local hospital	Skaraborgs Sjukhus Skövde/Lidköping (SKAS)
Private hospital	Capio Lundby Sjukhus, Gothenburg

Patients complying to the inclusion criteria were included in chronological order with the start of January 1:st each year until the calculated number of patients was reached. At the University hospital, 35 patients were included each year, at the Regional and Local hospital 45 patients were included each year and from the private hospital all patients who complied to the inclusion criteria were included 2013 and 2014, 37 and 26 patients respectively. In 2012 no gynaecologist was operating the investigated procedure at the private hospital.

Data collection: Anaesthetic techniques and surgical procedures were recorded. Patients' characteristics, surgical time, theatre time, number of patients who by-passed the PACU and number of patients that was discharged on the day of surgery was collected.

Procedures:
The three anaesthetic techniques used in the study was:

❶ Local anaesthesia with sedation consisting of the surgeon infiltrating the surgical area with mepivacaine/adrenaline and sedation with propofol given intravenously and occasionally supplemented with a small dose of alfentanil 0.25 – 0.5 mg intravenously.

❷ General anaesthesia based on total intravenous anaesthesia, propofol/remifentanil, or sevoflurane and a laryngeal mask airway (LMA).

❸ Spinal anaesthesia induced by hyperbaric bupivacaine. The local anaesthetic administration by the surgeon was given even though the patient had general or spinal anaesthesia since this also was included in the surgical procedure.

Time in theatre was defined as patient entering the theatre until leaving the theatre, while surgical time was defined as time from incision to wound closure. Theatre resource utilization was assessed as the quotation between surgical time and theatre time.

Primary outcome: The change in the amount of anaesthetic techniques used, LAS, SPA, GA, at the four hospitals during the 3-year time period studied; 2012 to 2014.

Secondary outcomes: Surgical time, theatre time, theatre resource utilization, number of patients that by-passed the PACU and number of patients who were discharged the day of surgery in the four hospitals during 2012 to 2014.

3.4.2 PAPER II

Subjects: 60 males, ≥18 years, with physical status ASA 1-3, scheduled for elective, primary open unilateral inguinal hernia repair using a modified Lichtenstein technique under general anaesthesia with LMA were asked to participate. Exclusion criteria were severe cardiovascular, respiratory, hepatic or renal diseases or not fluent in the Swedish language.

All seven surgical nurses who were involved in these 60 procedures were asked to answer a short quality of care questionnaire at the end of the study.

Design: This prospective randomised study was conducted at Capio Lundby hospital, a private hospital performing mostly public health care patients, during November 2016 to February 2017. The patients were randomised to one of two groups (30 patients in each group) by using sequentially numbered opaque envelope technique.

Data collection: Patient characteristics, perioperative observations (blood-pressure, heartrate, saturation), vasoactive medications, anaesthetic agent doses were recorded.

Theatre time, surgical time, time with LMA, time in PACU, time in hospital and worst pain during the PACU stay (VAS 0-10) were noted.

Both the patients and the surgical nurses were asked to answer anonymously a short quality of care questionnaire after the procedures.

Procedures:
The patients were randomly allocated to one of two groups:

❶ Patients were anaesthetised during the scrub and sterile covering of the surgical area. (The induction of the general anaesthesia was performed before the start of scrubbing/sterile covering.)

❷ Patients were awake/sedated during the scrub and sterile covering of the surgical area.

GA was performed using TIVA, propofol/remifentanil and sedation was performed using a small dose of propofol if requested from the patient. All the patients received wound LA infiltration at the end of the surgery. All the patients received the same premedication.

The surgeon was present in the theatre, dressed and ready for surgery when the induction for GA started.

WHO-checklist was performed before induction of GA for the anaesthetised group of patients and before the scrub/covering-procedure for the awake group of patients.

Vasoactive medications were given as follows:

❶ If MAP < 60, the anaesthetic doses were adjusted.

❷ If MAP remained < 60 and HR < 60 an intravenous dose of 5 mg ephedrine was given and repeated as necessary.

❸ If MAP still remained < 60 and HR > 60 an intravenous dose of 0.1 mg phenylephrine was given and repeated as necessary.

The patient questionnaire included a Visual Analogue Scale (VAS 0-10, 0=unacceptable to 10=fully acceptable) to describe their experience of the procedure as the first question. The second question was "Would you like to have the same care if you need surgery in the future?" (yes/no/I don´t know).

The seven surgery nurses were asked whether they found the surgical scrub and sterile covering acceptable from a patient care perspective (VAS 0-10, 0=not at all, 10=fully acceptable) only for the group with awake patients.

Primary outcome: Vasoactive medications perioperatively.

Secondary outcomes: Anaesthetic drug doses, theatre time, PACU-time, max pain in PACU, time in hospital, patient and surgical nurses´ assessed quality of care.

3.4.3 PAPER III

Subjects: 84 patients, 10 males/74 females who were scheduled for open repair of a distal radial fracture (DRF) completed the protocol to assess primary and secondary outcomes.

Design: This was a prospective randomised study with a follow-up 3 days postoperatively. All patients were scheduled for open repair of a DRF between September 3:rd 2018 and June 15:th 2020 at Department of Anaesthesia and Intensive Care, Sahlgrenska University Hospital/Mölndal Hospital, Gothenburg, Sweden.

The patients were randomly allocated to one of three groups (30 patients in each group) of different anaesthetic techniques using sequentially numbered opaque envelopes with a random allocation sequence in 2 blocks.

Opiod naïve patients with a closed DRF were included, (Orthopaedic Trauma Association, assessed on radiographs and classified as AO 23 A-C1), ≤ 17 days from trauma and scheduled for operative fixation using a volar locked plate. Finally, maximum length-of-surgery had to be < 90 min and all surgeons used tourniquet.

All fracture classifications were made by experienced orthopaedic surgeons and all supraclavicular blocks were placed by experienced anaesthesiologists using ultrasound technique. All patients had open surgical repair with internal fixation by a senior orthopaedic surgeon. Further, all patients received the same preoperative medication and also betametasone i.v. perioperatively. Post-surgery a dorsal plaster splint was applied and patients were immobilized 2 weeks postoperatively.

All patients obtained a protocol, before discharge, to note pain and report analgesic consumption at home and they all received the same postoperative pain management after discharge. Follow-ups were made by telephone calls at 1, 2 and 3 days postoperatively.

An Occupational therapist made follow-ups where the patients had their first appointment at day 2-4 postoperatively and then appointments scheduled at 2, 6 and 12 weeks and 1 year postoperatively.

Data collection: Data collected were; patient characteristics, NRS (0-10) for pain and PONV assessment at rest was performed; before surgery, 2 hours after surgery, 24, 48 and 72 hours after discharge. NRS and PONV were also assessed at block resolution, when patients experienced full motor and sensory function.

Information about oxycodone consumption in hospital and after discharge, (the first 3 postoperative days), was also collected.

Perioperative observations were registered as; time anaesthesia nurse was occupied with the patient, theatre time, surgery time including plastering, PACU-time and time-to-discharge. Moreover, total SCB effect-time and effect-time after surgery was noted as well as unplanned admissions and healthcare contacts during the first postoperative week.

Procedures:
The patients were randomly allocated to one of three anaesthetic groups:

1. *Group 1:* Supraclavicular block (SCB) given as a singleshot: mepivacain 1%, 25-30 ml and intravenous sedation using propofol.

2. *Group 2:* SCB given as a singleshot ropivacain 0.5%, 25-30 ml and iv sedation using propofol.

3. *Group 3:* General anaesthesia (GA) using propofol/fentanyl/sevoflurane and LMA and no LA (control group).

Primary endpoint; difference in pain (NRS) at rest at 24-hours and futher during the first three days after surgery between SCB performed with mepivacaine vs ropivacaine, with GA being control group.

Secondary endpoints; Postoperative Opioid Equivalent Consumption (OEC) during the first three postoperative days. Differences in pain related opioid consumption between SCB´s and GA controls were also analysed. Post Operative Nausea and Vomiting *(PONV)* and Post Discharge Nausea and Vomiting *(PDNV)* during the first 3 postoperative days. Perioperative events described above, number of patients by-passing PACU, number of unplanned admissions and unplanned health care contacts postoperatively were registered as well.

Oxycodone administered to patients in the PACU and/or step-down unit and/or consumed by patients after discharge within the first three postoperative days were converted into mg of peroral (p.o.) Morphine. *i.v.*

Table 8. Equianalgesic conversion ratios.

Type of opioid consumed	Conversion ratio to p.o. Morphine
Oxycodone i.v.	1:3
Oxycodone p.o.	1:2

3.4.4 PAPER IV

Subjects: Fifty-four patients, 8 males/46 females scheduled for open repair of a DRF completed the protocol to assess primary and secondary outcomes.

Design: This was a prospective randomised study with a follow-up of 7 days postoperatively. All patients were scheduled for open repair of a DRF between September 3:rd 2018 and June 15:th 2020 at the Department of Anaesthesia and Intensive Care, Sahlgrenska University Hospital/Mölndal Hospital, Gothenburg, Sweden.

The patients were randomly allocated to one of two groups (30 patients in each group) of different immobilisation methods using sequentially numbered opaque envelopes with a random allocation sequence in 2 blocks.
This study is a part of Study III and the two studies share 27 patients (3 drop-outs are excluded).

All patients in this study had the same anaesthetic technique, supraclavicular block (SCB) given as a singleshot: mepivacaine 1%, 25-30 ml and intravenous sedation using propofol. The procedure was otherwise the same as in Study III.

Data collection: The following data were collected; patient characteristics, QoR-15 at 4 times (baseline/preoperatively, 24, 72 hours and day 7 post-surgery). Postoperatively, we noted oral oxycodone consumption, administered at the hospital and after discharge; the first 3 postoperative days and 7 days after surgery.

The five domains and the QoR-15 questionnaire are described in Figure 4. The item “Getting support from hospital nurses/doctors” was not used in the present study since it is related to day surgery patients and everyone was followed-up with telephone calls in the study. Maximum points were therefore 140 points instead of 150 points.

Perioperative time events were registered; surgery-time (including fixation with cast or brace), the time the anaesthetic nurse was occupied with the patient and theatre time. Further, unplanned admission, number of patients needing PACU-stay, total time in hospital, SCB total duration time and duration time after surgery were registrated as well.

Procedures: All patients underwent surgical treatment using a volar plate fixation by senior orthopaedic surgeons and were then immobilised for 2 weeks with one of the two randomised immobilisation methods applied directly post-surgery.

1. Traditional dorsal cast

2. Removeable brace, prefabricated and stabled with volar and dorsal steel rails *("Wrist lacer", Camp Scandinavia AB).*

Primary outcome; Differences in median (IQR) QoR-15 score and its five domains, at baseline, 24 hours, 72 hours and 7 days after surgery between the two groups.

Secondary outcomes; Sum median (IQR) of postoperative oral oxycodone consumption administered at the hospital and after discharge, the first three postoperative days and day 7 after surgery. Finally, perioperative time events as described above.

QoR -15 questionnaire in its entirety is found in the Appendix.

3.5 STATISTICAL ANALYSES

The statistical methods that were used in this thesis are presented in Table 9.

Table 9. Statistical methods used in Studies I – IV.

Statistical method	Study I	Study II	Study III	Study IV
Student t-test/T-test		X	X	X
ANOVA	X		X	
Mann Whitney U-test		X	X	X
Kruskal- Wallis test			X	X
Chi-square/ Fischer`s exact test	X	X	X	X
Multiple logistic regression	X			
Power analysis		X	X	

Continuous numeric data is presented as means and standard deviations, categorical data as frequencies.

Continuous data was analysed by independent T-test for two-group comparisons and by ANOVA for multiple-group comparisons when a normal distribution of data could reasonably be assumed. Mann Whitney U-test or Kruskal-Wallis test were used for skewed data. Normal distribution was assessed by the Shapiro Wilk test.

Categorical data were compared using the Chi-square and Fischer´s exact test.

The multiple logistic regression analysis used in Study I was made, post publication, for this thesis.

In Study II both Students t-test and Mann Whitney U-test were used for quantitative variables (Students t-test for normal distribution and Mann-W-U-test for skewed). The Mann Whitney U-test is however not mentioned in the manuscript.

For all statistical analyses, a significance level of $p<0.05$ was used.

Analyses were performed with Statistical Package for the Social Science (SPSS, version 27) in Study IV, SAS 9.4 (SAS Institute Inc, Cary, NC) in Study III and StatView (v1.04) for MAC in Studies I and II.

4

RESULTS

The main results from each paper are reviewed in this section. The full results are presented in the respective papers found in the appendix.

4.1 PATIENT POPULATIONS

Demographics of the patients included in the study analysis are presented in Table 10. There was a clear predominance of female patients. The mean age in all studies was between 56 and 62 years, thus elderly adults. 400 (63%) of the patients were ASA physical status 2 and 182 (29%) patients were ASA 1, merely 54 (8.5%) patients were ASA 3 and two (0.3%) patients were ASA 4.

Table 10. Patients characteristics in the four studies. - = no data

Demographics	Study I n = 440	Study II n = 30/30	Study III n = 30/30/30	Study IV n = 30/30	Total n = 620
Patients included in the analysis of outcomes	**n = 440**	**n = 30/30**	**n = 27/28/29**	**n = 27/27**	**n = 611**
Gender m/f	0/440	60/0	10/74	8/46	**75/536**
Age mean year	62±11	60±15	60±13	56±13	**58.3**
ASA 1/2/3/4	110/287/41/2	14/35/11/0	31/52/1/0	27/26/1/0	**169/387/53/2**
BMI kg/m²	26±4	26±3	24±3	24±3	**25.2**
Smoking yes/no	-	8/52	8/76	7/47	**19/152**
Total	**440**	**60**	**84**	**54**	**638/611**

Studies III and Study IV share 27 patients. Those patients were allocated to SCB using the short-acting local anaesthetic agent mepivacaine and had a dorsal cast splint for immobilisation at the end of surgery.

4.2 TIME EVENTS

The lead times are taken from different Operation planning systems in the four studies. However, all the systems had similar lead times and all systems intent to follow the SPOR-registration. Time events are taken from Kliniken/Operätt/Orbit version 3 in Study I, Cosmic TM-module (The Theatre Management Logistic System) in Study II and Orbit version 5 in Studies III and IV.

Table 11. Time events in the four different studies. - = no data. Laryngeal Mask Airway (LMA).

Time events	Study I 2012/-13/-14 *Priv/Uni/Reg/Loc* n = 440	Study II two groups n = 29/28	Study III three groups n = 29/27/28	Study IV two groups n =27/27
Anaesthesia nurse time (min)	-	-	141/152/147	152/155
Time with LMA (min)	-	58/52	-	-
Theatre time (min)	118/112/100 *77/105/121/123*	70/69	187/192/168	192/172
Surgery time (min)	53/56/52 *51/54/52/57*	39/38	70/71/66	71/69
PACU time (min)	140/127/166 *30/68/141/236*	48/39	115/13/2	13/19
Hospital time (min)	-	224/235	553/501/501	501/503

The private hospital just had data from 2013 and 2014 in Study I, since they did not have a gynaecologist 2012. Both University hospital and the private hospital had a step-down-unit after PACU, that could have contributed to the shorter PACU times compared with the Regional and Local hospital, where all day surgery patients were treated in PACU postoperatively until discharge.

LMA-time was used in Study II to clarify how much longer the patients needed to be anaesthetised for the scrubbing and sterile covering by the surgical nurse. This is further discussed in chapter 5.1 and 5.2.2.

Total time in hospital (Hospital time) also differs between Study II and Studies III and IV. In the two later studies all patients had to undergo a postoperative radiograph of the operated wrist before discharge. This procedure caused some patients "waiting time".

Time for discharge can sometimes depend on e.g. "when someone can pick up the patient" and "when the surgeon can come back and give information". No account was taken to this in the studies.

4.3 THEATRE TIME RESOURCE UTILISATION

The theatre-time is a most valuable and expensive time in all surgical activities. It is important that theatre time never is a "waste of time". The theatre time resource utilisation can be described as the quota between "surgical time/theatre time". The quota will then tell us how large part of the theatre time that actually was the surgical time/knife time.

Table 12. The quota between theatre time and surgical time for the four studies in this thesis. In Study I are the four hospitals results merged for each year (2012, 2013, 2014). In Study II only a private hospital was included. Studies III and IV were performed in a University hospital. No account is taken to training assignments. - = no data

Theatre time resource utilisation	Study I 2012/-13/-14 n = 440	Study II two groups n = 29/28	Study III three groups n = 29/27/28	Study IV two groups n =27/27
Surgical time/theatre time	0.44/0.5/0.49	0.56/0.55	0.37/0.39/0.37	0.37/0.40
Total time in hospital (DS patients)	-	224/235	553/501/501	501/503

4.4 POSTOPERATIVE PAIN IMPACT ON THE PACU-TIME

A painful postoperative situation where the patient needs intravenous analgesia e.g. opioids can lead to an extended PACU-time, see Table 13.

Table 13. Postoperative pain impact on the PACU-time needed. The bold-marked patients are the group who received general anaesthesia in Study III. - = no data

Postoperative pain/PACU	Study I n =440	Study II two groups n = 29/28	Study III three groups n = 29/27/28	Study IV two groups n = 27/27
Number of patients that by-passed PACU	60	0/0	**0**/23/27	23/26
Pain 2 hours postoperative (mean VAS 0-10)	-	-	**5.3**/3.0/0	3.0/3.8
Max pain in PACU (mean VAS 0-10)	-	1.8/1.2	-	-
Mean time in PACU (min)	-	48/39	**114.7**/13.4/1.5	13.4/19

4.5 ANAESTHESIA METHOD IMPACT ON THE PACU-TIME AND DISCHARGE

General and spinal anaesthesia patients can normally not by-pass the PACU.

Table 14. The Anaesthesia method impact on PACU-time and possibility of discharge to home the same day as surgery. Only one patient (bold-marked) from the GA group in Study III was admitted over night at the hospital because of pain. - = no data. n = number.

Anaesthesia method/ PACU/Discharge	Study I 2012/-13/-14 n = 440	Study II two groups n = 57 (60)	Study III three groups n = 84	Study IV two groups n = 54
Local anaesthesia + sedation (n)	27/65/83	-	-	-
Spinal anaesthesia (n)	56/56/26	-	-	-
General anaesthesia (n)	42/42/42	(30/30)	29	-
SCB short-acting LA (n)	-	-	28	27/27
SCB long-acting LA (n)	-	-	27	-
Mean time in PACU (min)	-	48/39	**114.7**/13.4/1.5 *(GA/SCB-s/ SCB-l)*	13.4/19
Amount of patients that by-passed PACU (%)	5/12/23	0	0/82/93	85/96
Number of patients (and amount %) admitted over night	-	(3(5))	1(1)/1(1)/2(5)	2(4)/0
Amount (%) of patients that could discharge day of surgery in the different anaesthesia groups.				
Local anaesthesia + sedation (%)	*78/85/84*	-	-	-
Spinal anaesthesia (%)	*9/30/38*	-	-	-
General anaesthesia (%)	*10/33/67*	*100(95)*	*96.3*	-
SCB short-acting LA (%)	-	-	*93.1*	*96.3*
SCB long-acting LA (%)	-	-	*96.4*	-

Only one patient in the GA-group in Study III was admitted over night because of pain, all the other patients in Studies II – IV who were admitted overnight had social reasons or a more extended surgery (one patient in Study II that was excluded from the later part of the study).

The number of patients who could be discharged on the day of surgery increased between 2012 and 2014 in Study I in all three anaesthetic groups.
At the University hospital it was 46-80%, in the Regional hospital 31-64%, in the Local hospital 0-58% and the Private hospital 97-96%. (Table VI in Paper I).

This result tells us that the four hospitals included in the study at this time were improving their "Day surgery process concept" in more ways than just changing the anaesthetic method.

4.6 PAPER I

This observational study aimed at assessing the implementation of day surgery care for pelvic organ prolapses (POP) procedures.

Patient records for patients treated with elective prolapse surgery at 4 hospitals during a 3-year period was reviewed with a focus on the anaesthetic techniques, care logistics, number of patients that could by-pass PACU and subsequent be discharged day of surgery.

A pronounced increase in the number of patients being discharged on the day of surgery was found during the study period.

All the three anaesthetic technique were used at the four hospitals studied, but in varying number, (Table IV in Paper I). Over the study period there was an overall significant change in anaesthetic technique; LAS increased from 22% to 55%, SPA decreased from 45% to 17 % while GA was unchanged 33% to 28% (Table III in Paper I).

The surgical quota (surgical time/theatre time) changed significantly over the three studied years from 0.44 (±0.12) in 2012 to 0.50 (±0.13) in 2013 and to 0.49 (±0.16) in 2014 (Table III in Paper I).

By-passing the PACU (recovery room) was common only among the patients in the LAS-group. It increased from 17% to 58% in the hospitals with a step-down unit (Table V in Paper I).

Patients in the included procedures could significantly more often be discharged on the day of surgery in 2014 (72%) than in 2012 (24%) (Table III in Paper I). The proportion of patients being discharged on day of surgery increased in all the three anaesthetic technique groups over the study period, LAS 78% to 84%, SPA 10% to 67% and GA from 9% to 38% (Table VII in Paper I).

Table 15. The total number of patients who had a pelvic organ prolapse procedures performed at the 4 hospitals studied during 2012-2014 and the proportion of patients included at each hospital. (*www.gynop.se*).

Total procedures	2012	2013	2014	Total	% included in the study
University hospital	129	145	159	433	25
Regional hospital	103	99	115	317	43
Local hospital	55	46	70	171	79
Private hospital	-	37	26	63	100
Totally each year	287	327	370	**984**	

Post publication a multiple logistic regression analysis was made for this thesis. In this logistic regression analysis, the anaesthetic technique had the most powerful impact on the outcome discharge day of surgery. Local anaesthesia with sedation had an OR of 13 for discharge day of surgery as compared to spinal anaesthesia. The second most important factor was the change of the study period 2012 to 2014. The OR increased on annual basis.

The third factor was type of hospital. The private hospital had a significantly higher OR for discharge day of surgery than the other 3 hospital types. The regional hospital had no difference and the local hospital had a significant lower OR for discharge day of surgery than the University hospital, see table 16.

Tabel 16. Multiple logistic regression analysis. The outcome was discharge day of surgery (yes/no). Spinal anaesthesia, year 2012 and University hospital were used as references. Wald test in the context of logistic regression was used to determine whether a certain predictor variable was significant or not. It rejects the null hypothesis of the corresponding coefficient being zero.

Predictor variables	Wald Test	Odds Ratio	p-value
Anaesthesia: SPA	**49.377**		
Anaesthesia: GA	10.551	2.874	0.001
Anaesthesia: LAS	48.715	13.047	<0.0001
ASA (1+2)(3+4)	3.897	0.364	0.048
Age (≤65)(≥66)	1.412	1.369	0.235
Year, 2012	**30.086**		
Year, 2013	7.713	2.465	0.005
Year, 2014	29.906	6.387	<0.0001
Hospital: University	**21.225**		
Hospital: Private	5.466	3.815	0.019
Hospital: Regional	1.670	1.592	0.196
Hospital: Local	4.246	0.420	0.039

4.7 PAPER II

This prospective randomised study was performed at a private elective ambulatory centre, aimed at assessing the feasibility of surgical scrubbing and sterile covering with patients awake.

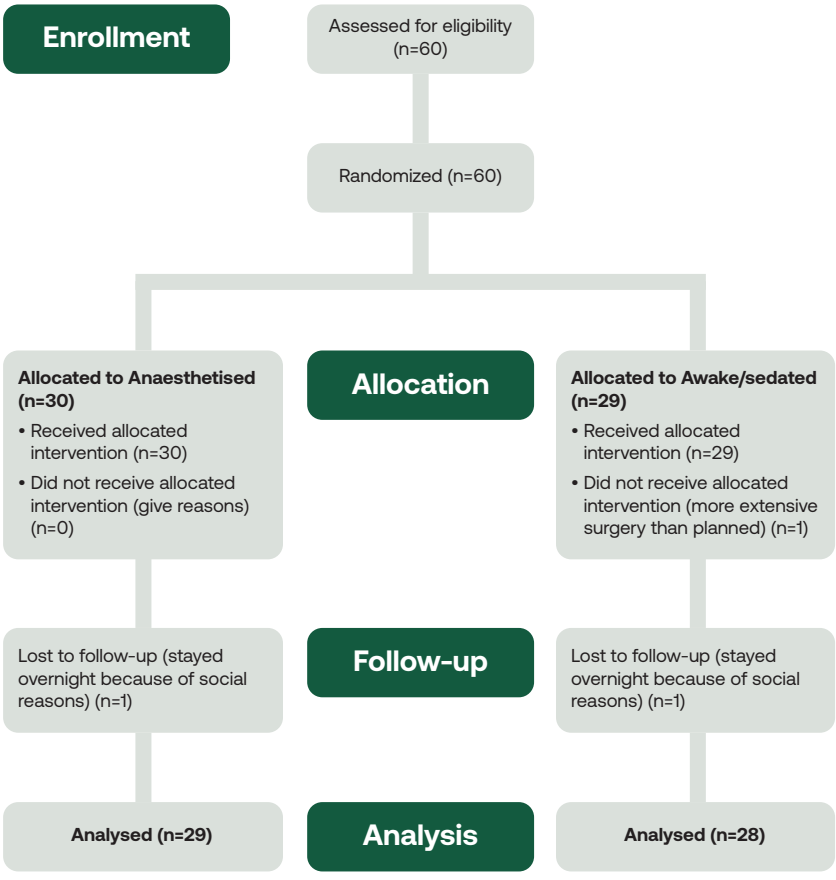

Figure 6. Flowchart of the patients included in Study II. Of 60 patients included, 57 remained "per protocol" for all analysis and 3 were drop-outs. However, those three drop-outs could be used as "intension to treat" for some analysis.

Patients were randomly allocated to surgical scrubbing and sterile covering awake or after induction of anaesthesia but prior to start of surgery preparation, Figure 6. We could not verify the hypothesis that; introducing the induction of anaesthesia after the surgical scrub/sterile covering and thus avoiding prolonged anaesthesia, would lower the incidence of drop in blood pressure and heart rate, compared with induction of anaesthesia prior to the start of surgery preparation. The median/mean doses and the number of doses of ephedrine and phenylephrine required are presented in Table 17.

Table 17. The need for vasoactive medication in mg calculated as median (IQR) and mean (±SD) and the number of doses.

Vasoactive medication in mg	Anaesthetised n= 29	Awake/sedated n=28
Ephedrine median **+ mean doses** **Number of patients**	0 (0-15) 3.3 (±5.1) 10	0 (0-25) 5.4 (±7.8) 13
Phenylephrine median **+ mean doses** **Number of patients**	0 (0-0.8) 0.04 (±0.2) 3	0 (0-0.4) 0.03 (±0,09) 3

Thus, postponing anaesthesia induction to just before start of surgery in this group of 60-year-old male patients did not significantly reduce anaesthesia drug consumption and yet it shortened significantly the PACU time.

The difference in LMA time was in mean 6 minutes between the groups. Thus, the anaesthetised group had 6 minutes more GA than the awake group. The surgical scrub/sterile covering was made during this 6 min.

The patients´ as well as nurse assessment of surgical scrubbing and sterile covering while awake was overall positive. In total, 27/30 of awake patients would like to undergo surgery again using the same logistics, two were indifferent and one was “negative”. 21/30 of the anaesthetised patients stated that they would like to have the same logistics again, while nine were indifferent. See Table 18.

Both patients´ and scrub nurse´s acceptance was high. The theatre nurses rated patients being awake during the surgical scrub/sterile covering preparation as acceptable; 4 out of 7 nurses rated 10 (scale 0-10), while the remaining rated as follows; 1 nurse had a rating of 6 and 2 nurses rated the process

of scrubbing and sterile covering as 8. All the 7 nurses involved in the patient care considered it achievable to perform surgical scrub and sterile covering before induction of anaesthesia as routine procedure. See Table 18.

Table 18. Patients´ self-reported quality of care. The theatre nurses were asked whether they found the surgical scrub and sterile covering acceptable from a patient care perspective for the awake patients.

Quality of care	Patient reported VAS 0-10, (median range) n = 29 asleep/28 awake	Theatre nurse reported VAS 0-10 (number of nurses) n = 7
Study II	10 (6-10) / 10 (3-10)	10(4) / 8(2) / 6(1)

VAS 0-10, 0 = not good, 10 perfectly acceptable

4.8 PAPER III

This prospective randomised study was aimed to assess differences in the postoperative pain course in patients having open repair of DRF with one of three anaesthetic techniques; SCB using short-LA, SCB using long-LA or GA as control-group. All the three anaesthetic groups of patients were comparable in terms of patients´ characteristics and preoperative use of analgesic medication. 90 patients were enrolled and 84 patients, 10 males and 74 females, aged 19-86 years completed the study procedure, (Flowchart in Paper III).

Pain described as NRS

There were no preoperative difference between the 3 anaesthetic technique groups in terms of pain (mean NRS) at baseline. However, significant difference in terms of postoperative pain profiles were found over the study period of 3 days, (Figure 2 in Paper III).

The pain scoring (mean NRS) at 24 hours (following resolution of blocks) was significantly lower in SCB-mepivacaine group of patients (*p=0.018*). (Figure 2 in Paper III).

The median mean NRS during the first 3 postoperative days was significantly lower between the SCB-mepivacaine group and the SCB-ropivacaine group (p=0.017). The GA-group (control) mean NRS value was lower than the SCB-ropivacaine and higher than the SCB-mepivacaine groups 24-72 hours postoperatively, (Table 2 in Paper III).

Pain, measured as mean NRS, at the time of brachial plexus block resolution, did not differ between the SCB-groups of patients.

Pain described as categories

The NRS results were also categorized into the 3 categories (0-3=mild, 4-6=moderate, 7-10=severe), [78, 129].

The NRS categories showed that 31% of the **GA patients** experienced severe pain 2 hours after surgery. At this time-point there was a significant difference between the GA-group and the SCB-mepivacaine group p=0.028 and the SCB-ropivacaine group p<0.0001 since these blocks had not or just partly worn off. At 24, 48 and 72 hours postoperatively 6.9%, 3.4% and 3,4% reported insignificant severe pain respectively, see Figure 7.

No patient in the **SCB-ropivacaine group** had pain during hospital stay. In this group 35.7% experienced severe pain at block resolution (mean 16.4 hours postoperatively) at home. For most patients this happened in the middle of the night or very early morning. At 24-hours post-surgery 21.4 % experienced severe pain and this was significantly more than the SCB-mepivacaine group of patients *(p=0.022).* Still at 48-hours post-surgery 17.9% experienced severe pain and at 72-hours 7.1% reported severe pain at the follow-up.

The **SCB-mepivacaine** group also had a rebound pain pattern at block resolution (mean 2.7 hours postoperatively) when 33.3% of the patients experienced severe pain. During follow-up at 24, 48 and 72-hours postoperatively 0%, 3.7% and 0% reported severe pain, respectively.

Conclusively, 2 hours after surgery 9 patients in the GA-group reported severe pain while after discharge only 4 patients reported severe pain during the first three postoperative days. In the SCB-ropivacaine group none had severe pain before discharge but 12 patients after discharge. In the SCB-mepivacaine group 3 patients reported severe pain 2 hours postoperatively and only 1 after discharge. At the time-point of brachial plexusblock resolution 10 patients in the SCB-ropivacaine group reported severe pain and 9 patients in the SCB-mepivacine group, see Figure 7.

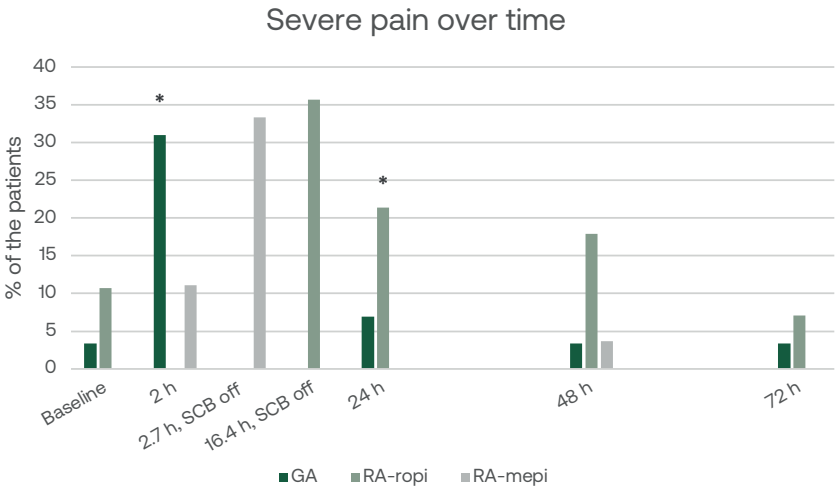

Figure 7. The amount of patients (%) with severe pain NRS (7-10) for each anaesthetic group at different time points. 2 h postoperative there was a significant difference between the GA-group and both the SCB-groups (p=0.028 mepi and p<0.0001 ropi). 24 h postoperative there was a significant difference between the SCB-mepivacaine group and the SCB-ropivacaine group (p=0.022).

Opioid consumption

The oral opioid consumption was significantly lower in the SCB-mepivacaine group related to the SCB-ropivacaine group (p=0.004), while the oral consumption in the GA-group was between the both SCB-groups, during the first 3 postoperative days (Table 3 in Paper III).

Looking specifically at the two SCB-groups, both pain ratings and opioid use was higher in the SCB-ropivacaine group of patients showing a more intense pain pattern, see (Table 2 + 3 in Paper III) and Table 19 below.

Table 19. Mean pain rating in Numeric Rating Scale (NRS) 24, 48 and 72 hours postoperative and mean Opioid Eqivalent Consumption (OEC) in mg at three timepoints, postdischarge-24 hours, 24-48 hours and 48-72 hours postoperatively.

Mean NRS/mean OEC in mg	24 hours	48 hours	72 hours
SCB-Mepivacaine (n=27)	1.8/14.8	1.9/13.7	1.6/10.7
SCB-Ropivacaine (n=28)	3.3/33.2	3.4/30.7	2.3/19.6

PONV/PDNV
PONV/PDNV were constantly low with no significant differences noted between the groups.

Logistics
In terms of the perioperative time events, only the PACU-time revealed a significant difference between the study groups. All 29 patients in the GA-group needed PACU monitoring while merely one patient in the SCB-ropivacaine group and four in the SCB-mepivacaine group required to stay in PACU.

The total block duration time in the SCB-ropivacaine group was significantly longer, i.e. a mean value of 18.9 hours compared with the SCB-mepivacaine group, with a mean value of 4.6 hours.

Four patients needed unplanned hospital admission; one in the GA-group because of pain, one in the SCB-ropivacaine group due to social reasons and two in the SCB-mepivacaine group, also due to social reasons.

During the first postoperative week 12 unplanned healthcare contacts were needed; one in GA-group due to fever, 11 in SCB-ropivacaine group due to; pain, great discomfort being anaesthetised for so long and burn-damage, but none in SCB-mepivacaine group.

4.9 PAPER IV

This prospective randomised study aimed to assess the differences in pain and quality of recovery in patients having applied either a traditional cast or a flexible brace. Sixty patients were recruited in the study and 54 patients, 8 males/46 females with mean age 56 (±15) years, ASA 1-3 were included in the final analysis. The patients in brace group was found to have a lower mean age (p=0.02) and a higher mean BMI (p=0.02) than the cast group. No other differences were found in baseline characteristics of the patients.

Quality of Recovery
There were no differences in the median QoR-15 between the two patient groups at preoperative baseline.

At the four time-points examined the different domains in the QoR-15 questionnaire showed only minor differences between the two groups. There was a significant difference in pain-score at the 24 hour-assessment when the brace-patients scored worse than the cast-patients (p=0.022). After one week, no significant differences were found between the groups in the median QoR-15 score.

From baseline and up to 1 week after surgery, there was an increase in median QoR-15 score within both study groups (cast p=0.001, brace p=0.001). No postoperative reduction was seen in median QoR-15 score in any of the groups.

There was a minor different pattern in the QoR-15 score between the two groups. The brace-group reached the largest increase from baseline at 72-hours post-surgery while the cast-group had the largest increase already from baseline to 24 hours postoperatively.

Oxycodone consumption

Median postoperative oral oxycodone consumption was overall low in both groups. No significant differences in oxycodone consumption existed during the study period, (Table 4, Paper IV).

Logistics

Most of the patients bypassed the PACU and were transported directly to the step-down unit. No other significant differences existed between the groups in any perioperative time events.

5

DISCUSSION

This thesis focus on improvements in the implementation of safe and effective DS for high volume operative procedures. The philosophy of DS is to achieve rapid and effective recovery, but also to secure patient reported quality of care and safety. In this thesis three common procedures were studied; POP surgery, open inguinal hernia repair and surgical correction of DRF.

These procedures are *per se* not lifesaving, but do have huge impact on the quality of life. The high number of operations combined with increased hospital turn-around of patients that safely can be discharged home on day of surgery have large impact on health care resource utilization.

In this context it is important not only to consider the effective use of healthcare resources, but also the quality of care including patient safety and adverse events [7]. DS has been proven to be safe and several large retrospective studies have documented this as well as the pivotal role played by the anaesthesiologist [30, 39, 40, 50, 51, 130-132]. However, patients´ self-assessment of quality of care needs further studies. Thus, in Studies II and IV we included patients' self-assessment of quality of care and although Study III had a focus on pain, PONV/PDNV and the need for unplanned health contacts, indirect signs of quality, were investigated. The surgical outcome is likewise of outmost importance.

Summary of the main findings.

Paper I:
Several changes in perioperative care were observed like the mixture of anaesthetic techniques changed to an increase of LAS, reduction in SPA while GA was unchanged. However, the proportion of patients being discharged on the day of surgery increased in all the three anaesthetic technique groups. Further, the resource utilization of the theatre room and patients by-passing PACU increased.

Paper II
There were no differences in terms of need for vasoactive medications between the groups. However, the time in PACU was significantly shorter for the awake-group of patients. Conclusively, both patients and surgical nurses found the new procedure acceptable and approved it as a new routine.

Paper III
The pain progression following resolution of the SCB´s was significantly worse at 24 hours post-surgery in patients given long-LA compared with short-LA, both in terms of NRS, patient reported severe pain events and in higher postoperative opioid consumption. Most SCB-patients could bypass the PACU and could directly be transported to the stepdown ward. Finally, SCB-patients with long-LA had significantly more unplanned healthcare contacts after discharge.

Paper IV
No significant differences in the QoR-15 score were found between the brace- and the cast-group the first postoperative week. Only a minor difference was seen in the subdomain pain at 24-hours post-surgery. In both study groups, the postoperative median QoR-15 score increased from baseline until one-week post-surgery. No deterioration was noted in neither of the two groups.

5.1 METHODOLOGICAL CONSIDERATIONS

Paper I was a retrospective observational study. We totally studied 440 consecutive patient records during a three-year period at 4 different hospitals in VGR. The study has limitations. Available patient record data prevented us from assessing patients´ satisfaction, quality of care, as well as pain and discomfort during or after surgery.

Further, we did not include any regression analysis assessing the impact of the 5 main factors that possibly could have had impact on the outcome "discharge day of surgery"; age, ASA-physical status, anaesthetic technique, change in logistics and DS policy over the 3 years studied and the 4 types of hospitals. A multiple logistic regression analysis was made post publication for this thesis. This regression analysis further strengthened the result showing the huge impact of anaesthetic technique but also emphasising the impact of year of procedure as well as hospital location.

Also, in this study we did not include assessment of surgical outcome, complication and/or side effects. Finally, no formal cost analysis was made.

Paper II was a prospective randomized study. The sample size was based on a power analysis from an earlier pilot study giving a risk that this study could eventually be underpowered.

The primary outcome "need for vasoactive medication" was probably not the optimal choice. Differences in blood-pressure might have been a better primary outcome and vasoactive medication a secondary outcome.

We used the LMA time, an indirect measure since it contains both surgical time and scrub/covering time, to assess the time for surgical scrub and sterile covering. However, no difference was found in surgical time between the groups.

The study was performed in a small private hospital with only elective procedures and no training assignments. The surgeon was routinely, (to decrease waiting time), in the theatre room at the start of induction of GA, ready to start the operation.

Paper III-VI were prospective randomized studies, where 27 patients in these two studies are based on the same study-material.

The power analysis to find an appropriate sample size was performed only for Study III.

The choice of mepivacaine 1% 25-30 ml, a very short-LA, was a challenge to the logistics. Thus, no waiting time and 30 ml rather than 25 ml is to be preferred. The three drop-outs in Study III and five in Study IV may have been avoided with “no waiting time” and/or 30 ml instead of 25 ml in the SCB.

Assessing pain must be done in the context of pain medication and the goal is certainly to provide effective pain relief. Thus, pain assessment must consider the amount of analgesic used. In Table 3 in Study III the statistical analysis was done with a non-parametric test using median of the sum of mean NRS pain scores the first three postoperative days, comparing the intervention-groups SCB-mepivacaine and SCB-ropivacaine. The oral analgesic component analysed, OEC, was summarised up to 3 days postoperatively and likewise compared with a non-parametric test between the two active groups (mepivacaine vs ropivacaine). It would possibly have been easier for the reader to follow if we used the median sum of NRS day 1, 2, and 3 as well instead of making it a mean value.

The brace procedure at the end of the operation in Study IV was new to the surgeons and the number of surgeons in the study was high. This may have extended the “surgical time”. Giving them a chance to practice this procedure before surgery could have shortened the surgical time and the theatre time. The surgeons’ commented however that the brace-procedure was much more convenient then the cast-procedure.

5.2 PAPERS IN CONTEXT

The result discussion from each paper are summarized in this section.

5.2.1 PAPER I

The impact of the ERAS mind set and the shift to the anaesthesia technique, LAS for POP surgery during 2012-2014, showed a significantly increased theatre efficacy, increased frequency of patients by-passing the PACU and also increased discharge on the day of surgery.

We did not investigate if this change of routines influenced hospital cost, but several other studies has showed beneficial effects in terms of more effective patient turn-around and cost-effectiveness with LAS as compared with SPA or GA[133-135]. Especially as POP-surgery is a high-volume procedure with more than 6000 surgical procedures each year in Sweden.

Pong et al. reported in 2015 that the LAS-technique was associated with a higher risk of experiencing vaginal bulge symptoms the first year after prolapse surgery compared with general or regional anaesthesia.[136] Patients with lower age, higher BMI and high-grade vaginal prolapse are at risk for this complication. It is therefore advisable to consider those risk factors before deciding which anaesthetic method that is most appropriate and needed for a good surgical outcome. Thus, the choice of anaesthesia should be based on input from the patient, surgeon and anaesthesiologist.

The surgical time was similar and constant at the four hospitals during the study period, while the theatre time was not. Between 2012 and 2014 the theatre time decreased by an average of 18 min and the theatre time/surgical time quota thereby increased significantly. Interestingly, the theatre time differed a lot between the hospitals. The reason for this difference was difficult to understand, at least retrospectively, but penetrating waiting times and bottlenecks seems relevant to explore.

There were differences in the anaesthetic techniques used between the four hospitals. The use of LAS varied between 0 (Local hospital) and 96% (private hospital) in 2014. This was probably due to whether the surgeons were comfortable with the method or not.

Also, the clinical pathways differed between the four hospitals studied, but since this was a retrospective study it is not possible to state why the implementation differed. During the study period 2 of the hospitals (Regional and Local hospital) did not use a step-down unit after the PACU. Instead the patients stayed in the PACU until they were discharged from the hospital. This, of course affects the PACU-time and the possibility to by-pass the PACU (Table V in Paper I).

Discharge on the day of surgery increased significantly over the period in all 4 hospitals (at the private hospital, it was constantly ≥ 96%). This phenomenon was most common among the LAS patients, but increased also for patients having SPA and GA.

The logistic regression analysis showed the huge impact the anaesthetic technique had on the amount of patients that could discharge day of surgery.

Addressing changes in logistics e.g. discharge day of surgery involves several factors. There has been a major trend during recent years to transfer minor and intermediate procedure from the logistic "in-hospital stay" to DS, thus annual change must be taken into account during the study period.

It is also obvious that there are different protocols and "traditions" between hospitals. The university hospital and the private hospital (dedicated and specialised on DS) did differ in patient turn around. Regional and local hospitals had at the time for the study not even a day surgical department (step-down unit). Day surgery was a minor integrated part of the general surgery unit, thus influencing logistics.

The results indicate that the ERAS concept including shortened hospital stay following gynaecological surgery were successfully implemented, to varying degrees, in the hospitals studied during 2012-2014. The shift in anaesthetic techniques was not surprising as now several superficial and minimally-invasive procedures may be performed effectively with LA with or without sedation cover [137-139].

5.2.2 PAPER II

This study underlines the importance of avoiding all unnecessary duration of anaesthesia, especially anaesthesia without surgical stimuli. The primary hypothesis, to be able to avoid hypotension post-induction during scrubbing and sterile covering, could not be verified. This could be related to the fact that the study was performed in a private hospital, where scrubbing and sterile covering-procedure took merely six minutes for the surgical nurse to complete and the surgeon was always present at the start of anaesthesia induction. The time for the preparation and waiting for surgeons are mostly much longer, particularly in a University hospital, where training assignments are common. Shortening the duration of anaesthesia, especially the part with minor stimulation, and decreasing anaesthetic drug doses may possibly be of value, particularly for elderly and fragile patients.

Instead of using the LMA time, an indirect measure (both surgical time and scrub/covering time), to assess the surgical scrub/sterile covering time, we could have clocked up the surgical nurses while they were doing the scrub/covering procedure. We suspected that a direct measurement like that might become distressful for the surgical nurses and could probably affect their answers in the anonymous questionnaire. However, only one minute differed in surgical time between the groups.

The theatre turnaround time is of importance, since all waiting time is a waste of time. There are studies showing significant shortening of anaesthesia time when surgeons are ready and available in the theatre at the time of induction[140].

The anaesthetized patients were non-significantly younger, a fact that could have impacted the demand for vasoactive medication. The ASA score was, however, comparable in both groups.

Open hernia repair can also be done under LA[141]. According to the Swedish Hernia register (*www.svensktbrackregister.se*) 13.6% of the open hernia repair in 2019 was performed under LA while 84% was performed under GA. It is unclear why LA is not utilized more in Sweden, especially when there is some evidence for beneficial effects in terms of more effective patients turn-around and cost-effectiveness.[135]

Surgical scrub and sterile covering prior to induction of anaesthesia was found to be feasible, including maintained quality of care. The patients did

not mind being awake during the preparation time; in fact, some patients gave positive feedback. The theatre nurses were equally positive. None of the patients complained about the freezing sensation that the liquid, used for scrubbing can cause.

There are discussions in terms of awake patients may be at an increased risk for surgical site infections (SSI). No evidence is found that the anaesthetic technique used, i.e. patient being awake or asleep during scrub and sterile covering, should impact the infection risk[142-145]. Unfortunately, we did not perform any follow-up after discharge in this study in relation to the risk of SSI.

5.2.3 PAPER III

In this prospective randomised study we showed that the pain pattern when the brachial plexus block wears off was significantly worse in the SCB-ropivacaine group of patients compared to the SCB-mepivacaine group in terms of NRS and patient-reported severe pain events at 24 hours post-surgery and during the first 3 postoperative days.

It is also interesting that the SCB-ropivacaine group of patients´ median sum opioid consumption postoperatively was higher than for both the SCB-mepivacaine group and the GA-patients (contol-group). The SCB-ropivacaine patients needed nearly no opioids at all before discharge from hospital, instead they consumed most opioids later at home. The patients in the other two groups consumed most opioids during their hospital stay, monitored and with the help and advise from the hospital staff.

This confirms the study hypothesis and may also have an important safety aspect as well. Usually the patient with a DRF is an elderly woman and the long-acting LA block wears off in the middle of the night at home, with sometimes unmanageble pain as a result. This is thus the time when these patients need to consume high doses of opioids without earlier experience of their side-effects.

The experience of “rebound pain” *i.e.* worse pain at block resolution has been reported in several studies similair to ours [10-12, 14, 16, 17, 146, 147]. Most previous studies have investigated the difference between GA and long-acting blocks. We evaluated if pain, at block resolution, could superiorly be treated with the patient still in hospital after a short-acting block and whether this could result

in less opioid consumption after discharge. This idea was found to be true in this current study.

Recent studies by *Barry et al.* and *Rodrigues et al.* found that intravenous dexamethasone decreased the risk for rebound pain at block resolution[73]. All patients in *Paper III-IV* were given 8 mg betametason intravenously peroperatively. They also found that younger age, female gender and bone-surgery were riskfactors for rebound pain[72, 73].

The findings in terms of time events was an extended stay in the PACU for the GA patients since all 29 GA-patients stayed in the PACU. Most SCB-patients could by-pass the PACU and were directly transferred to the step-down ward.

There were a significant difference in duration between the two SCB block-groups effect. The expected duration time is an important information to give the patients, preferably repeatedly.
Patients given SCB-ropivacaine had significantly more unplanned health care contacts during the first postoperative week than the two other groups. A previous study has reported the same finding[13]. The patients contacted health care by reasons as severe pain, unintended burn-damage or dissatisfaction of having a “dead arm” several hours after surgery.

5.2.4 PAPER IV

This study was a prospective randomized study and half of the patient cohort (n=27) are shared with Study III [128]. This study was instigated to explore the feasibility to use a removable brace, applied directly after surgery, compared with a traditional dorsal cast splint following surgical repair of DRF. Previous studies have shown high patient acceptance, but few investigations have been performed on an adult population [148-151].

The two main findings in the present study were:

First; there was no significant difference in the QoR-15 score between the groups during the first postoperative week. This supported the study hypothesis that the treatments were equal.

However, a minor difference in the subdomain pain was observed at the 24 hour-assessment. We did not further investigate the multifactorial reasons of

the pain experienced in the brace-group. The higher oxycodone consumption in the brace-group, though not statistically significant, might have been associated to oxycodone dosage, adjusted to age and BMI, since the patients in the brace-group were significantly younger and also had higher BMI.

Second; there was no deterioration in the QoR-15 score postoperatively in any of the groups. From baseline until 7 days postoperatively, the QoR-15 score increased with no differences at any of the assessment-points. This finding is uncommon. Usually most patients shows an impairment at 24 hours postoperatively[58]. All the patients had suffered a wrist fracture, in average 9 days before surgery, and most of them were tired, anxious and in pain the last 24 hours prior to surgery. This may not have been a true baseline of QoR-15 score, but still it constitutes a baseline for comparison.

The QoR-15 instrument may have a too low sensitivity for this intervention. Since QoR-15 is developed and validated to measure patients after anaesthesia and surgery and not to measure QoR following different immobilisation methods[118, 119, 152]. However, *Myles et al* defined in a study 2016 updated in 2021, the size of the minimum clinically meaningful difference to the patient. They recommend the value to be 6.0 and the largest difference between the groups that we noted in this study was 4.0[153, 154]. It´s important to know that a significant difference in QoR-points doesn´t necessary have to be of clinical value.

The Occupational therapists at Sahlgrenska University hospital/Mölndal hospital investigated in 2015 by follow-up visits the DRF-patients and the results showed that 81%, received some type of cast adjustment or switch to removable splint, during the first two postoperative weeks. This is an obvious waste of resources, especially when all patients switch from cast to brace, as a treatment-routine, after two weeks anyway, (Master thesis in Occupational therapy, Title: “Ability to perform activities, presence of pain, fear, and anxiety in patients with surgically treated distal radius fracture” 2015, Johanna Blomstrand, Gothenburg University). By using a brace as the immobilisation method already from the start, the Occupational therapist will have less cast adjustments.

We found no differences in time-events between the two groups in the present study, but every intervention that could enable a fast, safe and effective patient turnover during the whole day surgery logistic flow, is of importance, see Figure 2.

We did not note any significant theatre-time gain in the brace-group but both patients, theatre staff and surgeons found the brace-procedure convenient. Despite the insignificant theatre-time difference, it still was 20 minutes long with advantage for the brace-group. This can have a clinical implication especially if there are several similar procedures following one another the same day in the same theatre.

6

CONCLUSION

Paper I:
A clear evolution, with increase in day surgical logistics, was seen over the three-year study period. The implementation of Local Anaesthesia with sedation-technique for pelvic organ prolapse surgery improved theatre and PACU/recovery room efficacy and significantly increased the number of patients that could be treated in a day surgery concept.

A multiple logistical regression analysis, done after publication, revealed that anaesthetic technique had the most powerful impact on the logistic outcome discharge day of surgery. Annual change and impact of hospital location did have impact to a lesser extent.

Paper II:
We could not show any impact on the need for vasoactive medication related to avoid anaesthesia during the surgical scrub/sterile covering procedure. Surgical scrub/sterile covering before induction of anaesthesia decreases the need of anaesthetic agents and shortens significantly the need for time in PACU. This procedure is reasonable and does not risk the quality of care.

Paper III:
The long duration of analgesia, with a SCB related to a long-acting LA agent during the early postoperative period, has benefits that must be put in perspective of a possible worse pain pattern and a higher need for postoperative opioids when the SCB wears off after discharge at home. We recommend a short-acting LA agent for surgical repair of DRF to lessen postoperative opioid use and improve patient recovery and well-being.

Paper IV:
A brace instead of the traditional dorsal cast splint, right after surgery, was found to be a reasonable choice for immobilisation after surgical repair of DRF. There was no difference in Quality of Recovery, measured with QoR-15, between the brace and cast groups of patients during the first week post-surgery.

7

FUTURE PERSPECTIVES & CLINICAL IMPLICATIONS

Day surgery has showed itself to be a high-quality, safe and a cost-effective concept to surgical health care.

In the future even more procedures will be added to the DS-list, which also in line with more minimised surgical techniques, e.g. robotic surgery. The proportion of elderly and more fragile patients in the population will also be an increased challenge in the future. An important question is how can we improve perioperative care with focus on safety, effective early discharge and QoR for these patients?

Perhaps “Extended recovery”, the 23-hour treatment concept with one overnight stay for the most fragile patients, is the answer? A more extended follow-up monitoring with help from Artificial Intelligence (AI) and smartphones could be another?

All anaesthetic techniques used today are safe and efficacious. Optimization of patient care and tailored anaesthesia are of major importance for successful and effective DS. Anaesthesia should be individual patient targeted and goal directed. Patient care should be effective and likewise patient-centred, e.g. avoiding unnecessary waiting time and delays, shortening the duration of anaesthesia, optimising the surgical anaesthesia time quota and thus

optimising the total amount of anaesthesia delivered in order to do facilitate recovery. The perioperative anaesthesia care should also include procedures addressing specific pain management like MMA in order to achieve opioid sparing and adequate pain control and to avoid “pain rebound” and “pain peaks”.

It is important that the patients feel safe at the time of discharge and know where to turn if something unforeseen happens. Unplanned healthcare contacts/visits after discharge and unplanned admissions are negative experiences for the patients and costly for the healthcare system. The ERAS mind-set with quality before speed probably reduces cost more effectively over time.

Warnakulasuriya et al. have shown in a review 2020 the importance to gain and control more tools to follow-up after discharge, especially for the elderly and risk patients, since DS is expanding and not only elective but also subacute procedures are performed in this way. Technology will simplify the collection of data with the use of video, telephone or web-based tools. These tools can also be combined to measure both PROM and PREM. All those tools can help to keep the distance to the hospital in the postoperative period, something that the recent COVID-19 pandemic has instigated. “This pandemic has not only stressed inpatient bed resources but also increased the appetite for both clinicians and patients to avoid inpatient stays and unnecessary unplanned healthcare visits”[7].

Summary

The goal is to establish safe and effective perioperative course, but also a rapid recovery, still securing quality of care and safety. Preoperative preparation/ information, minimally-invasive surgical techniques, tailored anaesthesia, procedural specific multi-modal analgesia, optimising logistics and the development of new user-friendly follow-up tools after discharge are factors of importance for further development of high standard day surgery.

“National Day Surgery Guidelines” for best choice of anaesthesia is unfortunately still missing in Sweden.

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APPENDIX

Quality of Recovery - QoR-15 Studiekod:

Datum:

☐ ***Före operation*** ☐ ***24 timmar efter op*** ☐ ***72 timmar efter op*** ☐ ***7 dagar efter op***

DEL A:
Ringa in eller sätt ett streck vid den siffran som stämmer bäst överens med din upplevelse.
0 till 10, där 0 = inte alls (vilket betyder mycket dåligt) och 10 = hela tiden (vilket betyder mycket bra)

Under de senaste 24 timmarna har jag;

1. Kunnat andas lätt — inte alls _____ hela tiden
0 1 2 3 4 5 6 7 8 9 10

2. Kunnat njuta av maten — inte alls _____ hela tiden
0 1 2 3 4 5 6 7 8 9 10

3. Känt mig utvilad — inte alls _____ hela tiden
0 1 2 3 4 5 6 7 8 9 10

4. Sovit gott — inte alls _____ hela tiden
0 1 2 3 4 5 6 7 8 9 10

5. Kunnat sköta min hygien utan hjälp — inte alls _____ hela tiden
0 1 2 3 4 5 6 7 8 9 10

6. Kunnat kommunicera med familj och vänner — inte alls _____ hela tiden
0 1 2 3 4 5 6 7 8 9 10

(7. Fått stöd från vård-personal) — (inte alls _____ hela tiden)
0 1 2 3 4 5 6 7 8 9 10

8. Kunnat återgå till arbetet eller sköta om vanliga bestyr i hemmet — inte alls _____ hela tiden
0 1 2 3 4 5 6 7 8 9 10

9. Haft kontroll över min situation och haft det bekvämt — inte alls _____ hela tiden
0 1 2 3 4 5 6 7 8 9 10

10. Haft en känsla av allmänt välbefinnande — inte alls _____ hela tiden
0 1 2 3 4 5 6 7 8 9 10

Kommentarer:

DEL B: Datum: Studiekod:

Quality of Recovery - QoR-15

☐ ***Före operation*** ☐ ***24 timmar efter operationen*** ☐ ***48 timmar efter op***
☐ ***72 timmar efter operationen*** ☐ ***7 dagar efter op***

Ringa in eller sätt ett streck vid den siffran som stämmer bäst överens med din upplevelse.
OBS!! Skalan är nu omvänd! *10 till 0, där 10 = inte alls (vilket betyder mycket bra) och 0 = hela tiden (vilket betyder mycket dåligt)*

Har du upplevt något av följande under de senaste 24 timmarna?

11. Måttlig smärta	inte alls	10 9 8 7 6 5 4 3 2 1 0	hela tiden
12. Kraftig smärta	inte alls	10 9 8 7 6 5 4 3 2 1 0	hela tiden
13. Illamående eller kräkning	inte alls	10 9 8 7 6 5 4 3 2 1 0	hela tiden
14. Har känt mig orolig eller rädd	inte alls	10 9 8 7 6 5 4 3 2 1 0	hela tiden
15. Har känt mig ledsen eller nedstämd	inte alls	10 9 8 7 6 5 4 3 2 1 0	hela tiden