e-Assessed follow-up of postoperative recovery
– development, evaluation and patient experiences
To
My beloved family

Choose the aim and love the path
-Unknown

Ágætis byrjun
-Sigur Rós
e-Assessed follow-up of postoperative recovery
– development, evaluation and patient experiences
Abstract


The majority of all surgeries are performed as day surgery. After discharge, patients are expected to take responsibility for their postoperative recovery themselves. Recovery Assessment by Phone Points (RAPP) is an e-assessment developed for assessing and providing follow-up on postoperative recovery, which includes the Swedish web-version of the Quality of Recovery questionnaire (SwQoR). It also enables the patient to get in contact with the day surgery unit. The overall aim of this thesis was to further develop and evaluate a systematic follow-up of postoperative recovery using a mobile app in adult persons undergoing day surgery, as well as to describe their experiences of postoperative recovery when using the mobile app.

Study I: This study included three steps. Equivalence testing between the paper and app versions of the SwQoR showed agreement (n=69). The feasibility and acceptability evaluation showed that participants (n=63) were positive towards using a mobile phone application during postoperative recovery. Content validity of the SwQoR reduced the original 31 items to 24.

Studies II and III: A multicentre, two-group, parallel, single-blind randomized controlled trial including 997 participants was conducted to investigate the effect of e-assessment on postoperative recovery (II) and cost-effectiveness (III) in a RAPP group compared with a control group. The RAPP group reported significantly better quality of postoperative recovery on postoperative days 7 and 14 compared with the control group. Moreover, RAPP may be cost-effective as it provides low-cost care. Study IV: Explored experience of postoperative recovery in participants using a mobile phone app during their postoperative recovery. Qualitative inductive semi-structured interviews (n=18) were performed. Findings showed that feeling safe is important during postoperative recovery. This feeling can be created by patients themselves, but sufficient support and information from health care and next of kin is needed. Overall, this thesis showed positive results for RAPP, suggesting that RAPP is a solution that may benefit patients after day surgery.

Keywords: Ambulatory surgery, cost-effectiveness, eHealth, mobile applications, postoperative recovery, qualitative research, randomised controlled trial.

Karuna Dahlberg, School of Health Sciences
Örebro University, SE-701 82 Örebro, Sweden, karuna.dahlberg@oru.se
# Table of Contents

LIST OF ABBREVIATIONS .................................................................................................................. 12
LIST OF ORIGINAL PAPERS ............................................................................................................ 14
PREFACE ............................................................................................................................................ 15
BACKGROUND ............................................................................................................................... 16
Day surgery ..................................................................................................................................... 16
Postoperative recovery after day surgery ......................................................................................... 17
  Phase I recovery ............................................................................................................................ 17
  Phase II recovery .......................................................................................................................... 17
  Phase III recovery ....................................................................................................................... 18
Mobile phones in health care (mHealth) ......................................................................................... 20
  mHealth in the postoperative context ......................................................................................... 22
Patient-reported outcome .............................................................................................................. 23
Quality of recovery and the Swedish web -version of the Quality of Recovery questionnaire .......... 23
Recovery Assessment by Phone Points ......................................................................................... 24
RATIONALE ...................................................................................................................................... 26
AIMS .................................................................................................................................................. 27
METHODS ........................................................................................................................................ 28
Sample and settings ......................................................................................................................... 28
  Sample size .................................................................................................................................. 29
Data collection and analysis .......................................................................................................... 32
Study I .............................................................................................................................................. 32
Studies II and III ............................................................................................................................. 34
Postoperative recovery (Study II) .................................................................................................. 35
  Missing data ................................................................................................................................. 35
  Statistical analysis ....................................................................................................................... 35
Health economic evaluation (Study III) ....................................................................................... 36
  Description of costs ...................................................................................................................... 36
  Description of health effects ........................................................................................................ 37
  Cost-effectiveness ....................................................................................................................... 38
  Sensitivity analysis and missing data .......................................................................................... 38
  Statistical analysis ....................................................................................................................... 39
Blinding .......................................................................................................................................... 39
Study IV .......................................................................................................................................... 39
Participants ................................................................. 39
Data collection ........................................................................ 39
Analysis ............................................................................... 40

ETHICAL CONSIDERATIONS ............................................................. 41
Conflicts of interest ................................................................. 42

RESULTS ................................................................................................ 43
The SwQoR (Study I) .............................................................................. 45
  Equivalence between the paper and app versions of the SwQoR instrument ........................................................... 45
  Content validity .............................................................................. 46
RAPP and experiences of postoperative recovery (Studies I–IV) .......... 47
  Feasibility of using RAPP during postoperative recovery (Study I) 47
  Effect on postoperative recovery (Study II) .................................. 48
  Health economic evaluation (Study III) ...................................... 52
  Health effects and health care consumption ................................ 52
  Costs for health care consumption and RAPP ............................ 53
  Cost-minimisation analysis ....................................................... 53
Postoperative recovery when using RAPP (Study IV) ...................... 54
  Give it all you’ve got .................................................................... 55
    Believing in own capacity ............................................................. 55
    Being prepared ........................................................................... 55
    Taking action ............................................................................ 56
  The importance of feeling safe and sound ................................. 56
    Feeling safe and reassured ........................................................... 56
    Not being acknowledged .......................................................... 57
    Not being left alone .................................................................. 57

DISCUSSION .......................................................................................... 58
The SwQoR (Study I) .............................................................................. 58
RAPP and experiences of postoperative recovery (Studies I–IV) ........ 60
  Feeling safe (Studies II and IV) ...................................................... 61
  Involving the patient in decision making (Studies II–IV) .............. 61
  Satisfaction (Studies II and IV) ..................................................... 63
  Self-efficacy (Studies II and IV) ..................................................... 64
  Pre-recovery (Study IV) ............................................................... 65
  Support from next of kin (Study IV) ............................................ 65
Methodological considerations ....................................................... 66
Questionnaires (Studies I–III) .......................................................... 66
Clinical importance (Study II) ............................................................. 67
Health economic evaluation (Study III) ............................................... 68
Randomized controlled trials (Studies II and III) ................................. 69
Generalizability (Studies I–III) ............................................................. 71
Trustworthiness (Study IV) ................................................................ 72
Mixed methods (Studies II–IV) ........................................................... 74
Clinical implications.............................................................................. 74
Further studies ...................................................................................... 75

CONCLUSIONS ..................................................................................... 77

SVENSK SAMMANFATTNING (SUMMARY IN SWEDISH) .............. 78
Övergripande syfte ............................................................................... 79
Delstudie I ............................................................................................. 79
Delstudie II och III ............................................................................... 80
Delstudie IV .......................................................................................... 80

TACK (ACKNOWLEDGEMENT) ............................................................ 81
REFERENCES ...................................................................................... 83
### List of abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA</td>
<td>American Society of Anesthesiologists</td>
</tr>
<tr>
<td>BMI</td>
<td>body mass index</td>
</tr>
<tr>
<td>CEA</td>
<td>cost-effectiveness analysis</td>
</tr>
<tr>
<td>CI</td>
<td>confidence interval</td>
</tr>
<tr>
<td>CMA</td>
<td>cost-minimization analysis</td>
</tr>
<tr>
<td>CVI</td>
<td>content validity index</td>
</tr>
<tr>
<td>ED</td>
<td>emergency department</td>
</tr>
<tr>
<td>eHealth</td>
<td>health care supported by electronic health records and electronic communication</td>
</tr>
<tr>
<td>ENT</td>
<td>ear, nose, and throat</td>
</tr>
<tr>
<td>ePRO</td>
<td>electronic patient-reported outcome</td>
</tr>
<tr>
<td>EQ-5D</td>
<td>EuroQol Five Dimensions</td>
</tr>
<tr>
<td>ES</td>
<td>Cohen’s effect size</td>
</tr>
<tr>
<td>HRQoL</td>
<td>health-related quality of life</td>
</tr>
<tr>
<td>ICC</td>
<td>intraclass correlation coefficient</td>
</tr>
<tr>
<td>ICT</td>
<td>information and communications technology</td>
</tr>
<tr>
<td>I-CVI</td>
<td>item-level content validity index</td>
</tr>
<tr>
<td>IQR</td>
<td>interquartile range</td>
</tr>
<tr>
<td>ITT</td>
<td>intention to treat</td>
</tr>
<tr>
<td>KPP</td>
<td>Cost per patient database</td>
</tr>
<tr>
<td>LVCF</td>
<td>last value carried forward</td>
</tr>
<tr>
<td>MCAR</td>
<td>missing completely at random</td>
</tr>
<tr>
<td>MCID</td>
<td>minimal clinically important difference</td>
</tr>
<tr>
<td>mHealth</td>
<td>mobile health technology</td>
</tr>
<tr>
<td>NMB</td>
<td>Net Monetary Benefit method</td>
</tr>
<tr>
<td>NordDRG</td>
<td>Nordic patient classification based on diagnosis-related group</td>
</tr>
<tr>
<td>PACU</td>
<td>post-anaesthesia care unit</td>
</tr>
<tr>
<td>PADS</td>
<td>post-anaesthetic discharge scoring system</td>
</tr>
<tr>
<td>POD</td>
<td>postoperative day</td>
</tr>
<tr>
<td>PQRS</td>
<td>Postoperative Quality Recovery Scale</td>
</tr>
<tr>
<td>PRIC</td>
<td>Postoperative Recovery in Children</td>
</tr>
<tr>
<td>PRO</td>
<td>patient-reported outcome</td>
</tr>
<tr>
<td>PRP</td>
<td>Postoperative Recovery Profile</td>
</tr>
<tr>
<td>PSR</td>
<td>Post-discharge Surgical Recovery scale</td>
</tr>
<tr>
<td>QALY</td>
<td>quality-adjusted life year</td>
</tr>
<tr>
<td>QoL</td>
<td>quality of life</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>QoR</td>
<td>quality of recovery</td>
</tr>
<tr>
<td>QoR15</td>
<td>Quality of Recovery-15 item instrument</td>
</tr>
<tr>
<td>QoR40</td>
<td>Quality of Recovery-40 item instrument</td>
</tr>
<tr>
<td>RAPP</td>
<td>Recovery Assessment by Phone Points</td>
</tr>
<tr>
<td>RCT</td>
<td>randomized controlled trial</td>
</tr>
<tr>
<td>S-CVI</td>
<td>scale-content validity index</td>
</tr>
<tr>
<td>SD</td>
<td>standard deviation</td>
</tr>
<tr>
<td>SF-36</td>
<td>Short-Form 36-item health survey</td>
</tr>
<tr>
<td>SF-6D</td>
<td>Short-Form Six-Dimension instrument</td>
</tr>
<tr>
<td>SMS</td>
<td>short message service</td>
</tr>
<tr>
<td>SwQoR</td>
<td>Swedish web version of the Quality of Recovery questionnaire</td>
</tr>
<tr>
<td>VAS</td>
<td>visual analogue scale</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
List of original papers

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


Preface

Patients undergoing day surgery are at the hospital for a short time frame, during which perioperative care is provided. Care is also provided in the early phases of recovery. I am a registered nurse (RN) with a specialization in intensive care working at the post-anaesthesia care unit (PACU) and the day surgical unit at Örebro University Hospital. I have often wondered about the patients’ experiences after discharge. How do our patients experience symptoms and complications such as pain and nausea? Do they have problems voiding? What are their experiences of the care that they received and what is it like to recover from day surgery? Do we need to improve preoperative, intraoperative and postoperative care? This research project attempts to answer some of these questions and also to develop a follow-up method for postoperative recovery after patients are discharged from the day surgery unit.
Background

Day surgery

For the last few decades there has been a shift from traditional inpatient surgery to outpatient surgery, also called “day surgery”\(^1\). Day surgery is defined as surgery performed on a patient who is admitted and discharged from the hospital on the same day as the surgery is performed, or within 24 hours of surgery\(^2,3\). Day surgery is considered safe, with low morbidity and mortality\(^4,7\). Readmission rates after day surgery are low\(^1,5,7-10\), with the majority of surgery-related health care contacts and readmissions occurring within the first 2 postoperative weeks\(^5\). Day surgery leads to lower risk of nosocomial infections, and earlier mobilization and therefore also lower risk of venous thromboembolism\(^2,3\). Further, there are benefits for healthcare, such as day surgery being more cost-effective since patients do not occupy hospital beds\(^2,4,9\). Day surgery is considered fast and efficient by many day surgery patients. It is often preferred over inpatient surgery because patients prefer the interruption in their work and daily life to be minimal\(^11\).

Today, day surgery accounts for the majority of surgeries performed internationally\(^2,12\). In Sweden about 2.15 million day surgical procedures were performed in 2016, compared with 810,000 inpatient surgeries\(^13\). The increase in day surgical procedures is due to the technical advances in surgical and anaesthetic techniques. Suitable surgical procedures are surgeries with lower degree of surgical trauma and tissue damage, and low risk of postoperative complications such as blood loss and need for intravenous fluids. Furthermore, the postoperative pain should be manageable with local anaesthesia or oral analgesics\(^2,3,14\). Day surgery can be performed under general or regional/local anaesthesia. Many different surgical specialities are seen in day surgery, such as general, vascular, orthopaedic, urology, and ear, nose and throat (ENT) surgery. When selecting patients for day surgery, both medical and social factors should be considered. There are no absolute restrictions regarding age, American Society of Anesthesiologists (ASA) classification or body mass index (BMI); instead, each patient should be evaluated individually in the preoperative assessment\(^2,3,8,15\). Social factors to consider are that patients should have access to a telephone and live within reasonable distance of health care, and that they have someone to stay with them for the first night\(^14,16,17\).
Postoperative recovery after day surgery

Recovery after surgery includes gaining control of physical, psychological, social and habitual functions. Postoperative recovery starts immediately after the surgery and anaesthesia are completed and can last up to several months. Hence, it can be a time-consuming process and patients may be surprised at how much their physical and psychological status is affected after surgery. It has been described that some patients underestimate the time to recovery after day surgery because they think that day surgery means the same as same-day recovery. During postoperative recovery, patients may experience several different surgery and anaesthesia-related symptoms such as pain, nausea, vomiting, drowsiness, dizziness, fatigue, sore throat, back pain, headache, coldness/shivering, urinary retention, and postoperative cognitive dysfunction. Also, several studies suggest that there are gender differences in postoperative recovery: females have reported more postoperative symptoms compared with males, such as nausea and vomiting, pain, and sore throat, as well as poorer quality of postoperative recovery.

Postoperative recovery after surgery consists of three phases: early recovery (phase I), intermediate recovery (phase II) and late recovery (phase III).

Phase I recovery

Phase I of recovery starts when the patient leaves the operation room. During phase I the patient is closely monitored in the PACU until fully awake from anaesthesia and motor functions as well as protective reflexes are regained. In the PACU, numeric scoring systems are often used for assessing the patient’s recovery from anaesthesia. The Aldrete scoring system is one commonly used and assesses activity, respiration, circulation, consciousness and O\textsubscript{2} saturation using scores ranging from 0 to 2 (maximum total score = 10, indicating best possible condition). Transition from the PACU to the phase II recovery unit requires an Aldrete score of 9 or higher. Patients undergoing surgery under local anaesthesia usually proceed immediately to phase II recovery.

Phase II recovery

During phase II recovery, patients are still cared for at the day surgery unit but not monitored as closely as in phase I. The post-anaesthetic discharge scoring system (PADS) is widely used and assesses patients’ recovery during phase II. It uses scoring of vital signs (blood pressure and pulse), activity...
level, nausea and/or vomiting, pain and surgical bleeding (score range 0–2; maximum score = 10). A patient should not be discharged from the day surgery unit unless scoring ≥9 when assessed with the PADS16,32. Food and fluid intake and voiding after the surgery should be considered before discharge. It is not mandatory that all patients should drink or eat before discharge but it is preferred that they drink and eat a small amount2,16. All patients with risk factors for urinary retention (such as neurological disease; pre-existing obstructive urinary symptoms; age >50; male sex; spinal/epidural anaesthesia; surgery >60 minutes; intraoperative fluids >750 ml) should void before discharge16,33. Further, if the bladder volume is >270 ml when arriving at the PACU or if Midazolam (sedative medication) is administered postoperatively the risk of postoperative urinary retention increases33. Non-risk patients should be informed that they should return for evaluation if they have not voided within 6–8 hours of discharge16.

Patients remain at the day surgery unit where they are cared for until they are considered ready for discharge. Discharge from the day surgery unit is usually nurse-led, and follows certain protocols and discharge criteria. Protocols and discharge criteria are used to ensure patient safety. Before they are discharged from the day surgery unit, patients should receive information and instructions for how to manage the postoperative recovery at home2,16,34. Information about how to manage postoperative symptoms can affect the patient’s wellbeing35 and lack of information has a negative effect on the recovery process as well as on how prepared patients feel for the recovery at home36. It has been reported that patients who do not receive information on how to care for the surgical wound and manage pain have more unplanned health care contacts35. Furthermore, the timing of providing this information is important. If told this information when the anaesthesia effect has not fully worn off patients will not understand or remember the information that has been provided37-39. When a patient is discharged it is recommended that they be escorted home by a responsible adult and also that an adult stay with them for the first 24 hours14,16,17,34.

**Phase III recovery**
Phase III recovery starts when the patient is discharged from the day surgery unit and lasts until they have regained usual function and activity2,16,28. After the patient is discharged, self-care is a central part of recovery. Patients are expected to take care of their recovery by themselves or with assistance from next of kin40-42. Patients have described the importance of knowing
what is normal recovery so that they know what to expect when caring for themselves, as well as how to perform self-care. Many patients feel that they have received sufficient information and support and therefore are prepared for the recovery at home. However, not all are prepared for what to expect in the postoperative period and therefore may feel alone and insecure about how the recovery is proceeding. For patients and their next of kin, this can lead to stress and concerns regarding symptoms and whether these are normal and expected. Patients who are ill prepared for what to expect after day surgery might not ask their next of kin to be available for help during the recovery period; likewise, the next of kin might underestimate how much help is needed and therefore might not take time off to stay with the patient. Some patients do not have any support from next of kin and are left to manage their recovery by themselves. Moreover, patients have been described as thinking of the day surgery unit as busy and, therefore, as not wanting to burden the care staff with concerns. Instead, they turn to telephone advice lines or social networks when they have questions.

Pain, suspected infection and problems with the surgical wound are three of the main causes for patients to seek contact with the hospital after discharge. Postoperative symptoms may affect the patient’s ability to regain normal functional status and resume everyday routines, such as returning to work and engaging in social activities. Today there is no consensus on how to assess postoperative recovery in phase III.

Supporting the patient undergoing day surgery
Many patients have described that they are pleased with the care that they received at the hospital. Yet many experience a lack of professional support when discharged, not knowing where to turn for help and support, as well as not receiving the help they need and expected. Moreover, the provided support is not always experienced as received support by the patients. Support is unique to every person, situation and context and for this reason, patient-centred care is important. Every patient undergoing day surgery is an individual with different experiences and needs. The patient is their own expert and should be treated as a person, not as a diagnosis or condition. They should be treated as an equal partner and should be involved in the health decision making. This requires that health care staff have a holistic view and listen to patients’ narratives about their
Listening to a patient’s narratives can be seen as a challenging task because of the short period that the patient is cared for at the day surgery unit. However, day surgery patients have been reported to have felt that they were individually treated and that the nurse established a relationship with them and this contributed to a feeling of safety. Elsewhere, patients undergoing day surgery described that they wanted to be involved in decisions regarding their health and it has been suggested that shared decision making may improve patient satisfaction. According to Swedish law, all patient care should be individual and involve the patient in their care and health decision making.

That quality of care and support are important has been demonstrated in numerous studies. One showed that patients who reported inadequate support after surgery tended to have a poorer recovery process. Others reported that having contact with a nurse gave patients a feeling that there was someone to rely on and that a follow-up reduced anxiety after undergoing day surgery. To ensure a safe recovery after day surgery it is suggested that patients should receive a follow-up call within the first few postoperative days. Follow-up and support allow the patient to discuss their recovery, ask questions and get further assistance if needed, and also help patients manage their recovery. It has been suggested that the nurse caring for the patient should perform the follow-up call and that day surgery nurses should take more responsibility for the care of their patients after discharge. Routines for follow-up after discharge vary. In Sweden the majority of day surgery units perform a follow-up call on one of the first postoperative days. In Finland only four out of 13 units performed a follow-up call to >50% of their patients. When investigating day surgery routines at 100 hospitals in Europe it was reported that between 10% and 100% of the day surgery units performed a follow-up call. Some units described involving the patient’s general practitioner in the follow-up. However, many day surgery departments lack a routine for systematic follow-up.

**Mobile phones in health care (mHealth)**

Since the beginning of the 2000s, information and communications technology (ICT) has been used to improve health care by providing “eHealth” services. In 2016, 58% of the member states of the World Health Organization (WHO) reported that they had an eHealth strategy. That year the Swedish government and the Swedish Association of Local Authorities and
Regions decided on implementing eHealth in Sweden, via a programme called “Vision for eHealth 2025”. The aim is that by the year 2025 Sweden will be a world leader in the use of digitalization and eHealth in health care and social services. Shaw et al. described a conceptual model for eHealth that includes three domains: health in our hands (monitoring, tracking and information), interacting for health (communication between patients and health care, or between health care staff), and data enabling health (collecting and using data). According to Shaw and colleagues, eHealth interventions that are represented in all three domains are most impactful and have the potential to empower consumers. They suggest that the framework could be used in developing eHealth interventions and by decision makers in implementing an eHealth intervention.

A subcategory of eHealth is mHealth. There are several different definitions of “mHealth”; however, they all include the use of wireless technologies such as mobile phones, applications (apps), tablets or personal digital assistants and aim to support and improve health. To enable mHealth the population need to have the ability to connect to the internet. Further, patients need to have access to mobile phones, and in order to use apps they need smartphones. Smartphones are defined as mobile phones that are small computers and can connect to the internet. In this thesis a smartphone is referred to as a “mobile phone”.

Globally the number of mobile phones is constantly increasing, and the same is true for Sweden. The Swedish population are considered digitally mature compared with the rest of the world. This is due largely to the relatively high proportion with internet access; also, about 81% of the Swedish population have access to a smartphone.

Mobile phones have the ability to communicate wirelessly, whenever or wherever a person may be, and therefore they collect real-time data. Mobile phones are also highly useful as persons carry them with them and frequently use and check them. There are many mHealth solutions available in the different app stores, but it has been demonstrated that there are very few apps that are scientifically evaluated. A review of available pain management apps in app stores showed that there were few apps that involved the health care system and even fewer where the content and self-care advice was evidence-based. It is important that, like all other
interventions, mobile apps involve health care and end users in their development \(^75\) and should undergo evaluation\(^76\).

When mobile phones are used in health care they can offer the possibility to perform care-giving activities, such as communication, education, self-care, support\(^68,69\), and disease prevention to improve treatment\(^77\). It has been reported in a recent review that the majority of mobile phone-based interventions in health care studied have shown improved outcomes and increased patient engagement\(^78\). And it has also been suggested that the use of mobile phones in health care has the potential to lower health care costs\(^77\). Mobile apps have been tested in many different conditions, such as depression\(^79\), diabetes\(^80\), radiotherapy for prostate cancer\(^81\) and chronic obstructive pulmonary disease\(^82\).

**mHealth in the postoperative context**

eHealth solutions can be also used in the postoperative context\(^83\). Patients undergoing abdominal surgery stated that digital monitoring of recovery, evaluation of symptoms and focus on emotional wellbeing would be of value after a surgery\(^47\). In 2016, adults included in the New York Empire State Poll were asked about willingness to use a mobile app after surgery, as well as about barriers to and benefits of using a mobile app after surgery\(^84,85\). Overall, respondents were willing to use an app after surgery\(^85\). In answer to the question about benefits they put that the surgeon would be able to follow their recovery and that collection of data could lead to more knowledge and, in turn, more benefits for other patients undergoing surgery. Further, respondents thought that it would make them more aware of the recovery after surgery and reduce follow-up visits to the hospital. Some of the assumed barriers to app use were that using a mobile app after surgery might be experienced as an effort and that they would prefer face-to-face contact; also, some patients expressed worries about data security. It was also assumed that elderly patients would have a hard time to manage the app, although this was not seen as a barrier by the elderly people themselves\(^84\).

Mobile app use has been described in the postoperative context of self-management after lung transplant\(^86\), postoperative monitoring after fast-tracking lumbar discectomy\(^87\) and monitoring of postoperative recovery after day surgery\(^88\). There are also postoperative pain self-management apps available in different app stores; however, they lack evidence-based content\(^75\).
**Patient-reported outcome**

Patient-reported outcome (PRO) is assessment performed by patients themselves regarding their functional status and wellbeing. PRO can measure health and care in general or can be related to specific conditions. PRO is a suitable way of gathering information about patients when not under observation, especially because the patient is their own expert on information about their health status, symptoms and response to treatment. Technical advances have resulted in electronically reported PRO (ePRO) being widely used. This electronic version of PRO benefits from the technical solutions, for example by specifying the timing of reports and requiring all items to be answered. This leads to more complete and accurate data than collected via the original paper-based PRO. Moreover, many patients prefer ePRO to the paper version, but ask for adequate training in how to report answers as well as how to handle the device. Although ePRO has been reported to be equivalent to the paper-based PRO it has been suggested that for every PRO converted from a paper-based questionnaire into the electronic version, equivalence should be established. To test data equivalence it is recommended that parallel randomized controlled trials (RCTs) or crossover trials be used.

**Quality of recovery and the Swedish web-version of the Quality of Recovery questionnaire**

Having valid and reliable instruments for measuring quality of recovery in the postoperative period is of great importance in research as well as in clinical practice. It may reduce readmission to hospital and allows measurement of how the postoperative recovery is proceeding. Different instruments have been developed for assessing postoperative recovery, such as: the Post-discharge Surgical Recovery (PSR) scale, Postoperative Recovery Profile (PRP), Postoperative Quality Recovery Scale (PQRS), Postoperative Recovery in Children (PRiC) and Quality of Recovery–40 item instrument (QoR40). The last named, QoR40, is a PRO instrument measuring postoperative recovery and was developed by Myles in Australia in the late 1990s. It has shown to have excellent validity and reliability and can be used in both clinical practice and research. A short form of the English-version QoR40 has also been developed, the QoR15, including 15 items. In the QoR15 the scale was changed from a 5-graded scale to an 11-graded scale.
The QoR40 has been translated into Swedish and adapted to contain 29 items that have been psychometrically tested for patients undergoing day surgery in Sweden\textsuperscript{106}. In the further development of the Swedish version of the QoR instrument, three new items (trouble urinating, feeling constipated, and diarrhoea) were included (resulting in 32 items)\textsuperscript{107} inspired by the PRiC\textsuperscript{100}, PRP\textsuperscript{98, 108} and PSR scale\textsuperscript{97}. In the next step of development, the questionnaire was developed into a web-based version to be implemented in a mobile app, the Swedish web version of the Quality of Recovery questionnaire (SwQoR). The items nausea and vomiting were merged into one item: nausea and/or vomiting, thereby reducing the instrument to 31 items (eleven positively worded items followed by 20 negatively worded items).

In the SwQoR app, one item at a time is visible on the mobile phone screen, and when an answer is reported the next question appears automatically. The answers are reported on a numeric visual analogue scale (VAS) by moving a dot on the scale to choose a value between $0 = \text{none of the time}$, and $10 = \text{all of the time}$ (Figure 1). The dot on the scale is centred to 5 when a new item appears on the screen. Each question has to be answered before moving on to the next question. The SwQoR has been incorporated in the web-based mobile app called Recovery Assessment by Phone Points (RAPP)\textsuperscript{107}.

**Recovery Assessment by Phone Points**

The RAPP assesses postoperative recovery and was designed for follow-up after day surgery. The first phase in the development of RAPP included setting up an interdisciplinary team including researchers from nursing, medical science, informatics and health economics. The RAPP application software was developed by a software company commissioned to construct, in collaboration with the interdisciplinary research team, a mobile...
app that was secure, safe and easy to use. The second phase in the development included ten day surgery patients, all app users using their own mobile phone, as well as the staff at two day surgery units in Sweden. They evaluated the interface design and usefulness of the RAPP. The patients answered questions regarding layout, navigation between questions, obstacles using the app, overall opinion of the app and whether this was a useful follow-up to use after day surgery. The evaluation from patients and staff resulted in changes such as a darker background colour, increased text size, and adjustments to the numeric VAS to make it more clear to patients how to input their answers. Since day surgery patients have been reported to describe a lack of support and not knowing where and whom to turn to for help, a final question was added to the RAPP: “Do you want to be contacted by a nurse?” (Figure 2). This enabled an easy way of getting in contact with the day surgery unit. It was decided that the function would be available to

Figure 2 To answer the question “Do you want to be contacted by a nurse?”, patients click on the Yes or No response button.

the patient every day during the entire follow-up period. The primary aim of RAPP was that it would provide the patient with a feeling of being cared for and a sense of empowerment and it was important that the RAPP would be easy to understand and that it would reduce unnecessary contacts with health care staff.
Rationale

To the best of my knowledge, there is at present no long-term digital solution for follow-up or assessment of postoperative recovery in phase III, i.e. after the patient is discharged from the day surgery unit. Patients have expressed the need for support and follow-up in the postoperative period but do not know where and whom to turn to. To empower patients to manage postoperative recovery at home it has been suggested that follow-up and support can be performed through use of health technologies. In many cases today the health care system decides when the follow-up should be performed, although patients should be involved in their own care. And because of the short period that patients are cared for in the day surgery unit, new solutions to extend the time when patients may have contact with the day surgery unit should be developed. Moreover, Sweden’s “Vision for eHealth 2025” programme has the aim that by 2025 Sweden will be a world leader in the use of digitalization to make it easier for people to achieve good and equitable health and welfare. The RAPP mobile app which assesses postoperative recovery and enables initiating contact with the day surgery unit is in line with this vision for e-Health. A systematic follow-up using digital technology could provide real-time data that could be used to evaluate and improve anaesthetic, surgical and postoperative care for patients undergoing day surgery. This novel systematic follow-up intervention has not been previously tested in day surgical practice. To test this, the research approach should be both qualitative and quantitative to gain a deeper understanding of the intervention.
Aims

The overall aim of this thesis was to further develop and evaluate a systematic follow-up of postoperative recovery using a mobile app in adult persons undergoing day surgery, as well as to describe their experiences of postoperative recovery when using the mobile app.

Specific aims of each study were:

I. (1) To estimate the extent to which the paper and app versions of the SwQoR provide equivalent values; (2) to contribute evidence as to the feasibility and acceptability of a mobile phone web-based app for measuring postoperative recovery after day surgery and enabling contact with a nurse; and (3) to contribute evidence as to the content validity of the SwQoR.

II. To investigate whether a systematic follow-up e-assessment using RAPP, compared with standard care, had a positive effect on day surgery patients’ postoperative recovery as well as to investigate whether there were differences in women’s and men’s recovery and recovery scores.

III. To estimate the cost-effectiveness of RAPP for follow-up on recovery after day surgery, compared with standard care.

IV. To explore experience of postoperative recovery after day surgery in patients using a mobile app for systematic assessment of the quality of their recovery.
## Methods

### Table 1. Overview of studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants</th>
<th>Data collection</th>
<th>Data analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Cross-over design, prospective, descriptive</td>
<td>Adult day surgery patients n=69; staff working at the day surgery unit n=12</td>
<td>Questionnaires</td>
<td>ICC, Wilcoxon’s signed-rank test, CVI. Descriptive.</td>
</tr>
<tr>
<td>II</td>
<td>Randomized controlled design(^a)</td>
<td>Adult day surgery patients n=997(^b)</td>
<td>Questionnaires</td>
<td>Chi-square, Mann-Whitney U test, Cohen’s effect size.</td>
</tr>
<tr>
<td>III</td>
<td>Randomized controlled design(^a)</td>
<td>Adult day surgery patients n=997(^b)</td>
<td>Questionnaires</td>
<td>Chi-square, Mann-Whitney U test, Student’s t-test. QALYs, cost-effectiveness, Net Monetary Benefit method.</td>
</tr>
<tr>
<td>IV</td>
<td>Qualitative, exploratory, descriptive(^a)</td>
<td>Participation in the intervention group in Studies II &amp; III n=18</td>
<td>Interviews</td>
<td>Inductive thematic analysis.</td>
</tr>
</tbody>
</table>

\(^a\)Studies II–IV was a mixed method study with a concurrent embedded design where the qualitative study was embedded in the randomized controlled trial (RCT).  
\(^b\)Studies II and III are based on the same sample.  
CVI = content validity index; ICC = intraclass correlation coefficient; QALY = quality-adjusted life year.

### Sample and settings

Study I was carried out at two day surgery units in Sweden. In Studies II–IV, participants were recruited at four day surgery units in Sweden. Study I was carried out from January to May 2015, while inclusion and data collection for Studies II and III was carried out from October 2015 to July 2016 and for Study IV from December 2015 to July 2016.
The inclusion criteria were: undergoing day surgery, age >17 years, with access to a mobile phone (Studies I–IV), undergoing general anaesthesia (Study I) and ability to understand spoken and written Swedish (Studies I–IV). Exclusion criteria were: visual impairment (Studies II–IV), alcohol and/or drug abuse, memory impairment (Studies I–IV) and undergoing surgical abortion (Studies II–IV). Study IV was embedded in the RCT and inclusion criteria were: being allocated to the intervention group and requesting a call from a nurse via RAPP.

A total of 1,097 participants undergoing day surgery were recruited (Studies I–IV). Study I included 70 participants, but the surgery was cancelled for one participant, leaving 69 participants (41 male and 28 female) included in the analysis (see flowchart, Figure 3). Of these, 63 completed feasibility testing. Eighteen patients who were included last were asked to complete the content validity evaluation. Five submitted incomplete questionnaires, leaving 13 included in the analysis. In addition, twelve staff (four nurses, four anaesthesiologists and four surgeons) with experience in day surgery participated in the content validity evaluation. In Studies II and III, 1,027 participants were included for randomization. Surgery was cancelled for 23. Four declined to participate, and another one had technical issues and two dropped out for unknown reasons, resulting in 997 participants (455 male and 542 female) receiving treatment as allocated. A total of 494 were allocated to receive the intervention, and of these, 91 participants requested a contact call via RAPP and were therefore eligible for Study IV. Out of the 91 participants who requested a contact call via the app, 18 (eight males and ten females) were included in Study IV (see flowchart, Figure 4).

**Sample size**

Study I: The sample size in Study I was guided by two studies comparing paper and electronic questionnaires in other contexts: spondyloarthritis (n=55) and irritable bowel syndrome (n=72). In both studies, equivalence between the paper and electronic questionnaire was found.

Studies II and III: The sample size was estimated at 1,000 participants (477 participants per group + accounting for dropouts). This was based on quality-adjusted life year (QALY) weights in patients with asymptomatic gallstone disease (0.76) and patients with a surgical scar (0.79). Sample size calculation was based on the assumption of a difference of 0.03 in QALY weights being detected between the groups (0.79 in the intervention group...
vs. 0.76 in control group), with an $\alpha$ of 0.01 (two-sided type I error) and a power of 0.90\textsuperscript{112}.

Figure 3 Flowchart of participant flow in Study I. POD = postoperative day; RAPP = Recovery Assessment by Phone Points; SwQoR = Swedish web version of the Quality of Recovery questionnaire.
Figure 4 Flowchart of participant flow in Studies II–IV. POD = postoperative day; RAPP = Recovery Assessment by Phone Points.
Data collection and analysis

The RAPP was downloaded to the participants’ mobile phone before discharge from the day surgery unit. All participants received help with downloading the RAPP application software from the author of the thesis (Study I) or a research nurse (Studies II and III) and were trained in how to report answers and navigate between questions. Regarding the question “Do you want to be contacted by a nurse?”, they were informed that a nurse from the day surgery unit where the surgery was performed would call them within 24 hours (on weekdays) if they requested via the app to be contacted (Studies I–IV). The author of this thesis was always available on phone and e-mail to the research nurses (Studies II and III) and participants (Studies I–IV) during the studies if there were any technical issues or questions concerning the app, inclusion/exclusion criteria or data collection. Demographic data such as sex, age, type of surgery, type of anaesthesia (Studies I–IV), ASA physical status class and duration of surgery (Studies II and III) was collected from the patients’ medical records. Studies II, III and IV had a mixed method design in which data were collected, analysed and reported in separate papers. The merging of the data is conducted in the Discussion of this thesis. When merging qualitative and quantitative data the researcher seek for confirmation, expansion and discordance in the datasets109.

Study I

This study consisted of three steps with different data collections and analyses, which are described below. The first step of the study had a randomized crossover design and the second and third step had a prospective descriptive design. The author of this thesis conducted the data collection in all three steps.

Step 1. To measure equivalence between the paper and app versions of the SwQoR, a randomized crossover design was used, i.e. all participants answered both the paper version and the app version of the questionnaire. Equivalence testing was performed before the participants’ discharge from the day surgery, at the time when phase II recovery was completed. Participants were randomly allocated to either first answering the paper version or first answering the app version of the SwQoR. Randomization was performed with sealed envelopes ordered at random. This was a non-blinded study. Thirty minutes elapsed between the measurements, as in a study by Gower et al. where staff-administered vs. self-administered assessment of QoR is described113. When completing the second assessment on the other
version of SwQoR, the participants had no access to their previous answers. In the analysis, item-by-item difference was analysed with Wilcoxon’s signed-rank test, with a p-value <0.01 considered significant. Equivalence between the paper and app versions of the SwQoR was analysed using the intraclass correlation coefficient (ICC) (one-way, single measures) for items and the total SwQoR score. An ICC of ≥0.7 was considered acceptable. Cronbach’s alpha was used for estimating internal consistency and a value between 0.70 and 0.95 was considered to be satisfactory\textsuperscript{114, 115}.

**Step 2.** To explore feasibility and acceptability of RAPP, participants were asked to answer the RAPP daily for 7 days after the surgery. On postoperative day (POD) 7 a follow-up call was made to get participants to answer a study-specific questionnaire containing 16 questions about what the RAPP was like to use in the postoperative period. The questionnaire was guided by a questionnaire used in a study comparing mental illness assessment with a mobile app and assessment using text messaging\textsuperscript{116}, except that some questionnaire items were rephrased to fit our context of using an app in the postoperative period. Questions about the device were also excluded since the participants in this study used their own device. The questionnaire was checked for face validity\textsuperscript{115} including a check by healthy persons who owned a mobile phone (n=3). Face validity provided an overall view of the questionnaire. After this process one question was reformulated and two questions that were considered similar were merged into one. In the present study, eleven of the questions were statements such as “Answering the questions took a lot of time.” and “I would like to use this type of postoperative follow-up again if undergoing surgery.” that were rated from 1 = strongly agree, to 7 = strongly disagree. Further questions asked whether there were any items missing in the SwQoR and how many PODs it would be useful to use the app. If a contact call was initiated via the app, the number of occasions as well as reasons for the contact were asked. Lastly, opinions of having the opportunity to initiate contact with a nurse via RAPP were obtained as well as overall comments regarding RAPP.

**Step 3.** To evaluate content validity of the items in the SwQoR when assessing postoperative recovery daily for 7 days, staff working at the day surgery unit and 18 participants included in steps 1 and 2 were asked to assess the items in the SwQoR for relevance. All 31 items in the SwQoR as well as three items suggested by the participants in the follow-up questionnaire were rated on a 4-point scale, where 1 = not relevant, 2 = somewhat
relevant, 3 = quite relevant, and 4 = highly relevant. The day surgery patients performed the assessment 1–2 weeks postoperatively, i.e. after the feasibility and acceptability testing was completed. Content validity was analysed using the content validity index (CVI). The content validity index at the item level (I-CVI) was calculated by dividing the number of participants who rated the item 3 (quite relevant) or 4 (highly relevant) by the total number of participants. To indicate good content validity it is suggested that I-CVI should be ≥0.78 (when having more than six participants). For the scale CVI (S-CVI), the average of all I-CVI is calculated and should be at least 0.917.

**Studies II and III**

This was a multicentre, two-group parallel RCT where the primary outcome was cost-effectiveness when using RAPP after day surgery and the secondary outcome was the effect of RAPP use on quality of postoperative recovery112 (US National Institutes of Health Clinical Trials Registry: NCT02492191). A research nurse at each setting was responsible for participant inclusion. Participants were randomly allocated to the intervention group (RAPP for follow-up after day surgery) or the control group provided with standard care. Randomization was performed by a computerized random number list generated by the Department of Clinical Epidemiology and Biostatistics at Region Örebro County, Örebro, Sweden. Patients were randomly assigned at a 1:1 ratio, with permuted blocks of different sizes, stratified by centre. Allocation codes in sealed envelopes were ordered according to randomization. To ensure allocation concealment the envelopes were not opened until the participant agreed to participate in the study.

All participants in both study groups received the same standard care that was routine at the day surgery unit where the surgery was performed. Standard care included information about postoperative recovery and about where to call in case of concerns or questions. The information was provided by the nurse in charge of the patient, not the research nurse. At two of the units, patients were provided with a telephone number for the day surgery unit in case they had any questions or concerns, and at one unit this option was restricted to specific times of the day. One unit performed a follow-up call on postoperative day 1 to those patients who said at discharge that they wanted a call. One unit instructed patients to contact primary care or the outpatient clinic with questions or concerns. Both groups were informed to contact the 24-hour telephone helpline 1177 if questions or concerns arose out of office hours. In case of need for emergency care,
participants were advised to contact the emergency department (ED). No changes for follow-up appointments after the surgery were made in either of the groups. The participants in the intervention group answered the RAPP app daily (including the SwQoR as well as the function to initiate contact with a nurse at the day surgery unit) for 14 PODs. This time frame was guided by the results from Study I.

Postoperative recovery (Study II)
Postoperative recovery was assessed with the SwQoR. The assessment was daily in RAPP for the intervention group; using the paper-based questionnaire the assessment was done on POD 7 and POD 14 in the control group. The SwQoR has a possible range of 0–240 (24 items, scored between 0 and 10), where 0 = excellent quality of recovery, and 240 = extremely poor quality of recovery. A reminder to return the SwQoR questionnaires (in a prepaid envelope) was sent out to the control group on POD 14 or 15. Participants allocated to the RAPP group received a daily reminder, via the app, to answer the SwQoR.

Missing data
Some participants were lost to follow-up in both groups on both POD 7 and POD 14. Since the RAPP group did a daily assessment of the SwQoR, loss to follow-up was handled using last value carried forward (LVCF) in RAPP group. This method was used where the participant had reported a SwQoR answer on the previous day (i.e. POD 6 (n=64) or POD 13 (n=63)). The decision to do this was made under the assumption that postoperative recovery improves over time and that the participants’ score remained relatively constant from one day to another118.

Statistical analysis
Participant characteristics regarding gender, age, ASA class, type of surgery, duration of surgery, type of anaesthesia and type of airway management were described using number, per cent, mean and standard deviation (SD). Differences between the RAPP group and control group, as well as gender differences, were analysed using chi-square test for nominal data, Mann-Whitney U test for ordinal data and continuous data that were non-normally distributed, or independent t-test for continuous data.

In items with significant differences between the groups, Cohen’s effect size (ES) was used to calculate the magnitude of the effect between the two
groups. Effect size was calculated as: (intervention mean – control group mean)/ SDpooled. An ES of 0.2–0.5 was classified as a small effect, 0.5–0.8 as a moderate effect and ≥0.8 as a large effect\textsuperscript{118,119}. For analysing good and poor recovery, the mean score for all participants in this present study was used to define the dichotomization into good and poor recovery. Thus, POD 7 global SwQoR scores ≤31 were considered good recovery while scores ≥32–240 were considered poor recovery; corresponding values for POD 14 were ≤21 vs. ≥22–240.

For statistical analyses, IBM SPSS statistics version 24 for Windows was used (IBM, Armonk, NY, US). A p-value <0.01 was considered statistically significant in all analyses.

Health economic evaluation (Study III)

Both costs and consequences are taken into account in economic assessment of interventions, and play an important role in budget allocation in health care. The cost-effectiveness analysis (CEA) used individual data and was performed from a health care perspective\textsuperscript{120}. The analysis considered costs/savings in health care use, costs for the intervention, and health effects. At POD 14, participants answered five study-specific yes/no questions regarding surgery and anaesthesia-related health care contacts made to primary care, ED, the 1177 telephone helpline, the outpatient hospital, via RAPP (intervention group only) or other. Also, the number of contacts and the reason for each contact were requested. The 14-day follow-up was based on a previous study that showed that in most cases, surgery-related contact with health care is made during the first 14 days after day surgery\textsuperscript{5}.

Gained QALYs derived from quality of life (QoL) data were used to measure the health effects. Data collection regarding QoL was performed pre-operatively and on POD 14 using the Short-Form Six-Dimension (SF-6D) instrument\textsuperscript{121}. The SF-6D as well as the questions regarding health care contacts were answered in writing using pen and paper by both the intervention and control group. The questionnaires were returned to the research team in a prepaid envelope. A reminder to return the questionnaires was sent to all participants via e-mail or SMS on POD 14 or POD 15.

Description of costs

The analysed costs were costs associated with RAPP and costs for health care contacts. All cost estimates included social fees and overhead costs and
were converted from Swedish krona (SEK) to EURO (EUR) using an approximated exchange rate of 9.40 SEK = EUR 1 (February 2016). Costs for health care contacts were obtained from the KPP (Cost per patient) database, NordDRG 2016 (Nordic patient classification based on diagnosis-related group) weight (calculated from data in KPP), the 1177 help-line and price lists from Region Örebro County, Jönköping County and Dalarna County Council. Costs for the nurses’ time for follow-up calls initiated via RAPP were procured from the accounting departments at the hospitals included in this study.

Only unplanned health care contacts related to the surgery/anaesthesia were included in the CEA. A planned health care contact was considered as a contact planned before discharge and one which the patient would be informed about before discharge. Examples of planned health care contacts after day surgery are ones for removing stitches, physiotherapy or a planned follow-up to the physician or nurse. Any contact with 1177, the ED and via RAPP was considered unplanned. The reported health care contacts were categorized as planned or unplanned contacts. The categorization was performed individually by the author of this thesis and a researcher (not a member of the research group) with experience of work with postoperative recovery and day surgery. Both were blinded to group allocation.

Costs for RAPP included the estimated time the nurse spent on downloading the RAPP app and instructing the participant on how to use it, and the estimated time it would take to handle patient data in the administrator interface (i.e. handling data). The costs for the nurses were procured from the accounting department as described above. Further costs for RAPP included costs for the application software, licence, data storage, security, ICT support and the web administrator interface. Costs for RAPP were obtained from the company RAPP AB and were based on the costs described in the business plan and further based on a cost of EUR 1.06 per day of assessment. All above described costs are valid for 2016.

**Description of health effects**

Quality of life was measured using the SF-6D, which is an instrument for describing and valuing individuals’ health based on eleven items in the Short-Form 36-item (SF-36) health survey. The SF-36 acute version was
used in this study because of the 14-day interval between the two measurement points. The SF-6D represents six dimensions: physical functioning, role limitation, social functioning, bodily pain, mental health, and vitality. The SF-6D was designed for generating a preference-based index score suitable for CEA. Gained QALYs were calculated as \((\text{SF-6D POD 14} - \text{SF-6D preoperative}) \times \frac{2}{52}\), the difference in QoL between the intervention and control group preoperatively and on POD 14. The SF-6D has previously been tested after colorectal surgery and in carpal tunnel syndrome and in both cases was able to detect changes in QoL during postoperative recovery.

**Cost-effectiveness**
The CEA was performed as a cost-minimization analysis (CMA) since there were no differences in QALY between the groups. The CMA included net costs/savings for the intervention group compared with those for the control group; QALY was not included in the CMA. A ratio was calculated for the intervention group compared with the control group.

**Sensitivity analysis and missing data**
Sensitivity analyses were conducted. Analysis was conducted with different imputations for handling missing data and using different prices for RAPP. The uncertainty was handled with the Net Monetary Benefit (NMB) method, which is based on health effects (QALYs, in this study) given a value, at an individual level. When all data are expressed in money terms, it is possible to calculate the likelihood that an intervention is cost-effective when comparing it with another intervention or with standard care. In this study the willingness to pay for a gained QALY was set to EUR 0 since there was no QALY gain. A scatter plot of 5000 bootstrapped incremental cost-effectiveness ratios was created by repeatedly drawing a random sample with replacement, using parameters estimated from the study. This produced estimates of the probability that the intervention was cost-effective.

Missing data were handled with modified intention to treat (ITT): the returned questionnaires (n=719) were handled with stochastic regression imputation for SF-6D (n=20). Missing items regarding health care contacts were considered as no contact (n=139). The sensitivity analysis included two further analyses: (1) complete cases (SF-6D and health care contacts) and (2) classic ITT: loss to follow-up as well as missing items were handled with stochastic regression imputation for health care contacts and SF-6D (n=417).
Statistical analysis
Participant characteristics regarding gender, age, ASA class, type of surgery, duration of surgery and type of anaesthesia were described using numbers, per cent, mean and SD. Differences between the RAPP group and the control group were analysed with independent $t$-test for continuous variables, Mann-Whitney U test for continuous variables that were non-normally distributed, and chi-square test for nominal variables. Individual values were used for savings in health care, gained QALY and costs in the intervention and control groups. The significance level was set at $p<0.01$. The software IBM SPSS statistics version 23 for Windows (IBM Corp, Armonk, NY, USA) was used for all analyses.

Blinding
In Studies II and III the researchers who conducted the statistical analysis were blinded to group allocation. To ensure the blinding, data collected during the trial were input by an external person who was not part of the research team. After the statistical analysis and costs for the RAPP app as well as health care contacts were estimated, the code was broken.

Study IV
This study had a descriptive exploratory design with an inductive approach.

Participants
Participants in Study IV were recruited from Studies II and III. Participants were purposively selected to include maximum variation regarding setting, gender, age, type of surgery and anaesthesia. Participants received written information about the study via e-mail 14–30 days after the surgery. After 3–7 days a phone call was made to provide the participants with verbal information about the study and thereafter they were asked to participate in the study. Twenty-five patients were asked and 18 agreed to participate.

Data collection
The interviews were conducted face to face except for one interview that was conducted via Skype. All interviews were conducted by the author of this thesis. Participants decided when and where they wanted the interview to take place. A semi-structured interview guide was used. The interview included open-ended questions$^{134}$, and examples of questions were “Could you describe your experiences of the first days after the surgery?”, followed by questions about what it was like to use the app: “What are your thoughts
regarding this type of IT solution after surgery?” To gain a deeper understanding, probing questions were asked. The data collection started with one pilot interview to test the interview guide. No changes were made after this process and the pilot interview was included in the analysis. All interviews were audio-recorded and lasted between 30 and 99 minutes (mean 49.5 minutes). No new information was obtained in the last few interviews and it was judged that data saturation had been reached.

Analysis
The interviews were analysed with thematic analysis and followed the six steps outlined by Braun and Clarke135. The recorded interviews were transcribed verbatim by the author of this thesis (one interview) and a professional transcriber (17 interviews). All transcribed interviews were checked against the recorded interviews by the author of this thesis to ensure accuracy. The transcripts were then read repeatedly by the author and researchers to familiarize themselves with the data. Notes were made and the contents of the data discussed.

After reading through the interviews, the coding process started. The coding was performed by the author of this thesis and thereafter the codes were checked and discussed with a senior researcher with experience of conducting qualitative analysis (last author of study IV). The codes were searched for patterns. Codes belonging to the same area were grouped together into subthemes and themes. A researcher (second author in study IV) who had not been part of the analysis up to that point confirmed the findings at this stage. Themes and subthemes were reviewed and refined by all the authors as an ongoing process to ensure correspondence with the original data and the aim of the study. Subthemes were merged and divided so as to be internally homogeneous and externally heterogeneous. The headings of the themes and subthemes were reviewed to capture the essence of the theme and subtheme. The results of the analyses were discussed with all authors before producing the paper. Throughout the process the researchers moved back and forth between the different steps of analysis135. During the analysis process the authors’ pre-understanding was taken into consideration and the authors strove to be open to the text.
Ethical considerations

All studies were carried out in accordance with the principles set out in the 6th Declaration of Helsinki as well as according to Swedish law in research involving humans. Ethical approval was obtained from the ethical review board in Uppsala, Sweden (reference numbers: 2014/456 (Study I), and 2015/262 (Studies II–IV)). The trial was registered at the US National Institutes of Health Clinical Trials Registry (NCT0249219).

Information about the study, both written and verbal, was provided to all participants. In Studies I–III, written information about the study was sent together with the appointment for the operation and, if lost, was again administered on the day of the operation. Verbal information was provided on the day of surgery before any premedication was administered. In Study I, participants were informed by the author of this thesis and in Studies II and III the information was provided by the research nurse at the day surgery unit. For Study IV, participants received an e-mail with written information about the study; verbal information was provided via a phone call and again on the day of the interview. To ensure that all participants received the same, correct information, only the author of this thesis and the research nurses informed participants about the studies. Written informed consent was obtained from all participants who agreed to participate in the studies. All participants were informed that participation was entirely voluntary, and that they would be able to withdraw from the study at any time without any explanation and, furthermore, that withdrawal would not in any way affect their care. In an RCT it is important that participants allocated to the control group do not receive inferior care compared with routine. In Studies II and III the control group received standard care, which means that their care was not inferior to routine day surgical care.

Data were handled in accordance with Swedish law. All data were handled confidentially, meaning that participants were provided a unique study code, and the codes were stored in a secure place separate from the collected data. Only a study code was registered in the RAPP, but no personal information such as name, age, sex, type of surgery, social security number or telephone number was registered. The only possibility to identify the person who answered the RAPP app or requested a contact call via RAPP was via access to the code set. Electronically reported data via RAPP were stored in a secure data server requiring login data and a password to gain access.
Furthermore, the data collected did not include any sensitive information such as ethnicity or religious, political or union membership\textsuperscript{137}.

Being interviewed about personal experiences during postoperative recovery can be sensitive and can trigger unpleasant memories. Therefore, there was an opportunity for the participants to contact the researchers by e-mail or mobile phone. None of the participants contacted the researchers after the interviews.

**Conflicts of interest**

The main supervisor of this thesis and the principal investigator for the project, Ulrica Nilsson, holds shares in RAPP AB. Ulrica Nilsson is the originator of RAPP and has designed the overall project of which this thesis is a part. To ensure that neither Ulrica Nilsson nor anyone else from RAPP AB had access to the data or the analyses of Studies II and III, they did not have any access to the gathered data or the analyses until after the publication of Studies II and III (Örebro University Dr No. 6.3.1-03493/2016). Because of the conflict of interest that exists it was important that Studies II and III were single-blinded so that the researchers performing the analysis were unaware of group allocation.
Results

In this section, the results of the four separate studies are presented together under the two headings “The SwQoR” and “RAPP and experiences of postoperative recovery”. Characteristics of the participants in the studies are presented in Tables 2 and 3.

Table 2. Characteristics of participants in Studies I and IV

<table>
<thead>
<tr>
<th></th>
<th>Study I (n=69)</th>
<th>Study IV (n=18)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, yrs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>50 (15)</td>
<td>49.5 (17)</td>
</tr>
<tr>
<td>Median (min, max)</td>
<td>51 (19, 78)</td>
<td>52 (21, 80)</td>
</tr>
<tr>
<td><strong>Gender, n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female/male</td>
<td>28 (41)/41 (59)</td>
<td>10 (56)/8 (44)</td>
</tr>
<tr>
<td><strong>Type of surgery, n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>33 (48)</td>
<td>5 (28)</td>
</tr>
<tr>
<td>Orthopaedic</td>
<td>26 (38)</td>
<td>7 (39)</td>
</tr>
<tr>
<td>Hand</td>
<td>3 (4)</td>
<td>5 (28)</td>
</tr>
<tr>
<td>Ear, nose, throat</td>
<td>3 (4)</td>
<td>1 (6)</td>
</tr>
<tr>
<td>Gynaecological</td>
<td>4 (6)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Type of anaesthesia, n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General anaesthesia</td>
<td>70 (100)</td>
<td>14 (78)</td>
</tr>
<tr>
<td>Regional/local anaesthesia</td>
<td>–</td>
<td>4 (22)</td>
</tr>
</tbody>
</table>

SD = standard deviation.
Table 3. Characteristics of participants in Studies II and III (n=997)

<table>
<thead>
<tr>
<th></th>
<th>RAPP group n=494</th>
<th>Control group n=503</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, yrs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>45 (15)</td>
<td>46 (15)</td>
</tr>
<tr>
<td>Median (min, max)</td>
<td>46 (18, 81)</td>
<td>47 (18, 82)</td>
</tr>
<tr>
<td><strong>Gender n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female/male</td>
<td>274 (55)/220 (45)</td>
<td>268 (53)/235 (47)</td>
</tr>
<tr>
<td><strong>ASAa class</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/II/III</td>
<td>242 (49)/147 (30)/11 (2)</td>
<td>255 (51)/148 (29)/8 (2)</td>
</tr>
<tr>
<td><strong>Type of anaesthesiab, n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General anaesthesia</td>
<td>362 (73)</td>
<td>369 (73)</td>
</tr>
<tr>
<td>Regional/local anaesthesia</td>
<td>107 (22)</td>
<td>111 (22)</td>
</tr>
<tr>
<td><strong>Type of airway managementc</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETT</td>
<td>77 (16)</td>
<td>68 (14)</td>
</tr>
<tr>
<td>LMA</td>
<td>267 (54)</td>
<td>279 (55)</td>
</tr>
<tr>
<td>MASK</td>
<td>6 (1)</td>
<td>3 (0.6)</td>
</tr>
<tr>
<td>Spontaneous breathing</td>
<td>119 (24)</td>
<td>129 (26)</td>
</tr>
<tr>
<td><strong>Type of surgeryd</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orthopaedics</td>
<td>160 (32)</td>
<td>181 (36)</td>
</tr>
<tr>
<td>General</td>
<td>126 (26)</td>
<td>115 (23)</td>
</tr>
<tr>
<td>Hand</td>
<td>116 (23)</td>
<td>111 (22)</td>
</tr>
<tr>
<td>ENT</td>
<td>52 (11)</td>
<td>49 (10)</td>
</tr>
<tr>
<td>Gynaecology</td>
<td>26 (5)</td>
<td>28 (6)</td>
</tr>
<tr>
<td>Eye</td>
<td>5 (1)</td>
<td>3 (0.6)</td>
</tr>
<tr>
<td>Urology</td>
<td>3 (0.6)</td>
<td>7 (1)</td>
</tr>
<tr>
<td>Oral, maxillofacial</td>
<td>2 (0.4)</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td><strong>Duration of surgery, min</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>40 (29.6)</td>
<td>42 (30.2)</td>
</tr>
</tbody>
</table>

*aMissing data, RAPP group n=94, control group n=92.

*bMissing data, RAPP group n=26, control group n=23.

*cMissing data, RAPP group n=25, control group n=24.

*dMissing data, RAPP group n=4, control group n=8.

ASA = American Society of Anesthesiologists; ENT = ear, nose and throat; ETT = endotracheal tube; LMA = laryngeal mask airway; MASK = mask ventilation; RAPP = Recovery Assessment by Phone Points; SD = standard deviation.
The SwQoR (Study I)

Equivalence between the paper and app versions of the SwQoR instrument

In the equivalence testing between the paper version and the app version of the SwQoR instrument the ICC for the total SwQoR score was 0.89 (95% CI 0.83–0.93). The ICC for the SwQoR items ranged from 0.13 to 0.90. The differences between the paper version and the app version were statistically significant for three items: *feeling rested, feeling restless* and *shivering or twitching* (Table 4). Cronbach’s alpha was 0.91 for both versions. The participants expressed a risk of inadvertently giving the wrong answer due to the SwQoR containing both negative and positive items. They said that either all items should be positive or they should all be negative, and suggested allowing good vs. bad ratings to be on the same side of the scale for all items (I).

<table>
<thead>
<tr>
<th>Item</th>
<th>Paper version, median (IQR)</th>
<th>App version, median (IQR)</th>
<th>P-value*</th>
<th>ICC 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Able to return to work or usual duties</td>
<td>5 (1–10)</td>
<td>5 (2–9)</td>
<td>0.82</td>
<td>0.90</td>
</tr>
<tr>
<td>about the home</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea and/or vomiting</td>
<td>0 (0–3)</td>
<td>0 (0–2.75)</td>
<td>0.06</td>
<td>0.89</td>
</tr>
<tr>
<td>Sleeping well</td>
<td>10 (8–10)</td>
<td>10 (8–10)</td>
<td>0.28</td>
<td>0.89</td>
</tr>
<tr>
<td>Nightmares</td>
<td>0 (0–0)</td>
<td>0 (0–0)</td>
<td>0.02</td>
<td>0.87</td>
</tr>
<tr>
<td>Able to write as usual</td>
<td>10 (10–10)</td>
<td>10 (9–10)</td>
<td>0.04</td>
<td>0.86</td>
</tr>
<tr>
<td>Back pain</td>
<td>0 (0–0)</td>
<td>0 (0–1)</td>
<td>0.07</td>
<td>0.83</td>
</tr>
<tr>
<td>Feeling in control</td>
<td>9 (8–10)</td>
<td>9 (7–10)</td>
<td>0.75</td>
<td>0.82</td>
</tr>
<tr>
<td>Able to breathe easily</td>
<td>10 (9.75–10)</td>
<td>10 (9.75–10)</td>
<td>0.25</td>
<td>0.81</td>
</tr>
<tr>
<td>Headache</td>
<td>0 (0–2)</td>
<td>0 (0–2)</td>
<td>0.39</td>
<td>0.81</td>
</tr>
<tr>
<td>Depressed</td>
<td>0 (0–1)</td>
<td>0 (0–1)</td>
<td>0.16</td>
<td>0.80</td>
</tr>
<tr>
<td>Being able to enjoy food</td>
<td>10 (8–10)</td>
<td>10 (8–10)</td>
<td>0.12</td>
<td>0.69–0.87</td>
</tr>
<tr>
<td>Feeling rested</td>
<td>9 (7–10)</td>
<td>8 (5–10)</td>
<td>0.008</td>
<td>0.80</td>
</tr>
<tr>
<td>Sore throat</td>
<td>0 (0–1)</td>
<td>0 (0–2)</td>
<td>0.02</td>
<td>0.79</td>
</tr>
<tr>
<td>Sore mouth</td>
<td>0 (0–0)</td>
<td>0 (0–0.25)</td>
<td>0.05</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Table 4. Comparison between the paper version and the app version of the SwQoR instrument (n=66)
Content validity

Participants suggested including three new items in the SwQoR: fever, reddened surgical wound and swollen surgical wound. These three items were included in the content validity evaluation of the SwQoR. When evaluating content validity the patients rated items lower (i.e. as less relevant) compared with the staff group. The I-CVI for the patient group was between 0.30 and 0.92 and the S-CVI 0.67. In the staff group the I-CVI was between 0.64 and 1.0, with an S-CVI of 0.88. The results of the content validity guided the revision of items and the inclusion of new items in the SwQoR.
Items with an I-CVI <0.78 for both the patient group and the staff group were excluded from the SwQoR. This resulted in seven items being removed: being able to enjoy food, able to write as usual, feeling restless, shivering or twitching, feeling too cold, feeling lonely, and back pain. The three new items fever, reddened surgical wound and swollen surgical wound were included because the I-CVI >0.78. Patients felt that four items, sleeping well, feeling rested, difficulties getting to sleep and nightmares, were similar and these items were merged into one item, sleeping difficulties. Thus, after the content validity evaluation the SwQoR included 24 items (I).

RAPP and experiences of postoperative recovery (Studies I–IV)

Feasibility of using RAPP during postoperative recovery (Study I)
In Study I, 63 participants used RAPP after discharge and participated in the feasibility and acceptability testing. The app was answered on 5 days on average (min 1–max 7). The main reasons for not answering the app were technical issues such as being logged out from the app or network connection issues. Two participants were readmitted to hospital. A daily reminder to answer the app was suggested by the participants who forgot to answer the app every day. When participants were asked for how many days they wanted to answer the RAPP app after day surgery the average time was 9 (min 3–max 60) days. Participants were positive towards using RAPP in the postoperative period. They found it helpful and did not think that it took too much time to report. If admitted for surgery again participants wanted to use RAPP again (Table 5) (I).

RAPP was described as one solution to the problem of getting in contact with health care, which was experienced as troublesome. This new way of using digital technology enabled an easy way of contacting the caregiver. The chance to initiate contact with a nurse via RAPP increased the feeling of being safe and not being left alone after the surgery. The opportunity to initiate contact with the nurse via RAPP was used by 22% (14/63) of the participants. In total, 15 contacts were requested via RAPP, which is 3.4% out of 441 possible contacts (63 participants using RAPP for 7 days). The function that enabled contact with a nurse via RAPP was preferred by all except one participant who preferred to call the health care instead of initiating contact via the app (I).
Table 5. Results from the follow-up questionnaire on what it was like to use RAPP (n=63)

<table>
<thead>
<tr>
<th>Question</th>
<th>Median (IQR)</th>
<th>Min–max</th>
</tr>
</thead>
<tbody>
<tr>
<td>I felt familiar with using this type of technology.</td>
<td>1 (1–1)</td>
<td>1–3</td>
</tr>
<tr>
<td>I would like to use this type of postoperative follow-up again if undergoing surgery.</td>
<td>1 (1–1)</td>
<td>1–4</td>
</tr>
<tr>
<td>I think other people would find the software tool easy to use.</td>
<td>2 (1–3)</td>
<td>1–5</td>
</tr>
<tr>
<td>This type of systematic follow-up helped me and would help other patients in the same situation.</td>
<td>1 (1–2)</td>
<td>1–4</td>
</tr>
<tr>
<td>Answering the questions made me feel better.</td>
<td>5 (3–7)</td>
<td>1–7</td>
</tr>
<tr>
<td>It was difficult to answer the questions.</td>
<td>7 (7–7)</td>
<td>2–7</td>
</tr>
<tr>
<td>I would like to avoid answering the questions.</td>
<td>7 (7–7)</td>
<td>2–7</td>
</tr>
<tr>
<td>Answering the questions took a lot of time.</td>
<td>7 (7–7)</td>
<td>4–7</td>
</tr>
<tr>
<td>It was difficult to keep track of what the questions were asking.</td>
<td>7 (6–7)</td>
<td>4–7</td>
</tr>
<tr>
<td>It was inconvenient to answer the questions using my smartphone.</td>
<td>7 (7–7)</td>
<td>2–7</td>
</tr>
<tr>
<td>Answering the questions made me feel worse.</td>
<td>7 (7–7)</td>
<td>1–7</td>
</tr>
<tr>
<td>Total score $^a$ (positive items reversed)</td>
<td>69 (66–73)</td>
<td>45–77</td>
</tr>
</tbody>
</table>

1 = strongly agree, 7 = strongly disagree.

$^a$Minimum possible total score = 11; maximum possible total score = 77.

IQR = interquartile range; RAPP = Recovery Assessment by Phone Points.

Effect on postoperative recovery (Study II)

Investigating whether RAPP would have a positive effect on postoperative recovery showed that the RAPP group reported significantly lower global SwQoR scores, indicating a better QoR on POD 7. The RAPP group also reported significantly lower scores in the items **sleeping difficulties, not having a general feeling of wellbeing, having difficulty feeling relaxed, dizziness, headache, sore mouth, pain in the surgical wound and swollen surgical wound** (Table 6). On POD 7, altogether 69% of the participants in the RAPP group vs. 57% in the control group reported a good postoperative recovery (i.e. a SwQoR score ≤31) (p=0.001).
Four of these items as well as the Global SwQoR score were still significantly lower in the RAPP group compared with the control group on POD 14: sleeping difficulties, not having a general feeling of wellbeing, having difficulty feeling relaxed, and pain in the surgical wound (Table 7). On POD 14 the RAPP group still reported better QoR when using cut-off values

<table>
<thead>
<tr>
<th>Item</th>
<th>RAPP group Mean (SD)</th>
<th>Control group Mean (SD)</th>
<th>P-value&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Cohen’s effect size&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trouble breathing</td>
<td>0.39 (1.17)</td>
<td>0.47 (1.49)</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>Sleeping difficulties</td>
<td>1.54 (2.56)</td>
<td>2.49 (2.84)</td>
<td>&lt;0.001</td>
<td>0.35</td>
</tr>
<tr>
<td>Not having a general feeling of wellbeing</td>
<td>1.49 (2.21)</td>
<td>2.27 (2.64)</td>
<td>&lt;0.001</td>
<td>0.32</td>
</tr>
<tr>
<td>Not feeling in control of my situation</td>
<td>1.14 (2.07)</td>
<td>1.52 (2.47)</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Having difficulty feeling relaxed</td>
<td>1.55 (2.30)</td>
<td>2.05 (2.52)</td>
<td>0.001</td>
<td>0.20</td>
</tr>
<tr>
<td>Voice not sounding the same as usual</td>
<td>0.57 (1.70)</td>
<td>0.63 (1.84)</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>Having difficulty taking care of my personal hygiene</td>
<td>1.78 (2.49)</td>
<td>1.72 (2.51)</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>Having difficulty returning to work or usual home activities</td>
<td>4.14 (3.55)</td>
<td>4.65 (3.65)</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>Nausea and/or vomiting</td>
<td>0.57 (1.57)</td>
<td>0.87 (2.12)</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td>0.60 (1.55)</td>
<td>1.00 (2.08)</td>
<td>0.006</td>
<td>0.21</td>
</tr>
<tr>
<td>Depressed</td>
<td>1.10 (1.95)</td>
<td>1.52 (2.38)</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>1.08 (1.99)</td>
<td>1.48 (2.36)</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td>0.86 (1.88)</td>
<td>1.21 (2.11)</td>
<td>0.005</td>
<td>0.17</td>
</tr>
<tr>
<td>Muscle pain</td>
<td>1.37 (2.16)</td>
<td>1.90 (2.72)</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Sore throat</td>
<td>0.60 (1.65)</td>
<td>0.60 (1.62)</td>
<td>0.98</td>
<td></td>
</tr>
<tr>
<td>Sore throat</td>
<td>0.39 (1.33)</td>
<td>0.26 (1.14)</td>
<td>0.012</td>
<td>0.10</td>
</tr>
<tr>
<td>Difficulties concentrating</td>
<td>1.13 (2.02)</td>
<td>1.04 (1.91)</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>Trouble urinating</td>
<td>0.33 (1.14)</td>
<td>0.45 (1.47)</td>
<td>0.91</td>
<td></td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>0.43 (1.42)</td>
<td>0.52 (1.57)</td>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td>Feeling constipated</td>
<td>0.64 (1.70)</td>
<td>1.09 (2.29)</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Fever</td>
<td>0.31 (1.13)</td>
<td>0.32 (1.21)</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>Pain in the surgical wound</td>
<td>2.80 (2.74)</td>
<td>3.69 (2.92)</td>
<td>&lt;0.001</td>
<td>0.31</td>
</tr>
<tr>
<td>Reddened surgical wound</td>
<td>1.46 (2.37)</td>
<td>1.61 (2.45)</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Swollen surgical wound</td>
<td>1.93 (2.64)</td>
<td>2.75 (3.11)</td>
<td>0.001</td>
<td>0.28</td>
</tr>
<tr>
<td>Global SwQoR score score</td>
<td>28.23 (29.97)</td>
<td>34.87 (30.68)</td>
<td>&lt;0.001</td>
<td>0.21</td>
</tr>
</tbody>
</table>

<sup>a</sup>Mann-Whitney U test.

<sup>b</sup>0.2–0.5 = small effect; 0.5–0.8 = moderate effect; >0.8 = large effect.

0 = none of the time – 10 = all of the time

RAPP = Recovery Assessment by Phone Points; SD = standard deviation; SwQoR = Swedish web version of the Quality of Recovery instrument.
based on the mean for all participants (SwQoR ≤21), but this was a non-significant difference (70% vs. 64%; p=0.06).

Table 7. SwQoR on postoperative day 14. Cohen’s effect size is reported where p<0.01 (n=733)

<table>
<thead>
<tr>
<th>Item</th>
<th>RAPP group Mean (SD)</th>
<th>Control group Mean (SD)</th>
<th>P-valuea</th>
<th>Cohen’s effect sizeb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trouble breathing</td>
<td>0.22 (0.78)</td>
<td>0.24 (1.10)</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>Sleeping difficulties</td>
<td>1.06 (2.12)</td>
<td>1.54 (2.35)</td>
<td>&lt;0.001</td>
<td>0.21</td>
</tr>
<tr>
<td>Not having a general feeling of wellbeing</td>
<td>1.11 (2.01)</td>
<td>1.50 (2.26)</td>
<td>0.007</td>
<td>0.18</td>
</tr>
<tr>
<td>Not feeling in control of my situation</td>
<td>0.85 (1.84)</td>
<td>1.12 (2.28)</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>Having difficulty feeling relaxed</td>
<td>1.09 (2.08)</td>
<td>1.37 (2.11)</td>
<td>0.008</td>
<td>0.13</td>
</tr>
<tr>
<td>Voice not sounding the same as usual</td>
<td>0.29 (1.15)</td>
<td>0.39 (1.52)</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>Having difficulty taking care of my personal hygiene</td>
<td>1.54 (2.46)</td>
<td>1.17 (2.03)</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Having difficulty returning to work or usual home activities</td>
<td>3.06 (3.38)</td>
<td>3.19 (3.46)</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>Nausea and/or vomiting</td>
<td>0.34 (1.12)</td>
<td>0.29 (1.19)</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td>0.43 (1.31)</td>
<td>0.43 (1.33)</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Depressed</td>
<td>0.78 (1.74)</td>
<td>1.03 (1.95)</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>0.90 (1.91)</td>
<td>0.97 (1.83)</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td>0.67 (1.65)</td>
<td>0.83 (1.71)</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Muscle pain</td>
<td>1.20 (2.07)</td>
<td>1.45 (2.37)</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>Sore throat</td>
<td>0.24 (0.91)</td>
<td>0.29 (0.97)</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>Sore mouth</td>
<td>0.22 (0.90)</td>
<td>0.15 (0.80)</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Difficulties concentrating</td>
<td>0.74 (1.66)</td>
<td>0.71 (1.52)</td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td>Trouble urinating</td>
<td>0.19 (0.79)</td>
<td>0.22 (1.0)</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>0.29 (1.19)</td>
<td>0.34 (1.17)</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>Feeling constipated</td>
<td>0.41 (1.40)</td>
<td>0.50 (1.54)</td>
<td>0.39</td>
<td></td>
</tr>
<tr>
<td>Fever</td>
<td>0.20 (0.90)</td>
<td>0.20 (0.98)</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Pain in the surgical wound</td>
<td>1.79 (2.46)</td>
<td>2.27 (2.47)</td>
<td>&lt;0.001</td>
<td>0.20</td>
</tr>
<tr>
<td>Reddened surgical wound</td>
<td>1.07 (1.97)</td>
<td>1.14 (1.94)</td>
<td>0.48</td>
<td></td>
</tr>
<tr>
<td>Swollen surgical wound</td>
<td>1.37 (2.23)</td>
<td>1.60 (2.23)</td>
<td>0.025</td>
<td></td>
</tr>
<tr>
<td>Global SwQoR score (0–240)</td>
<td>20.12 (26.19)</td>
<td>21.90 (22.40)</td>
<td>0.002</td>
<td>0.07</td>
</tr>
</tbody>
</table>

aMann-Whitney U test.
b0.2–0.5 = small effect; 0.5–0.8 = moderate effect; >0.8 = large effect.
0 = none of the time – 10 = all of the time
RAPP = Recovery Assessment by Phone Points; SD = standard deviation; SwQoR = Swedish web version of the Quality of Recovery instrument.
Cohen’s ES showed small effect in the items and global scores that were statistically significant. Effect size was between 0.10 and 0.35 (Table 6) on POD 7 and 0.07–0.21 on POD 14 (Table 7).

Females in the RAPP group reported significantly lower scores (i.e. better QoR) compared with females in the control group in terms of global SwQoR score on POD 7 and in the items sleeping difficulties and pain in the surgical wound at both POD 7 and POD 14. Furthermore, the items not having a general feeling of wellbeing, having difficulty feeling relaxed, dizziness, anxiety and headache were scored significantly lower in the RAPP group compared with the control group at POD 7 (Table 8).

Table 8. SwQoR scores for females, RAPP group vs. control group. Significant differences (non-significant differences on postoperative day 14 included if significant on postoperative day 7)

<table>
<thead>
<tr>
<th>Item</th>
<th>RAPP/control group, POD 7</th>
<th>Mann-Whitney U test</th>
<th>RAPP/control group, POD 14</th>
<th>Mann-Whitney U test</th>
<th>P/Coen’s effect sizeb</th>
<th>RAPP/control group, POD 14</th>
<th>Mann-Whitney U test</th>
<th>P/Coen’s effect sizeb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeping difficulties</td>
<td>1.74 (2.77)/</td>
<td>0.001/</td>
<td>1.25 (2.39)/</td>
<td>&lt;0.001/</td>
<td>0.36/</td>
<td>1.71 (2.44)/</td>
<td>&lt;0.001/</td>
<td>0.19/</td>
</tr>
<tr>
<td>Not having a general feeling of wellbeing</td>
<td>2.77 (2.91)/</td>
<td>0.36/</td>
<td>1.71 (2.44)/</td>
<td>&lt;0.001/</td>
<td>0.07/</td>
<td>0.04/</td>
<td>&lt;0.001/</td>
<td>0.36/</td>
</tr>
<tr>
<td>Having difficulty feeling relaxed</td>
<td>1.55 (2.31)/</td>
<td>0.002/</td>
<td>1.30 (2.25)/</td>
<td>&lt;0.001/</td>
<td>0.31/</td>
<td>1.66 (2.47)/</td>
<td>&lt;0.001/</td>
<td>0.04/</td>
</tr>
<tr>
<td>Dizziness</td>
<td>2.34 (2.72)/</td>
<td>0.006/</td>
<td>1.30 (2.30)/</td>
<td>&lt;0.001/</td>
<td>0.30/</td>
<td>1.66 (2.38)/</td>
<td>&lt;0.001/</td>
<td>0.01/</td>
</tr>
<tr>
<td>Anxiety</td>
<td>1.39 (2.42)/</td>
<td>0.004/</td>
<td>0.57 (1.59)</td>
<td>&lt;0.001/</td>
<td>0.32/</td>
<td>1.66 (2.38)</td>
<td>&lt;0.001/</td>
<td>0.01/</td>
</tr>
<tr>
<td>Headache</td>
<td>1.14 (2.07)/</td>
<td>0.011/</td>
<td>0.79 (1.79)</td>
<td>&lt;0.001/</td>
<td>0.27/</td>
<td>1.15 (2.01)</td>
<td>&lt;0.001/</td>
<td>0.01/</td>
</tr>
<tr>
<td>Pain in the surgical wound</td>
<td>1.78 (2.54)/</td>
<td>0.011/</td>
<td>0.79 (1.79)</td>
<td>&lt;0.001/</td>
<td>0.27/</td>
<td>1.15 (2.01)</td>
<td>&lt;0.001/</td>
<td>0.01/</td>
</tr>
<tr>
<td>Global SwQoR score (0–240)</td>
<td>1.39 (2.29)/</td>
<td>0.011/</td>
<td>0.79 (1.79)</td>
<td>&lt;0.001/</td>
<td>0.22/</td>
<td>1.10 (2.0)</td>
<td>&lt;0.001/</td>
<td>0.01/</td>
</tr>
</tbody>
</table>

*Mann-Whitney U test.

0.2–0.5 = small effect; 0.5–0.8 = moderate effect; >0.8 = large effect. 0 = none of the time – 10 = all of the time

RAPP = Recovery Assessment by Phone Points; SD = standard deviation; SwQoR = Swedish web version of the Quality of Recovery instrument.

For males, a significant difference was seen in four items and in the Global SwQoR score at POD 7, but no significant differences were seen at POD 14 (Table 9). Effect sizes between the RAPP group and the control group in
males and females were considered small (between 0.19 and 0.36 in females and between 0.18 and 0.37 in males).

<table>
<thead>
<tr>
<th>Item</th>
<th>RAPP vs. control group, POD 7 Mean (SD)</th>
<th>P* / Cohen’s effect sizea</th>
<th>RAPP vs. control group, POD 14 Mean (SD)</th>
<th>P* / Cohen’s effect sizea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleeping difficulties</td>
<td>1.25 (2.21)/2.13 (2.70)</td>
<td>&lt;0.001/0.36</td>
<td>0.79 (1.62)/1.32 (2.20)</td>
<td>0.021/0.07</td>
</tr>
<tr>
<td>Not having a general feeling of wellbeing</td>
<td>1.40 (2.07)/2.17 (2.54)</td>
<td>0.002/0.33</td>
<td>0.86 (1.57)/1.29 (1.95)</td>
<td>0.07/0.034</td>
</tr>
<tr>
<td>Pain in the surgical wound</td>
<td>2.78 (2.71)/3.49 (2.89)</td>
<td>0.014/0.25</td>
<td>1.71 (2.34)/2.09 (2.38)</td>
<td>0.034/0.17</td>
</tr>
<tr>
<td>Swollen surgical wound</td>
<td>1.92 (2.63)/2.99 (3.12)</td>
<td>0.001/0.25</td>
<td>1.48 (2.27)/1.75 (2.32)</td>
<td>0.04/0.034</td>
</tr>
<tr>
<td>Global SwQoR score (0–240)</td>
<td>26.54 (27.78)/31.35 (26.52)</td>
<td>0.008/0.18</td>
<td>17.65 (22.45)/19.64 (20.14)</td>
<td>0.04/0.034</td>
</tr>
</tbody>
</table>

*aMann-Whitney U test.

*b0.2–0.5 = small effect; 0.5–0.8 = moderate effect; >0.8 = large effect.

0 = none of the time – 10 = all of the time

RAPP = Recovery Assessment by Phone Points; SD = standard deviation; SwQoR = Swedish web version of the Quality of Recovery instrument.

**Health economic evaluation (Study III)**

Health effects and health care consumption
In both the RAPP group and the control group there was a significant decrease in QoL from the preoperative measure to POD 14 (p<0.00). There were no differences in QoL and gained QALYs between the RAPP group and the control group (p=0.75). The RAPP group had a total of 155 unplanned health care contacts/visits and the control group 140 (p=0.36). There were no significant differences between unplanned health care contacts (i.e. to the ED or 1177 helpline, or primary care contacts) between the groups, except for unplanned outpatient hospital contacts which were significantly higher in the control group (n=54) compared with the RAPP group (n=23), p=0.001. The number of contacts with the outpatient hospital was 59/140 (controls) vs. 31/155 (RAPP group), p=0.001. Regarding contacts via RAPP, this option was not available to the control group. In the RAPP group, the number of persons who initiated contact via RAPP was 54/342 (16%); 39% of the total number of unplanned contacts were via RAPP (61/155) (III).
Costs for health care consumption and RAPP 
The mean cost for health care contacts was estimated. Costs for both the nurse and the physician were included together in the mean cost since it was not specified whether the contact was with a nurse or a physician. The follow-up calls initiated via RAPP had an average estimated duration of 6 minutes and 23 seconds. The length of the follow-up calls was estimated by the nurses who performed the follow-up calls. The estimated mean cost per minute of nurse time was EUR 0.76, including social fees and overheads. The total cost for the intervention was estimated at EUR 18.89 per participant (Table 10). The total cost consisted of the cost for the software (EUR 14.89) as well as costs for handling RAPP (EUR 4.00). For handling the RAPP app, the estimated average time was 7 minutes per participant on app instruction, which included downloading the app and handling data. This gave a mean cost of EUR 5.33 for RAPP handling. Since a substantial part of RAPP handling (e.g. instructing participants in RAPP use) was assumed to be part of the discharge routine, only 75% of the cost for handling the RAPP was used in the analysis (EUR 4.00) (III).

<table>
<thead>
<tr>
<th>Type of cost</th>
<th>Mean cost (EUR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED (physician or nurse)</td>
<td>330.11</td>
</tr>
<tr>
<td>Outpatient hospital (physician or nurse)</td>
<td>194.15</td>
</tr>
<tr>
<td>Primary care (physician or nurse)</td>
<td>128.51</td>
</tr>
<tr>
<td>1177 (24-hour helpline)</td>
<td>12.77</td>
</tr>
<tr>
<td>Follow-up phone call via RAPP</td>
<td>4.75</td>
</tr>
<tr>
<td>Intervention (RAPP)</td>
<td>18.89</td>
</tr>
</tbody>
</table>

ED = emergency department; RAPP = Recovery Assessment by Phone Points.
*KPP (Cost per patient database).
*NordDRG 2016 (Nordic patient classification system based on diagnosis-related groups) weight.
*Using price lists from Region Örebro County, Jönköping County and Dalarna County Council.
*Data obtained from the 1177 helpline in Örebro County and Dalarna County.
*Procured from the accounting departments at Region Örebro County, Region Jönköping County and Dalarna County Council.
*Only the intervention group
*Costs obtained from RAPP AB.

Cost-minimization analysis 
The mean costs for health care consumption by the RAPP group and the control group are presented in Table 11. The CMA showed a probability of 71% that RAPP use is cost-effective (Table 12) and a net saving for the RAPP of EUR 4.77 per participant (Table 11).
Table 11. Results of the cost-minimization analysis (CMA), postoperative day 14

<table>
<thead>
<tr>
<th></th>
<th>RAPP group</th>
<th>Control group</th>
<th>Difference, RAPP group-control group (99% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean health care costs, EUR</td>
<td>37.29</td>
<td>60.96</td>
<td>-23.66 ([-46.57, -0.76])</td>
<td>0.008*</td>
</tr>
<tr>
<td>Intervention costs, EUR</td>
<td>18.89</td>
<td>0</td>
<td>18.89</td>
<td></td>
</tr>
<tr>
<td>Total costs, EUR</td>
<td>56.18</td>
<td>60.96</td>
<td>-4.77 (i.e. a saving)</td>
<td></td>
</tr>
<tr>
<td>NMB 1 QALY = EUR 0</td>
<td></td>
<td></td>
<td>4.77 ([-17.39, 28.37])</td>
<td></td>
</tr>
</tbody>
</table>

* t-test.
CI = confidence interval; NMB = Net Monetary Benefit method; RAPP = Recovery by Assessment Phone Points.

The sensitivity analyses included a low and high cost for RAPP, based on a lower and higher price for the software (EUR 10.64 and EUR 21.27, respectively) and lower and higher costs for managing the RAPP (0.5 * EUR 5.33 = 2.67 and 1 * EUR 5.33 = 5.33, respectively). The results from the sensitivity analysis are given in Table 12.

Table 12. Matrix for sensitivity analyses, net costs/savings (EUR) and probability of cost-effectiveness for different levels of intervention cost and different methods of handling missing data on health care consumption

<table>
<thead>
<tr>
<th></th>
<th>RAPP, low costa</th>
<th>RAPPb</th>
<th>RAPP, high costc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete cases (n=580)</td>
<td>2.91 (36%)</td>
<td>8.50  (16%)</td>
<td>16.21 (2%)</td>
</tr>
<tr>
<td>Missing answers = no contact (n=719)</td>
<td>-10.54 (87%)</td>
<td>-4.77 (71%)</td>
<td>2.94 (36%)</td>
</tr>
<tr>
<td>Stochastic regression imputation for loss to follow-up and missing answers (n=997)</td>
<td>-15.84 (94%)</td>
<td>-10.25 (84%)</td>
<td>-2.53 (59%)</td>
</tr>
</tbody>
</table>

a RAPP (software, EUR 10.64) + 50% management cost (EUR 2.67) = EUR 13.31.
b RAPP (software, EUR 14.89) + 75% management cost (EUR 4.00) = EUR 18.89.
c RAPP (software, EUR 21.27) + 100% management cost (EUR 5.33) = EUR 26.60.
RAPP = Recovery Assessment by Phone Points.

Postoperative recovery when using RAPP (Study IV)
Participants who used RAPP in the postoperative period described their experiences of recovery. The analysis resulted in two themes and six subthemes, which are presented in Table 13:
Give it all you’ve got
Participants described aspects of participation and contribution through their own actions and attitudes that improved their postoperative recovery. They described believing in their own capacity, being prepared and taking action.

**Believing in own capacity**
Participants felt that they had been chosen for day surgery, and that health care trusted in their ability to undergo the surgery and recover at home. This made participants believe in their capability both to undergo day surgery and to handle the postoperative recovery. The confidence they felt contributed to the postoperative period being more positive.

When feelings of insecurity emerged they handled the situation by being positive and encouraging themselves. Being familiar with the health care system made participants feel more secure. Several related that the recovery had not always turned out as they had expected, but participants still felt confident and believed in their own ability. Some said that the unexpected recovery made them feel uncertain about whether they should have had the surgery and that they did not trust themselves or their ability to undergo surgery again.

**Being prepared**
A strategy, pre-surgery, aiming to enhance the recovery in the best possible way was for participants to prepare for their recovery. They considered previous experiences of undergoing surgery and recovery. Those who had no previous experience prepared themselves based on how they thought they

<table>
<thead>
<tr>
<th>Subtheme</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Believing in own capacity</td>
<td>Give it all you’ve got</td>
</tr>
<tr>
<td>Being prepared</td>
<td></td>
</tr>
<tr>
<td>Taking action</td>
<td></td>
</tr>
<tr>
<td>Feeling safe and reassured</td>
<td>The importance of feeling safe and sound</td>
</tr>
<tr>
<td>Not being acknowledged</td>
<td></td>
</tr>
<tr>
<td>Not being left alone</td>
<td></td>
</tr>
</tbody>
</table>
should prepare for recovery. The preparations included psychological, physiological, social and practical preparations as well as active participation in decisions regarding the surgery and anaesthesia. Examples of preparations were: physical training, preparing school work and organizing the support of next of kin. Participants who felt prepared were less worried and anxious during the recovery.

**Taking action**
Participants described their wish to get better, to recover and be able to do things they were unable to do before or after the surgery. They described focusing on the recovery and letting go of other things in their everyday life. They performed self-care activities to handle postoperative symptoms and prevent complications. They said that it was up to them to prepare for, and experience, a positive and good recovery; they did not rely on health care for this. This resulted in positive feelings when the recovery was experienced as successful; however, when it did not proceed as planned and there were complications, participants often blamed themselves for this.

**The importance of feeling safe and sound**
Having support from health care and next of kin was described as important for the recovery process and contributed to a feeling of safety.

**Feeling safe and reassured**
It was important to be treated as an individual and also to be treated professionally. Getting sufficient information and reassurance and being able to discuss worries and symptoms contributed to the feeling of safety. When participants received a follow-up call or visited health care to get answers to questions, have symptoms seen to and confirm that the recovery was proceeding as expected they felt safe and reassured.

Getting in contact with health care was described as troublesome. Participants related that they sometimes did not know whom to approach or where to get assistance with symptoms or answers to their questions. This resulted in hopelessness and feeling unsafe. The RAPP app was described as one solution to these issues as using this new technology enabled an easy way to contact the caregiver. Moreover, RAPP provided the opportunity to report and reflect on postoperative symptoms. It was the possibility to be contacted by a nurse that especially improved postoperative care because it increased the feeling of being safe and not being left alone after the surgery.
The contact with the nurse, initiated via RAPP, provided reassurance and often reduced anxiety and worries because the nurse gave advice, explained symptoms and answered questions. It was even described as a lifeline as, for some, this was the only way to get information and to get questions answered and have support during the postoperative recovery.

**Not being acknowledged**
Participants felt forsaken when they got insufficient information, or experienced insufficient support and lack of acknowledgement. This made them feel abandoned by health care and forced them to cope with symptoms as well as solve issues by themselves. Participants felt frustrated when they thought the information they had received about the surgery and how to handle postoperative recovery was insufficient. This could contribute to more postoperative discomfort such as pain and anxiety. Some expressed disappointment regarding the support that was received via RAPP, for example when they received conflicting advice or were told to “just deal with it”. Others felt that 24 hours was too long to wait for a follow-up call.

**Not being left alone**
It was important for the participants to have support from next of kin. During the recovery they described symptoms related to the anaesthesia and surgery, such as mobility impairment, feeling groggy and dizziness. They expressed that they needed psychological, physical and practical support. Next of kin provided support by giving advice, assisting with food and with hygiene and providing company and a positive atmosphere. Participants relied on the support from next of kin, sometimes more than on support from health care. To recover at home without the support from next of kin was described as difficult, even impossible.

Insufficient support from work negatively affected the recovery. It made participants feel stressed and worried about returning to work. On the other hand, being self-employed was experienced as stressful because there was no-one to help them with the workload and share their worries about the company.
Discussion

This thesis describes the further development and evaluation of, and patient perspectives on, a mobile app follow-up on postoperative recovery after day surgery. In this thesis different methods are used to describe different aspects of the intervention. The RAPP mobile app includes the SwQoR, a questionnaire assessing postoperative recovery, as well as a function to initiate contact with a nurse. The results are discussed under the headings “The SwQoR” and “RAPP and experiences of postoperative recovery”.

The SwQoR (Study I)

The equivalence testing between paper version and the app version of the SwQoR showed good equivalence of results (ICC = 0.89). This finding is consistent with previous studies investigating the ICC for QoR (ICC = 0.86–0.99)\textsuperscript{101, 105, 113}. The results of the equivalence testing are also in line with a review investigating paper vs. electronically administered PRO\textsuperscript{138} and questionnaires in apps compared with other measurements (including paper, laptop and Short Message Service (SMS))\textsuperscript{139}. However, when investigating item-level ratings, ICC was <0.7 for nine of the items. There are several possible reasons for the lower ICC. Firstly, a lower ICC was seen when the items changed from positive to negative and, as a consequence, the “good” and “bad” rating also shifted sides. This was described as confusing by the participants (I). It is possible that some low ICC were due to careless responding, which is when a responder assumes the direction in which to respond to an item based on earlier items. This can be seen in questionnaires with inconsistencies between regular and reversed items. This is also seen when many regular items are followed by reversed items\textsuperscript{140}. In the paper version of the SwQoR it was clearer when items shifted from positive to negative compared with the app version where items appeared one at a time on the screen (I). It has been reported that questionnaires including both positive and negative items have lower internal consistency\textsuperscript{141}; for this reason, including both negatively and positively worded items in the same questionnaire should be done with caution\textsuperscript{142}.

Secondly, some items may have had a low ICC because it was possible with RAPP to answer a question without actively choosing an answer, with the result that the value 5 was reported. This is because every time a new item appeared on the screen the dot on the numeric VAS moved to the default
position at 5. Such accidental false reporting was assumed in the items *diarrhoea* and *feeling constipated*: participants who had reported 0 (zero) in the paper-based version reported 5 in the app version. This is very unlikely “reporting” since both diarrhoea and constipation are a relatively stable measure during a 30-minute assessment (I). To my knowledge, this technical issue has not been reported in any previous studies.

The content validity evaluation resulted in addition of three items, deletion of seven items and four items merged into one item. After the content validity evaluation there were seven positively worded items and 17 negatively worded items in the SwQoR, constituting an imbalance between items\(^{140}\). Furthermore, it was requested by participants in Study I that the items be either uniformly positively or uniformly negatively worded. As the majority of items in the SwQoR were negatively worded, this meant that all items were (re)formulated negatively (I). This included rephrasing of items, but it also meant adding the word “not” for those items that had no antonym\(^{143}\). Use of negatively worded items is supported by a study investigating positively and negatively worded oral health-related QoL (HRQoL) questionnaires\(^{144}\). It was found that the possible response “Don’t know” was more frequent in positively worded items compared with negatively worded ones and therefore the authors recommended using negatively worded items. On the other hand, they suggested that the negative “not” should be avoided in the phrasing of a question because it can be challenging to respond to\(^{144}\).

The equivalence testing showed the importance of evaluating a questionnaire when converting from the paper version to an app version. Even though the questionnaires included the same questions, digital assessment involves technical issues and challenges that may impact reporting (I). This is contradictory to Muehlhausen et al.\(^{138}\) and Coons et al.\(^{95}\). They suggest that PRO instruments converted to ePRO where only minor changes have been made (e.g. asking the same questions with the only difference being one-item-per-screen vs. multiple-item questions in the paper version, as in Study I) do not need to undergo equivalence testing. Their suggestion is based on findings of equivalence between paper PRO and ePRO, reported in the reviews by Muehlhausen\(^{138}\) and Gwaltney et al.\(^{90}\). However, without equivalence testing these technical issues in the app version of the SwQoR would possibly not have been discovered at this early stage (I).
Based on the results from Study I the app was reprogrammed so that an answer had to be chosen before proceeding to the next question. The positively worded items were reformulated as negatively formulated items to enhance answering of the SwQoR and also reduce the risk of falsely reported answers. After Study I was completed the SwQoR consisted of 24 items, all negatively worded, which is the version used in Study II.

RAPP and experiences of postoperative recovery (Studies I–IV)

In this thesis the results from the different studies are confirming, expanding on and complementing each other. All four studies report positive findings regarding the RAPP mobile app. The e-assessed follow-up through RAPP was found feasible and easy to use (I), had a positive effect on postoperative recovery (II), could be cost-effective (III) and was perceived as supportive, enhancing the patient’s feelings of safety and being cared for (IV). The RAPP app, in line with Shaw et al., has three domains in the conceptual model: to assess postoperative recovery with the SwQoR (I), SwQoR data are reported to the day surgery unit (domain 1: health in our hands); further, RAPP enables patients to get in contact with the day surgery unit (I–IV) (domain 2: interacting for health); finally, the data collected via RAPP can be used to improve and individualize postoperative care (II, IV) (domain 3: data enabling health). An eHealth solution including all three domains is suggested to be an impactful eHealth solution since it enables communication as well as interaction and therefore contributes to patient involvement and empowerment. The goals that were initially formulated during the development of RAPP were that RAPP would provide a feeling of being cared for and a sense of empowerment; also, that RAPP would be easy to understand and that it would reduce unnecessary contacts. These goals are supported by the findings in this thesis, except for the last aim, that RAPP would reduce unnecessary contacts. Our findings indicate that day surgery patients are willing to adopt digital technology in postoperative care to assess and improve postoperative recovery. Our participants found that using RAPP was a feasible and acceptable way of assessing postoperative recovery and, further, of enabling contact with the day surgery unit (I). The feasibility of, and positive attitude towards, using a mobile app to assess postoperative recovery after day surgery has also been described by Semple et al., Debono et al. and Stomberg et al. Further, some of our participants said that having to respond to recovery-related questions was a way of reflecting on the recovery and how it changed from day to day (IV). It has been reported elsewhere that e-assessed self-monitoring of recovery,
evaluation of symptoms and focus on emotional wellbeing are helpful after surgery\textsuperscript{47}.

**Feeling safe (Studies II and IV)**
The participants allocated to the RAPP group reported significantly better QoR compared with the control group (II). There is no clear and obvious explanation for this. It has previously been described that eHealth solutions have positive effects on medical outcomes. However, the relationship between eHealth solutions and their effect on outcomes is unclear and needs further research\textsuperscript{146}.

It is possible that the results of Study II can be explained by the findings in Study IV: having the opportunity to initiate contact via RAPP was described as a possible solution to difficulties in getting in contact with health care when at home after a day surgical procedure (I, IV). Having RAPP made participants feel safe and not alone (IV).

Patients have many ways of handling their postoperative recovery when at home after the surgery. They have prepared for their recovery. They believe in their capacity to handle the situation and take responsibility and actions to improve their recovery. However, they still need support and help from health care to manage their situation. When the participants felt unsafe and left alone they experienced this as stressful and as having a negative impact on their recovery (IV). Previous studies have described that insufficient support may negatively affect recovery\textsuperscript{56}. Insufficient support can lead to feelings of loneliness, as well as feelings of being unprepared for the recovery and not knowing whom to contact when in need of support\textsuperscript{38, 41}. Patients have described the need for support from health care during postoperative recovery, as well as lack of confidence to perform self-care\textsuperscript{41, 58} and fear of having missed out on important information\textsuperscript{38}.

**Involving the patient in decision making (Studies II–IV)**
It is possible that the positive effects seen in Studies II and III may have been due to participants feeling more involved in their care because of the daily reporting on how the recovery was proceeding. They may have felt in charge of the process of getting in contact with health care and getting support (IV). A contact considered minor or even unnecessary by health care can be experienced as a major issue by the patient\textsuperscript{35}. In one study it was reported that
patients felt that they needed to have a specific question in order to approach health care, even though they really just needed someone to talk to\textsuperscript{147}. Evaluating the necessity of making a health care contact is not in line with person-centred care. I believe that all contacts are important if the patient experiences that the contact is needed, no matter what the reason. We need to adopt the patient’s perspective when supporting our patients\textsuperscript{48, 49, 148} and involve the patient in the decisions regarding their care. All patients should be treated individually, as their own expert, and as an equal partner\textsuperscript{51}. Hence, it is important that every patient can decide for themselves when and whether they need support and assistance during their postoperative recovery. As previously mentioned, the need for follow-up persists for longer than just the first postoperative days (IV). Patients undergoing day surgery experience different issues and questions at different times during the recovery\textsuperscript{43}. To limit the time of the follow-up call to the first postoperative day as is the most common routine\textsuperscript{15, 59} may be unfeasible. On the first postoperative day, patients have just returned home\textsuperscript{56, 87}; often they describe relief and sometimes even euphoria that the surgery is done and they feel free from pain. After the first postoperative day, patients may experience more symptoms and concerns about pain, swelling and bleeding as well as worries that everything is not as expected. After 3 days postoperatively, patients still report pain and fatigue; they cannot return to normal activities and have questions about mobility and constipation\textsuperscript{43}. Dewar et al. described a telephone follow-up intervention to support patients during the first 3 postoperative days plus an additional follow-up of pain on POD 5. On POD 5, patients still reported pain issues that needed to be addressed\textsuperscript{57}. These findings underline the need for patients to have easy access to health care for several days post-surgery. Dewar et al. also suggest that patients should receive support when they actually need support\textsuperscript{57}.

The reason why the RAPP can be cost-effective is because costs for health care consumption when using RAPP are lower. This is because the costs for initiating contact via RAPP are less expensive compared with other health care contacts. It is possible that being in charge of, and having an easy way of, getting in contact with the caregiver may result in multiple contacts for small issues, but this may possibly prevent later, severe issues. Patients who do not get help and assistance with symptoms and issues may experience these as severe and may possibly seek more expensive health care. Poor aftercare and support\textsuperscript{149}, as well as pain and inability to manage the recovery, can be associated with higher readmissions after surgery\textsuperscript{56} and ED visits\textsuperscript{42}. 
There was a non-significant difference in the number of ED visits between the groups, with a higher proportion of ED visits in the control group. Visits to the ED are the most expensive health care contact, and this consequently also contributed to higher costs in the control group (III). Reasons for the lower number of ED visits in the RAPP group may include that participants knew whom to contact and also that they got help earlier because they had an easy way to initiate contact. In Study IV some participants described that it was hard to get in contact with health care. This was described by participants in the RAPP group and it is probably correct to assume that this problem was present, and worse, in the control group.

A recent national report on how the Swedish Patient Act\textsuperscript{54} has been fulfilled\textsuperscript{151} showed that patients have been less involved in their care since the law was introduced in January 2015. In fact, patients’ experiences of availability, information and participation in health care had decreased. It is suggested in the investigation that digitalization should be used to increase patient involvement in care\textsuperscript{151}, and RAPP may be one solution to promote enhanced compliance with the Swedish Patient Act.

**Satisfaction (Studies II and IV)**

It is possible that the effect on postoperative recovery (II) can be explained by satisfaction. Patients want to be involved in the decision making in their anaesthetic care and shared decision making can improve satisfaction\textsuperscript{53}. Another predictor of satisfaction is how well the patients’ expectations of care are met\textsuperscript{152}; for this reason, the need for individualized care is important in terms of patient satisfaction. It is possible that participants allocated to the RAPP group were more satisfied with their care, not only because of accessibility and availability\textsuperscript{153}, but also because of individualized nursing care\textsuperscript{154–156} – factors that are described as improving satisfaction. It has been reported that QoR has a positive correlation with satisfaction\textsuperscript{157}, yet this result was not confirmed by Berning et al.\textsuperscript{154}.

Another important factor in perioperative care that enhances satisfaction after surgery is information\textsuperscript{152,155}, which is also reported in Study IV. Insufficient information has a negative impact on the recovery process. The RAPP app was found helpful in this respect as it made it possible to get in contact with the day surgery unit and receive the lacking information (IV). Lack of information has been described in several studies\textsuperscript{19,36–38} but seems
to continue to be an unmet problem for many patients undergoing day surgery and therefore needs to be addressed. Since satisfaction was not measured in this thesis we cannot confirm the effect of RAPP use on satisfaction.

**Self-efficacy (Studies II and IV)**

Self-efficacy is a person’s belief in their own ability to handle a certain situation. Self-efficacy has four different sources: *enactive mastery experience, vicarious experience, verbal persuasion* and *psychological and affective states*. The sources of self-efficacy were not used in the analysis in Study IV, but during the analysis it became clear that the findings in Study IV could be seen in terms of the sources of self-efficacy.

When preparing for surgery and handling postoperative recovery, participants used *vicarious experience* if they had not themselves had previous experiences of undergoing day surgery. In other words, they considered their situation and assumed what actions they had to take to enhance their recovery. Those who had earlier experiences of undergoing surgery used those experiences to judge how they could handle the situation and also what actions were needed to influence the recovery in a positive way. This was also related to previous experiences of support from health care and next of kin. Participants who had previously experienced a negative recovery doubted themselves and their ability to undergo surgery again (*enactive mastery experience*). On the other hand, participants felt that health care had faith in them and that they had the ability to handle the postoperative recovery (*verbal persuasion*). Feeling safe and experiencing support from health care staff and/or next of kin during recovery had a positive impact on recovery (*psychological and affective states*). It is possible, in Study II, that the impact on postoperative recovery may be explained by increased self-efficacy when using RAPP during the postoperative recovery. Elsewhere, higher self-efficacy was reported to improve outcomes in chronic diseases and was associated with better postoperative recovery and emotional and functional outcomes after joint surgery. Undergoing day surgery requires self-care and therefore also self-efficacy. It is important that patients believe in their ability to handle the situation of undergoing and recovering after day surgery and that they experience support and safety. Mitchell has described that self-efficacy can be enhanced by interventions that make patients feel safe when they are at home after day surgery. This is supported by studies investigating interventions after inpatient surgery. One intervention provided support by a nurse-led telephone
follow-up on POD 4 and POD 14 after total knee arthroplasty. Results showed a significant increase in self-efficacy in the intervention group compared with standard care\textsuperscript{163}. An increase in self-efficacy has also been described when testing a home communication intervention to enhance support after discharge in patients undergoing coronary artery bypass graft surgery. The intervention assessed symptoms and provided health-related information\textsuperscript{164}. A recent study reported a relationship between perceived support and higher self-efficacy in patients undergoing lung surgery\textsuperscript{165}. It was suggested that patients should receive help, advice and emotional support from both health care and next of kin during the initial postoperative week to enhance self-efficacy\textsuperscript{165}. It is important to note that self-efficacy was not assessed in this thesis so these are conjectures based on theoretical explanations as to the positive effect of RAPP.

**Pre-recovery (Study IV)**

In Study IV it became clear that the conditions for recovery start before the surgery, in a pre-recovery phase. Participants prepared for their surgery and recovery like an athlete prepares for a race. They wanted to recover in the best possible way. They considered barriers and hurdles in their everyday life that would stand in the way of a good recovery. They both used earlier experiences and gave thought to what it would be like to recover at home. Being prepared reduced anxiety and worries in the postoperative period. The importance of preparation before surgery has been described in previous studies\textsuperscript{38, 166, 167}, but without terming it a “pre-recovery phase”. Various studies report that patients undergoing day surgery prepare emotionally and practically for their surgery\textsuperscript{38} and that preparing for surgery is a way of coping in the postoperative period\textsuperscript{166, 167}. Before the surgery many patients are worried about postoperative pain and symptoms\textsuperscript{168} and hence it is important that health care supports the patient in their preparation so that they know what to expect and how to handle postoperative recovery and symptoms\textsuperscript{50, 169, 170}. Day surgery patients who believe that the surgery is minor and that it will not affect them much do not prepare for the surgery\textsuperscript{43}. Therefore, it is so important that health care supports the patients in their pre-recovery phase. Nurse-led preoperative assessment visits are one way to help patients prepare for the recovery and reduce anxiety\textsuperscript{50, 166}.

**Support from next of kin (Study IV)**

Study IV shows that it is not only the support from health care that is important. In our participants, the support from next of kin was important for
how the recovery at home was experienced. Many participants relied on and trusted in the support from their next of kin more than the help from health care. Next of kin provided practical support and contributed with a safe and positive atmosphere in the participants’ everyday life. The importance of support from next of kin has previously been described\textsuperscript{38, 40, 166}. Previous studies have also shown that both patients and next of kin may underestimate the need for help during the postoperative recovery\textsuperscript{42, 43}. At many day surgery units it is recommended that patients have an adult person stay with them for the first 24 hours\textsuperscript{14, 16, 17}, but in many day surgery units it is not mandatory\textsuperscript{15}. Both patients and their next of kin may underestimate the effects of the surgery, so they may not make arrangements for support after the return home\textsuperscript{42, 43}. Therefore, it is important that patients scheduled for day surgery are informed that support from next of kin is important during the recovery. Based on the findings in Study IV, I suggest that it should be mandatory for patients to have an adult stay with them for at least the first 24 hours as our participants experienced this as an important aspect of the recovery.

**Methodological considerations**

**Questionnaires (Studies I–III)**

In all quantitative studies the reliability and validity of the instruments and questionnaires used is important for the interpretation of the results. This thesis includes PRO instruments and questionnaires with several items to capture an unobservable construct and therefore it is important to consider the reliability and validity of the questionnaires. **Reliability** implies the amount of error in a measurement\textsuperscript{115} or as the consistency and dependability of a measurement. **Validity** is a measurements ability to measure what it intends to measure\textsuperscript{171}. The SwQoR questionnaire used in this thesis was evaluated for reliability regarding agreement between the paper and app versions of the SwQoR, as well as internal consistency and content validity. This resulted in a reduction of the items from 31 to 24 in Study I. Parallel with this thesis a psychometric evaluation of the SwQoR used in Study II was performed\textsuperscript{172}. The psychometric evaluation included: acceptability and feasibility, construct validity, discriminant validity, internal consistency, test–retest reliability and responsiveness. Based on the results described by Nilsson et al., and Study I, the SwQoR used in a mobile app can be considered user-friendly, highly valid, responsive and reliable\textsuperscript{172}.
In Study I a follow-up questionnaire was used to evaluate how the participants experienced using a mobile app to assess postoperative recovery. This questionnaire was guided by an earlier study by Ainsworth et al. The questionnaire used in Study I nor the questionnaire used by Ainsworth et al. had undergone validity or reliability testing. Only face validity was performed for the questionnaire used in Study I. It is therefore possible that there are measurement errors, or that the questionnaire is not stable over time and that it does not measure what it is intended to measure. It is also possible that additional questions were needed to capture how participants experienced using the app.

In Study III the SF-6D was used to estimate QALYs. The SF-6D is derived from the SF-36, which is a reliable and valid instrument. Quality-adjusted life years can be measured with different indirect utility instruments such as the EuroQol Five Dimensions (EQ-5D) instrument and SF-6D. In Study III the SF-6D was used based on earlier studies reporting that the SF-6D was found valid in a population undergoing carpal tunnel syndrome and elective colorectal surgery. In the study by Lee et al. the SF-6D was found to be more valid compared to EQ-5D in assessing postoperative recovery after colorectal resection surgery.

**Clinical importance (Study II)**

The effect sizes were small regarding postoperative recovery (II), and minimal clinically important difference (MCID) was not evaluated, so we have no knowledge of the minimal important change in SwQoR score that is beneficial for the patient. Minimal clinically important difference can be estimated using an anchor-based method (using an external criterion) or a distribution-based method (based on statistic characteristics in the sample). A recommended approach for estimating MCID is using an anchor-based method. The MCID has recently been estimated for the QoR scales QoR9, QoR15 and QoR40 where the MICD was reported to be 0.9, 8.0 and 6.3, respectively. In that report, an anchor-based approach was used and included both inpatient surgeries and day surgery. In Study II the mean difference of 7 points between the RAPP group and the control group on POD 7 could be clinically important. However, the mean difference of 2 points between the groups at POD 14 is probably not of clinical importance. This will, however, need to be further evaluated using pre- and postoperative values of the SwQoR. According to Hays and Woolley, MCID should
not be treated as a threshold value, but it should be complemented with a CEA to describe costs related to the gain in MCID.

**Health economic evaluation (Study III)**

There was no difference between the RAPP group and the control group regarding QALYs (III). Quality-adjusted life years were calculated with the SF-6D, which is based on social functioning, physical functioning, role limitation, mental health, vitality, and bodily pain\(^{121,126}\). These are dimensions for which a digital assessment of postoperative recovery might not show an effect. However, the economic analysis was designed so that it was possible to take into account a small difference in QALYs.

In health economic analyses it is recommended that costs per gained QALY should be included, as well as the probability of cost-effectiveness with a given willingness to pay for a QALY. When there is no QALY gain, net savings and probability of net savings are what matters. Probability of cost-effectiveness is important information for decision makers and budget allocation\(^{120}\). In this case, with a 71% probability of cost-effectiveness, RAPP is preferable to no RAPP (III). It has previously been described that follow-up on postoperative recovery after day surgery using a mobile app can be cost-effective\(^ {177}\). This has also been found when using a web-based follow-up after total joint arthroplasty\(^ {178}\). In both of these cited studies the aim was to replace in-person visits; however, this was not the aim in Study III and therefore it is not appropriate to compare the results from these CEAs.

The costs for the RAPP used in this thesis was an estimated cost since RAPP is still not used in general clinical practice. There were uncertainties regarding the costs and therefore this was handled with three different costs in the sensitivity analysis to demonstrate different scenarios when calculating probability of cost-effectiveness. Results from the sensitivity analysis showed that the low cost for RAPP had a high probability of being cost-effective in modified and classic ITT (Table 12). The high costs for RAPP were only found to be cost-effective in the classic ITT analysis (59%). None of the costs for RAPP were cost-effective in the analysis including only complete cases (III). There are few cost-effectiveness studies that consider the costs for an app including PRO data. Costs in the follow-up by Armstrong et al. described above were: Canadian dollar (CAD) 42 (approx. EUR 30.26) for a 30-day assessment\(^ {177}\). In another study, costs were GBP 69 (approx. EUR 81.48) for a 6-month period using an app for self-assessment of
asthma twice daily\textsuperscript{179}. These costs are higher than those described for RAPP, which may indicate that the price for RAPP is too low. However, when dividing costs per day of the assessment period, the costs for RAPP (EUR 1.06/day) are higher than those described by Armstrong et al.\textsuperscript{177} (approx. EUR 1.00/day) and Ryan et al.\textsuperscript{179} (approx. EUR 0.45/day).

Costs for health care contacts were those that were described in price lists, the KPP database and NordDRG. Relying on standard prices is most common in economic analyses. The only health care cost that was calculated for this study was RAPP-related costs. In this study we used patient-reported data regarding health care contacts and therefore we have no knowledge about the severity of the contacts and this is a limitation that may have affected the results of the CEA (III).

**Randomized controlled trials (Studies II and III)**

In Study II, the SwQoR was not measured preoperatively. This is a limitation, since it is possible that there was a difference between the groups preoperatively that may have influenced the outcome. The trial was a RCT and if the randomization was successful it should have provided equal groups\textsuperscript{180}, which seems to be the case judging from participants’ baseline characteristics. However, since the preoperative SwQoR score was not measured this cannot be stated with any certainty. In further studies, SwQoR score should be measured preoperatively.

Bias can affect results and lead to overestimation or underestimation of the effect studied. To avoid selection bias, a randomized controlled design was used\textsuperscript{180, 181} in Studies II and III. When conducting a RCT all participants have an equal chance of being allocated to either group, which prevents systematic differences between the groups. To further avoid selection bias, the procedure was by allocation using sealed envelopes\textsuperscript{181}, meaning that the participants were randomized after consenting to participate in the study. The randomization was performed by using a computer-generated randomization with block randomization and stratification by centre. The stratification was undertaken to ensure that not all participants of one group came from one centre. All centres were slightly different in how they provided postoperative care and this might otherwise have influenced the outcomes of this study.
Ascertainment bias is when results are affected and distorted because of awareness of group allocation. Blinding in a RCT reduces ascertainment bias\textsuperscript{180}. Studies II and III were single-blinded\textsuperscript{181}, with the researchers performing the analysis being blinded to group allocation. Participants and research nurses were not blinded to group allocation owing to the nature of the intervention. Ascertainment bias could occur if a research nurse or staff treated the two groups differently. The research nurse was the only person who informed about the study and was trained by the author of this thesis to treat the groups equally. The staff at the day surgery unit were usually not aware of allocation of the patients to RAPP or control group since the research nurse was the only one handling the study. Further, both groups received the same treatment at discharge including information about postoperative recovery and where to seek help if needed. It is possible that the findings in Study II can be explained by ascertainment bias due to participants’ awareness of group allocation\textsuperscript{180} – in other words, that the control group reported poorer recovery because they knew that they were allocated to the control group and were not receiving the intervention. It is also possible that the RAPP group reported more positive values to favour the intervention. This, on the other hand, would confirm the findings from Studies I and IV, that participants were positive towards using RAPP after day surgery.

Bias because of inappropriate handling of withdrawals, dropouts and protocol violation may result in missing data and wrong interpretation of results\textsuperscript{180}. In Studies II and III there was no protocol violation and an effort was made to reach all participants for follow-up by sending out a reminder to return the questionnaires\textsuperscript{132}. However, 28\% of the participants were lost to follow-up. There were no significant differences regarding baseline characteristics between those lost to follow-up and those that returned their questionnaires. Missing data increase the risk of bias effects of an intervention because the balance between groups resulting from randomization is threatened. In RCTs it is therefore recommended that missing data should be handled with classic or modified ITT analysis. This includes imputing values for missing data\textsuperscript{132}. In Study II, missing data were handled with LVCF\textsuperscript{118} for the RAPP group. Imputations in the RAPP group were made when there was a reported value from the day before (i.e. POD 6 or POD 13). Values from the day before were likely to be as similar as possible to those of POD 7 and POD 14 and did not contribute to overestimation of
effects in the RAPP group. Using LVCF for the control group was not considered possible because of 7-day intervals between the measurements; using POD 7 values on POD 14 would not be advisable because they would differ too much and skew the result in favour of the intervention. The procedure followed was not a classic ITT and therefore still had the potential for imbalance between groups caused by missing data.

In Study III, a modified ITT and classic ITT were used in the sensitivity analysis. The sensitivity analysis included (1) complete cases; (2) imputation for missing data in the returned questionnaires; and (3) classic ITT. As discussed previously in this Discussion, the sensitivity analysis showed conflicting results for the different handling of missing data and costs for RAPP. When including complete cases in the CMA, results were in favour of the control group regarding all the different costs for the RAPP app, while the classic ITT CMA showed that the probability of RAPP being cost-effective was between 59% and 94% for the different costs of RAPP. One reason why the complete case analysis showed conflicting results is that the participants who had missing data in their health care contact questionnaires often were the ones who had had many health care contacts. This resulted in 34% of the health care contacts in the RAPP group and 46% of the contacts in the control group not being included in the complete case analysis. It is recommended that complete case analysis should only be performed when data are missing completely at random (MCAR), otherwise this may bias the results. It is most likely that the missing data regarding health care contacts would be 0=no contact. This is based on the assumption that an unanswered question would indicate no contact rather than a contact.

**Generalizability (Studies I–III)**

Study I was conducted at two day surgery units and included several surgical specialties and patients undergoing general anaesthesia. These allows the results to be generalized to patients undergoing many different types of day surgery, but perhaps not to all anaesthetic techniques.

Studies II and III were conducted at four different day surgery units located in different parts of Sweden, including a university hospital, a county hospital, a district hospital and a private health care setting. Inclusion in the studies was not restricted to specific surgical specialties or anaesthetic techniques. This means that the findings in both Study II and Study III may be generalized to several day surgery settings.
However, Studies I–III were conducted in Sweden and only included day surgery patients with access to a mobile phone, which means that these results cannot be generalized to a population that has no access to mobile phones. There are many smartphone owners in Sweden (81% of the population)\(^67\) and it is most likely that this proportion will increase in the near future. Barriers to using health apps include lack of health app literacy\(^182\) as well as health literacy\(^183\). Other barriers to using eHealth solutions are older age, lower level of education, and lower income level\(^184\). Consequently, these patient groups may not be reached with this kind of e-assessment. Studies I–III included adult patients between 18 and 82 years of age with a median age of 46–52 years. According to Swedish health statistics, the median age of all day surgery patients in Sweden is 55–59 years and 13% of day surgery patients are >79 years of age\(^13\). This implies that the study population in this thesis were slightly younger than the Swedish population undergoing day surgery, especially regarding the age group >79 years. Zhang et al. argue that older age is a barrier to using eHealth solutions as older people may be less likely to own a mobile phone\(^184\). Income level, health literacy and education level were not measured in this thesis so we have no knowledge concerning these aspects. However, it has been reported that sociodemographic factors are becoming less important in the context of using mobile phone health solutions\(^185\) and that older adults are increasingly willing to use mobile apps\(^186\). Furthermore, it has been described that properly designed digital mobile phone solutions were found to be useful in vulnerable (low-income, low health literacy and low-education) populations\(^187\) and older age\(^186\).

**Trustworthiness (Study IV)**

In qualitative research, the parallel to validity and reliability in quantitative research is trustworthiness, which stands for rigour in the research and includes four criteria: *credibility, dependability, confirmability* and *transferability*\(^188\).

*Credibility* considers the truth in the data, the analysis and interpretation of the results\(^171\). In Study IV, data were coded by the author of this thesis and checked by the last author of Study IV; furthermore, the coding and initial findings were confirmed by a third researcher. This increases the credibility of the analyses. Also, triangulation of different methods has been said to increase credibility\(^189\). In this thesis, RAPP was evaluated using quantitative
data (Studies I–III) and further explored using qualitative data (IV). The resultant findings confirmed and complemented each other.

In qualitative research the researcher is the instrument in the data analysis. For this reason, it is important to know the researcher’s knowledge and pre-understanding. Three of the researchers had experience of working with; and four had experience of research in day surgery, postoperative recovery and also doing research related to RAPP. It was therefore important to be reflective about their pre-understanding as this pre-understanding may of course have affected the reported results. The analysis was discussed between the author with no pre-understanding (n=1) and authors with pre-understanding (n=4), which allowed the researchers to be more aware of the pre-understanding.

The interviews were conducted by the author of this thesis who had clinical and theoretical knowledge of postoperative care, day surgery and RAPP use. It is possible that the participants described more positive attitudes towards RAPP because of this. Consequently, it was important to create an environment that encouraged participants to speak freely about their experiences as well as opinions about RAPP.

Confirmability refers to the accuracy of data and to the findings being in line with what the participants said (and not statements produced by the researcher). All interviews were audio-recorded and transcribed verbatim. Throughout the analysis process, all the researchers went back and forth between the different analysis steps to ensure that descriptions from the participants were captured. None of the researchers worked at any of the four day surgery units included in the studies during the data collection. This means that none of the participants had any relationship with any of the researchers.

Dependability refers to data stability and, hence, stability of findings over time. In this study, data were collected over 8 months, meaning that day surgery and day surgical care would be relatively stable during that time period. In the last interviews there was a feeling that no new information was added, and this was also confirmed during the analysis. This suggests data saturation and dependability of the data. Further, some findings were similar to previously reported studies in day surgery patients, as mentioned previously in this thesis.
Finally, *transferability* refers to how the results can be transferred to other settings. The participants were adult day surgery patients who had access to a mobile phone. This means that the results from this study concerning RAPP can probably only be transferred to those having access to a mobile phone. None of the participants reported any difficulties handling the app and this would probably be a bigger issue for those not familiar with the technology. However, since many patients have described the need for more support after day surgery, it can be assumed that day surgery patients generally may benefit from an assessment and follow-up such as provided by RAPP. Further, only patients who had requested contact with a nurse via RAPP were included. This inclusion criterion may have contributed to participants being more positive towards using this kind of digital assessment since they had experienced a need to use it in the postoperative period. At inclusion, maximum variation was strived for regarding participants’ gender, age, type of surgery and general vs. regional anaesthesia. This contributes to the transferability of the results to several different day surgical patients.

**Mixed methods (Studies II–IV)**

Studies II–IV had a mixed method, concurrent embedded design where the qualitative study was embedded in the RCT. The level of interaction between the studies were independent. Quantitative and qualitative data were analysed separately, after both the qualitative and quantitative data collections were completed. Separate analyses were conducted to fully understand the separate results before merging the data. Here, the results are merged in the Discussion. It is hoped that reporting the data together has given a deeper understanding of the RAPP intervention. In mixed methods it is important that both the qualitative and quantitative studies are conducted rigorously and for this reason, qualitative and quantitative methods are discussed separately.

**Clinical implications**

The SwQoR can be used in assessing postoperative recovery in adult persons undergoing day surgery during phase III recovery. The RAPP involves the patient in assessing their recovery and it also allows the patient to initiate contact with the day surgery unit. It can be used to follow up day surgical patients who have access to a mobile phone and allows patients to decide
for themselves when and whether they need support and assistance during their postoperative recovery. It is possible that RAPP can replace routine follow-up calls performed at many day surgery units in Sweden and internationally, and result in patients’ increased involvement in their own care and decision making during postoperative recovery.

The RAPP provides real-time data that can be used by health care to evaluate and improve perioperative care both for the individual patient and for patient groups undergoing the same type of surgery or anaesthesia. Since day surgery is believed to continue to expand and include more advanced surgeries and patients with more co-morbidities it is important to ensure quality and safety for our patients. Assessing postoperative recovery is therefore important.

Patients need to receive sufficient information to be able to manage their recovery at home and decrease feelings of frustration and of being left alone during their recovery. Day surgery patients therefore need to receive information both preoperatively and postoperatively so that they can make necessary preparations for their recovery. The conditions for the recovery start before the surgery, in a pre-recovery phase. Preoperative information, one of these conditions, is important in supporting postoperative recovery. Moreover, patients need to have support from next of kin during their postoperative recovery. The results presented in this thesis and in previous studies imply that it should be mandatory to have someone stay with the patient for the first 24 hours after the surgery and sometimes longer.

**Further studies**

Further studies should establish the MCID for the SwQoR to estimate what is a clinically significant difference in SwQoR score, and to perform a CEA including MCID.

It is likely that the SwQoR may be useful for inpatient surgeries as well. This should be investigated in patients undergoing inpatient surgery. The SwQoR has only been developed and tested in a Swedish-speaking population. In Sweden there are many patients undergoing day surgery who do not understand or speak Swedish. These patients should also be assessed regarding their postoperative recovery and have an easy way of initiating contact with the day surgery unit. Therefore, the SwQoR should be translated and
tested in other languages to ensure safe and equal care to all day surgery patients.

It is important to further support patients to be actively involved in their own care and strengthen their ability to perform self-care. Digital information and recommendations for self-care activities for day surgery patients should therefore be developed in order to further involve patients in their care and increase self-care after a day surgical procedure.

In this study only actual health care contacts were included in the analysis, not other possible follow-up routines. It would be interesting to investigate whether further health economic studies could use modelling including different methods of follow-ups such as RAPP, the mandatory follow-up call and follow-up visits.
Conclusions

- Equivalence was found between the paper and app versions of the SwQoR scale. However, low agreement was found in nine items in the SwQoR. Low agreement was due to technical differences between the two measurement methods and showed the importance of evaluation when converting from paper-based PRO to ePRO.

- The RAPP was found to be feasible and acceptable when used in the postoperative period after day surgery. Patients were positive towards using the app and thought that it was helpful during their postoperative recovery. Especially the function to initiate contact with a nurse at the day surgery unit was important and made patients feel safe.

- The content validity evaluation included the SwQoR plus three new items. Results led to reduction of items, from 34 to 24. The content validity evaluation showed that, compared with patients recovering from day surgery, staff rated more assessment items as relevant in the postoperative recovery.

- Using RAPP to assess postoperative recovery after day surgery and allow patients to initiate contact with the day surgery unit, compared with standard care, had a positive effect on QoR on POD 7 and POD 14. Similar results were seen in males and females when comparing the RAPP group with the control group – however, in males only for POD 7.

- It is suggested that RAPP may be cost-effective due to providing low-cost health care contact. The RAPP does not seem to have any effect on QALY.

- For patients to feel safe and comfortable at home after day surgery, there has to be a balance between the patient’s own capability and contribution, on the one hand, and sufficient information and support from health care and next of kin, on the other. This study highlights that recovery after surgery has a pre-recovery phase, since the process and experience of the recovery starts before the surgery, when patients prepare for surgery and recovery. The RAPP mobile app for assessment of postoperative recovery after day surgery was experienced as a service that improved care and created a feeling of safety – as opposed to a feeling of being left on your own after the surgery.
Svensk sammanfattning (Summary in Swedish)


Quality of Recovery (QoR) är ett instrument där patienten själv skattar sin postoperativa återhämtning. Instrumentet har god validitet och tillförlitlighet, och kan med fördel användas inom klinisk verksamhet och inom forskning. QoR har översatts och anpassats för en svensk population som genomgått en dagkirurgisk operation. Den svenska webb-versionen av QoR (SwQoR) har programmerats och anpassats till en smartphone applikation (app) under namnet Recovery Assessment by Phone Points (RAPP). I SwQoR besvarar patienten ett antal frågor om i vilken utsträckning de haft olika symptom det senaste dygnet på en numerisk visuell analog skala (VAS) där 0=inte alls och 10=hela tiden. Eftersom patienter har beskrivit att de upplever att det är svårt att veta var och till vem de ska vända sig efter dagkirurgisk operation så lades en fråga till i RAPP: Vill du bli kontaktad
av en sjuksköterska? Detta för att underlätta för patienter att komma i kontakt med den dagkirurgiska enheten efter sin operation.

År 2016 beslutade Regeringen och Sveriges Kommuner och Landsting om en e-hälsovision. Målet med denna vision är att år 2025 ska Sverige vara världsledande i användande av digitala hjälpmedel för att främja hälsa; arbetet att utveckla RAPP ligger helt i linje med denna vision. Då RAPP är en nyutvecklad e-hälso-lösning för att systematiskt följa upp dagkirurgiskt opererade patienter bör olika forskningsmetoder används för att ge en djupare förståelse av hur det är att använda denna typ av uppföljning.

Övergripande syfte
Det övergripande syftet med avhandlingen är att vidareutveckla, testa och utvärdera en eHälso-lösning för uppföljning av den postoperativa återhämtningen efter dagkirurgi samt att beskriva erfarenheter av postoperativ återhämtning efter dagkirurgi hos dem som använder en smartphoneapp för att följa upp postoperativa återhämtning.

Delstudie I
I delstudie I undersöktes överensstämmelsen mellan app- och pappersversioner av SwQoR, användbarheten av att använda en app för att följa upp postoperativ återhämtning samt innehållsvaliditeten för SwQoR. Resultatet visade att svaren mellan app och pappersversion överensstämde men att tekniska justeringar krävdes för att öka överensstämmelsen och användbarheten. Exempel på dessa var daglig påminnelse att besvara SwQoR samt möjlighet att backa och justera föregående frågor. Vidare att ett värde på den numeriska VAS-skalan var tvunget att väljas innan nästa fråga kunde besvaras, samt omformulering av de frågor som var positiva utsagor (ex sova gott) till negativa (ex sömnsvårigheter) så att svaren på samtliga frågor fortsättningsvis hade samma riktning. Dagkirurgiskt opererade patienter var mycket positiva till denna typ av uppföljning. Framför allt uppskattades möjligheten att kunna initiera kontakt med en sjuksköterska via appen. Utvärdering av innehållsvaliditeten ledde till att frågorna i SwQoR reducerades från 31 till 24 frågor. De föreslagna justeringarna genomfördes innan delstudie II-IV påbörjades.
Delstudie II och III
Delstudie II och III presenterar resultat från en randomiserad kontrollerad studie som genomfördes vid fyra dagkirurgiska enheter i Sverige med 997 deltagare. Syftet var att undersöka om RAPP hade någon påverkan på den postoperativa återhämtningen samt om det fanns några hälsoekonomiska effekter av RAPP. Deltagarna randomiserades (lottades) till att antingen använda RAPP dagligen under 14 dagar eller till en kontrollgrupp som fick den vård som var rutin på den enhet där de genomgått operationen. RAPP-gruppen rapporterade signifikant bättre postoperativ återhämtning jämfört med kontrollgruppen både dag 7 och 14 efter operationen. Postoperativ dag 7 rapporterade RAPP-gruppen bättre återhämtning i sju av 24 symtom/besvär: sömnsvårigheter, saknat en känsla av allmänt välbefinnande, svårt att känna mig avslappnad, yrsel, huvudvärk, sårsmärta och svullet operationssår (delstudie II).
RAPP-gruppen sökte mindre dyr vård vilket innebar en lägre kostnad för hälso- och sjukvårds konsumtion även då kostnaden för interventionen räknades med. RAPP tycks därmed vara kostnadseffektiv men det fanns ingen skillnad i livskvalitet mellan grupperna (delstudie III).

Delstudie IV
Delstudie IV var en kvalitativ intervjustudie med 18 informanter som genomgått dagkirurgisk operation och som deltagit i RAPP-gruppen i delstudie II-III. Syftet var att undersöka hur deltagare som använde RAPP efter sin operation upplevde sin postoperativa återhämtning. Intervjuerna genomfördes utifrån en semistrukturerad intervjuguide och intervjuerna analyserades med tematisk analys. Resultatet visade att återhämtningen påverkas av informanternas förmåga att tro på sig självt, förbereda sig, vidta åtgärder så som egenvård och ta ansvar för sin egen återhämtning. Återhämtningen börjar redan i en pre-återhämtningsfas eftersom hur de som ska opereras förbereder sig inverkar på återhämtningen. Informanterna beskrev ett behov av stöd från hälso- och sjukvården och anhöriga för att få en så bra postoperativ återhämtning som möjligt och för att känna sig trygga. Stöd innebar att få tillräcklig information för att klara sin återhämtning självständigt, men också att få professionellt stöd när behov uppstod. Informanterna ansåg att RAPP var ett sätt att bidra till detta stöd och gjorde att de kände sig mer trygga och mindre ensamma.
Tack (Acknowledgement)

Det första jag slås av när denna del av avhandlingen ska skrivas är den stora tacksamhet jag känner inför alla som hjälpt till eller peppat på något sätt under min forskarutbildning. Det finns några som jag vill rikta ett särskilt tack till:

Stort tack till Örebro universitet och Fakultetsnämnden för medicin och hälsa för att jag fått möjligheten att genomgå min forskarutbildning.


Maria Jaensson, min bihandledare. Du har generöst delat med dig av din tid och kunskap. Du finns alltid där och svarar så klokt på alla mina frågor. Vi har delat så många spännande diskussioner och fina pratstunder, du är verklig en förbild som forskare och medmänniska.

Mats Eriksson, min bihandledare. Du är en klippa, du finns där när det gäller och kommer alltid med uppmuntrande ord och stöd. Du ställer kluiga frågor som utmanar och utvecklar. Din outtröttliga entusiasm för forskningen och att sprida den över världen är så inspirerande!

Mina medförfattare Sigrid Odencrants, Lars Hagberg, Maria Hälleberg-Nyman och Anna Philipsson. Det har varit otroligt lärorikt att arbeta tillsammans med er. Er input och ert stöd har varit ovärderligt för mig. Jag har lärt mig så mycket och vill lära mig ännu mer!

Institutionen för hälsosvetenskaper och alla på enheten för omvårdnad. Jag har alltid känt mig så välkommen och inkluderad trots att jag till största delen av min tid varit ”bara” doktorand.

Operationsservice, AnIVA kliniken USÖ, Christina Hedenskog och Ulla Ward, ni har alltid stöttat mig och kommit med stöttande ord och hejarop. Kollegorna på Operationsservice, ni är så topp! Trots att jag känner mig
lika ringrostig varje gång och ställer tusen frågor om nya rutiner så är ni så fantastiska och det är så roligt att arbeta med er!

Stort tack till de enheter som lätit mig få komma och bedriva mina studier hos er: Dagkirurgiska mottagningen och Kirurgkliniken, Mora lasarett; Capio Låkargruppen; Dagkirurgiska enheten, Universitetssjukhuset Örebro samt Dagkirurgen, Länssjukhuset Ryhov. Och stort tack till Annelie Nilsson, Anna Tomvik, Maria Ståhlkrantz och Michaela Breistrand, de forskningssköterskor som hjälpt till med datainsamling i studie II och III.


Fredrik, doktorand, rumskamrat och även tabellexpert. Vi har suttit framför var sin skärm med matlådor, dålig hållning och diskuterat allt från studiedesign till träning.

Nethouse, tack för gott samarbete.


Familj, släkt och vänner som bjuder på glädje i alla dess former genom skratt, fika, poolbad, bullar, lunchdejter, melloquiz, bubbel, skogspromenader, restaurangbesök och andra pensionärsaktiviteter. Mamma och pappa, ni har alltid funnits och stöttat i stort och smått, (även ryckit in som fotomodell när det behövts). Framför allt har ni gett mig det finaste man kan få: min syster. Nandi du är så otroligt värdefull för mig. Snart är det även din tur att ta din doktorsexamen.

Sist men absolut inte minst, den största kärleken! Min fina familj. Tack för att ni tar ner mig på jorden och ser till att jag får fokusera på de viktiga sakerna i livet så som pussar, kramar, tvätt, vad vi ska äta till middag och allt annat roligt som livet bjuder på. Matthias, min ungdomskärlek, du har alltid stöttat mig oavsett. Marius och Iris ni är så kloka och nyfikna och gör mig så stolt för att ni är de fantastiska personerna ni är.
References

41. Mottram A. 'They are marvellous with you whilst you are in but the aftercare is rubbish': a grounded theory study of patients' and their carers' experiences after discharge following day surgery. J Clin Nurs. 2011;20:3143-51.
46. Rosén HI, Bergh IH, Oden A, Martensson LB. Patients experiences of pain following day surgery - at 48 hours, seven days and three months. Open Nurs J. 2011;5:52-9.


49. Cutcliffe JR, McKenna HP. The essential concepts of nursing: building blocks for practice; Elsevier Health Sciences; 2005.


86 KARUNA DAHLBERG e-Assessed follow-up of postoperative recovery


141. Solis Salazar M. The dilemma of combining positive and negative items in scales. Psicothema. 2015;27.


Prospective Psychometric Evaluation Study. JMIR mHealth uHealth. 2017;5:e188.


35. Söderqvist, Fredrik (2009). Health symptoms and potential effects on the blood-brain and blood-cerebrospinal fluid barriers associated with use of wireless telephones.


41. Gustafsson, Sanna Aila (2010). The importance of being thin – Perceived expectations from self and others and the effect on self-evaluation in girls with disordered eating.

42. Johansson, Bengt (2010). Long-term outcome research on PDR brachytherapy with focus on breast, base of tongue and lip cancer.

43. Tina, Elisabet (2010). Biological markers in breast cancer and acute leukaemia with focus on drug resistance.


46. de Leon, Alex (2010). Effects of Anesthesia on Esophageal Sphincters in Obese Patients.


52. Loiske, Karin (2011). Echocardiographic measurements of the heart. With focus on the right ventricle.


64. Nordin Olsson, Inger (2012). *Rational drug treatment in the elderly: "To treat or not to treat".*


67. Thuresson, Marie (2012). *The Initial Phase of an Acute Coronary Syndrome. Symptoms, patients’ response to symptoms and opportunity to reduce time to seek care and to increase ambulance use.*


75. Gustavsson, Anders (2012): *Therapy in Inflammatory Bowel Disease.*
83. Lönn, Johanna (2013): The role of periodontitis and hepatocyte growth factor in systemic inflammation.


96. Sundh, Josefin (2013): Quality of life, mortality and exacerbations in COPD.


98. Palmetun Ekbäck, Maria (2013): Hirsutism and Quality of Life with Aspects on Social Support, Anxiety and Depression.


102. Söderström, Ulf (2014): Type 1 diabetes in children with non-Swedish background – epidemiology and clinical outcome

103. Wilhelmsson Göstas, Mona (2014): Psychotherapy patients in mental health care: Attachment styles, interpersonal problems and therapy experiences


109. Törös, Bianca (2014): Genome-based characterization of Neisseria meningitidis with focus on the emergent serogroup Y disease


120. Pelto-Piri, Veikko (2015): Ethical considerations in psychiatric inpatient care. The ethical landscape in everyday practice as described by staff.


140. Östlund Lagerström, Lina (2016): ”The gut matters” - an interdisciplinary approach to health and gut function in older adults.


157. Olsson, Emma (2017): Promoting Health in Premature Infants – with special focus on skin-to-skin contact and development of valid pain assessment.


177. Christos Karefylakis (2018): Vitamin D and its role in obesity and other associated conditions.


