SUMMARY

Hospital stay after abdominal surgery has been reduced significantly during the past decades as a result of the use of minimally invasive surgery. As a consequence, the period of in-hospital postoperative care has been reduced accordingly and the greater part of the recovery process takes place at home. This means that the amount of postoperative care received by patients these days has also been reduced. It has been demonstrated previously that high quality patient counseling improves postoperative recovery. It is therefore not surprising that literature shows that recovery after minimal invasive surgery takes much longer than what was originally expected from a medical perspective. In this thesis we have developed and evaluated a perioperative eHealth program which offers patients personalized care during the perioperative period and aims to improve return to normal activities after various forms of abdominal surgical procedures.

Chapter 1 provides a general introduction on this topic and an outline of this thesis. The following research questions were formulated in this chapter:
1. Is there a need for eHealth in perioperative care?
2. What should the optimal eHealth intervention to improve return to normal activities after abdominal surgery focus on?
3. How can the effect of an eHealth intervention in terms of return to normal activities after abdominal surgery be measured?
4. What are the effects of the eHealth intervention in terms of recovery, use and costs?

Research question 1 and 2 are answered in part 1 of this thesis, question3 in part 2 and question 4 in part 3.

Part 1: Development of a perioperative eHealth intervention
The chapters in this part of the thesis are all focused on the development of a perioperative eHealth intervention and aim to answer research question 1 and 2.

To develop the optimal perioperative eHealth intervention, first all the available evidence regarding this topic was reviewed. **Chapter 2** presents the results of this systematic review. 27 studies were included with a large diversity in type of patients, interventions and outcome measures. Only two studies were performed in patients undergoing abdominal surgery. 25 studies (92.6%) reported at least an equal (n=8) or positive effect (n=17) of the eHealth intervention compared to usual care. We concluded that eHealth interventions can improve clinical patient outcomes for patients who have undergone various forms of surgery. There was however, a lack of good quality (cost)-effectiveness studies, with only a limited proportion of studies reporting on compliance with the intervention or the occurrence of adverse events. This, in combination with the overall positive results, justified undertaking a randomized controlled trial (RCT), taking these considerations into account.

In **Chapter 3**, the shortcomings in perioperative care were investigated from a patient perspective, as well as how eHealth could be of assistance in this. Patients who underwent various forms of abdominal surgery in a one-year period were invited to complete a questionnaire about this topic. In total 207 participants (57.2%) completed the questionnaire. Although most participants reported that they had received some basic information about the surgical procedure and the recovery process, more than half of the participants searched the internet for additional information. Most reported shortcomings included the absence of detailed information about the resumption of (work) activities as well as the inconsistency between advice received by different healthcare professionals involved in the recovery process. Women had a slightly higher need for additional information and support than men. A majority (78%) of the participants expected an e-health program to be helpful during the recovery process. A website was assessed as most useful, followed by a mobile phone application. In particular practical functions focusing on the preparation for surgery and monitoring after surgery were expected to be valuable. The majority of patients opposed the option to

replace the standard postoperative consult by an eConsult, since they preferred a personal contact with their surgeon.

Chapter 4 describes the role of healthcare providers in the development of the eHealth intervention. A panel of 13 experts consisting of surgeons, occupational physicians and general practitioners participated in a modified Delphi study. In this study, multidisciplinary convalescence recommendations were developed for the graded resumption of 34 activities after uncomplicated laparoscopic cholecystectomy, laparoscopic and open appendectomy, laparoscopic and open colectomy and laparoscopic and open inguinal hernia repair. After four Delphi rounds, consensus was reached for all of the 34 activities. A sample of occupational physicians, general practitioners and surgeons regarded the recommendations as feasible in daily practice. These convalescence recommendations were incorporated in the eHealth intervention and further evaluated in the RCT (chapter 8).

Part 2: Development of a study to evaluate a perioperative eHealth intervention

This part of the thesis is focused on the development of a study to evaluate the intervention which was developed in part 1 of this thesis. The chapters in this part aim to answer research question 3.

Considering the fact that the eHealth intervention aimed to improve recovery after surgery, the effect of the intervention was planned to be measured in terms of return to normal activities. However, most measuring instruments focusing on return to normal activities are very generic and not sensitive to measure relevant changes from a patient perspective in post-operative function. It was therefore necessary that new measuring instruments were evaluated which have the potential to measure the outcome in an objective or personalized way and which were are sensitive enough to measure patient relevant outcomes. For this reason, an observational pilot study was performed in which several measurement instruments to assess postoperative recovery were evaluated in a small sample (n=30) of patients undergoing laparoscopic abdominal surgery (laparoscopic hysterectomy, laparoscopic adnexal surgery, laparoscopic cholecystectomy and laparoscopic inguinal hernia repair).

Chapter 5 describes the results regarding the feasibility of an accelerometer to measure postoperative recovery. Participants (n=30) were instructed to wear an Actigraph wGT3X-BT accelerometer one week before surgery (baseline) and during the first, third and fifth week after surgery. Five patients were excluded from analyses because of technical problems with the accelerometer (n=1) and protocol non-adherence (n=4). The different activity intensity levels and step count showed a clear recovery curve after surgery. Wearing the accelerometer was well tolerated and not regarded as being burdensome by the patients. Although this study showed that it was possible to measure postoperative recovery by an accelerometer, the clinical application remained controversial because of the fact that using this accelerometer was relatively time consuming and expensive.

Chapter 6 describes the results of the pilot study with regard to the PROMIS physical function (PROMIS-PF) and PROMIS Ability to Participate in Social Roles and Activities (PROMIS-APS) item bank as measuring instruments for recovery. Of this item banks 4-10 items could be selected to conduct (personalized) short-forms. The construct validity and responsiveness of the two PROMIS short forms were evaluated by testing pre-defined hypotheses and were considered adequate when at least 75% of the data was in accordance with the hypotheses. The construct validity and the responsiveness of the PROMIS-PF for measuring recovery in abdominal surgery were confirmed (85.7% of the hypotheses were confirmed) but this was not approved for the PROMIS-APS. Considering the major advantages of PROMIS, we recommend using PROMIS instruments in future studies.

In **chapter 7** the study protocol for the evaluation of the eHealth intervention developed in part 1 of this thesis, is described. The study design was a multicentre randomized, single blinded, controlled trial. Patients between 18 and 75 years old who were on the waiting list for a laparoscopic cholecystectomy, inguinal

hernia surgery or laparoscopic adnexal surgery for a benign indication were assessed for eligibility. The power calculation showed that at least 308 participants had to be included. Patients were randomized to an intervention or a control group. The intervention group would get access to the perioperative eHealth intervention developed in part 1, consisting of a website, mobile phone application (app) and an activity tracker. The intervention aims to improve patient self-management and empowerment by providing guidance to patients in the weeks before and after surgery. The control group was provided with usual care and access to a non-intervention (standard) website, consisting of the digital information brochure about the surgical procedure which will be performed. The primary outcome measure was time to return to normal activities. This was measured by a personalized PROM based on the PROMIS physical functioning item of which the construct validity and responsiveness was approved in chapter 6. bank v 1.2. Participants could select before surgery eight activities which were applicable to them in daily life, while after surgery they were asked whether or not they had already resumed these activities. The time between surgery and the date on which the last activity was resumed was defined as the time to return to normal activities. Secondary outcomes included social participation, self-rated health, duration of return to work, physical activity, length of recovery, pain intensity and patient satisfaction. In addition, an economic evaluation alongside this randomized controlled trial was conducted from the societal and healthcare perspective.

Part 3: Evaluation of a perioperative eHealth intervention
In this part, the eHealth intervention developed in part one was evaluated in the randomized controlled trial (RCT) which was conducted in part 2.

Chapter 8 describes the clinical effects on the recovery process of the eHealth intervention. 344 participants were included and randomized to the intervention (n=173) or the control group (n=171). 14 participants (4.1%) were lost to follow-up, resulting in 330 participants included in the primary outcome analysis. The median time until return to normal activities was 21 days in the intervention group and 26 days in the control group (hazard ratio 1.38, 95% CI 1.09 – 1.73; p=0.007). Complication rates did not differ between groups. The social participation scores and physical function scores were significantly higher during the follow-up period in the intervention group compared with the control group. We concluded that using this eHealth intervention after abdominal surgery, resulted in a quicker return to normal activities, compared with the usual care.

In **chapter 9** the results regarding the cost-effectiveness of the eHealth intervention are presented. Total costs were higher in the intervention group than in the control group, but this difference was not statistically significant (€168, 95%CI -775-1129). The incremental cost-effectiveness ratio (ICER) for return to normal activities was 22, indicating that each day that normal activities were resumed earlier in the intervention group was associated with an extra €13 compared with the control group. The probability of the intervention being cost-effective compared with usual care was 0.38 at a willingness to pay (WTP) of €0/day earlier return to normal activities. This probability increased to 0.97 when the WTP was € 100/day. As it was unknown how much decision-makers are willing to pay for each day that normal activities were resumed earlier, strong conclusions about the intervention's cost-effectiveness in terms of this outcome were not drawn. The cost-utility analysis showed that the intervention was not cost-effective for QALYs.

In **chapter 10** the results of the process evaluation which was performed alongside the RCT are presented. This showed that the implementation scores of the different functions of the intervention ranged between 60% and 65%. The website, mobile phone application and activity tracker were rated 7.3-7.6 on a scale from 1-10. Almost all participants who were interviewed about the eConsult function rated it as being of additional value if combined with the usual care, but not as a replacement for usual care.

Finally, **chapter 11** concludes with a general discussion. The main findings of this thesis were summarized and research questions were answered. Further, methodologic considerations of the different studies were

discussed and in an appendix the implementation process was discussed and a protocol for future research was described.

The answers to the research questions were as follows:

1. Is there a need for eHealth in perioperative care?

- EHealth may have a positive effect on several aspects in postoperative care
- There is a need for eHealth in perioperative care in abdominal surgery from a patient perspective

2. What should the optimal eHealth intervention to improve return to normal activities after abdominal surgery focus on?

A perioperative eHealth intervention in abdominal surgery should:

- Focus on the resumption of (work) activities after surgery, multidisciplinary convalescence recommendations were developed for this purpose
- Focus on preparing before and monitoring after surgery
- Not include eConsultations with the aim to replace standard care, however using eConsultations as an extra can be useful

3. How can the effect of an eHealth intervention in terms of return to normal activities after abdominal surgery be measured?

- An accelerometer is a feasible way to measure postoperative recovery, but turns out to be time consuming
- The PROMIS-PF and PROMIS-APS can be used for this purpose and have the advantage that they can be personalized. Only the construct validity and responsiveness of the PROMIS-PF short form has been proved in abdominal surgery and thus we recommend using the (personalized) PROMIS-PF short form to measure return to normal activities after surgery

4. What are the effects of the eHealth intervention in terms of recovery, use and costs?

- Patients who used the eHealth intervention returned to normal activities five days earlier than participants who received usual care
- Costs were higher in the intervention group, but this difference was not significant
- Although participants were overall satisfied with the intervention, the implementation scores of the different functions of the intervention were fair.

Based on this, we have concluded that, in view of the need for eHealth from a patient perspective and the proven effectivity with regard to return to normal activities after surgery, this personalized eHealth program should be considered for implementation in standard perioperative care. Future research will focus on the barriers for implementation. Based on the results of this an implementation strategy can be chosen.