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Objectively measured mobilisation is enhanced by a new behaviour support tool in patients undergoing abdominal cancer surgery

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ABSTRACT

Introduction: Mobilisation reduces the risk of complications after abdominal surgery. Despite that, patients spend most of their time immobilised during hospital stay. Hence, the aim of this study was to evaluate a tool called the Activity board, which includes behaviour change techniques, regarding effects on mobilisation and postoperative recovery after abdominal cancer surgery.
Material and methods: Patients who were planned for abdominal surgery due to colorectal, ovarian or urinary bladder cancer, and at least three postoperative days at Karolinska University Hospital were included in this non-randomised controlled trial, from January 2017 to May 2018. The patients were allocated to Activity board or standard treatment when they were admitted to hospital. Mobilisation was evaluated objectively with activity monitor the first three postoperative days, and postoperative recovery was assessed continuously during hospital stay.
Results: In total, 133 patients, mean (sd) age 68.1 (12.3) years were included. The patients with the Activity board had postoperatively higher levels of mobilisation, compared to standard treatment, as mean value over the first three days, steps, median (min-max) 1057 (3–10433) and 360 (0–6546), respectively ($p = 0.001$), and for each day separately. Further, the group with the Activity board had a shorter length of stay, 6 (3–13), compared to standard treatment 7 (3–14) ($p = 0.027$).
Conclusion: The Activity board is an effective tool to enhance mobilisation after abdominal surgery due to cancer, in hospital settings. Using the Activity board could lead to improved postoperative recovery.

Introduction

To minimise postoperative complications after surgery is an important part of hospital care. Early mobilisation is thought to be one of the key factors to succeed [1]. Today the standard treatment of solid cancer tumours is surgery, often in combination with chemo- and/or radiotherapy [2]. Patients diagnosed with cancer are often suffering from symptoms such as malnutrition, decreased physical function, or pain, which increase the risk of suboptimal healing post surgery [3]. Consequently, the risk of complications such as ileus, pneumonia or deep venous thrombosis is significant after major abdominal cancer surgery [3–5]. Early mobilisation such as sitting, standing and walking after surgery decreases the risk of complications and a long hospital stay [6,7]. This emphasises the importance of mobilisation during the first postoperative days. A prolonged hospital stay due to complications does not only affect the individual person but also carries a cost to society.

The patients' knowledge of their own care during a hospital stay is poor [8]. Furthermore, their knowledge of the importance of mobilisation is unknown. A systematic review showed that people who were treated in hospital for acute conditions were active 1–6%

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of the time they spent in hospital [9]. The low level of upright mobilisation is also shown after upper abdominal surgery, where patients spent only 3 min upright on the first postoperative day [10]. Considering elective abdominal surgery, most postoperative fast track protocols originate from ERAS (Enhanced Recovery After Surgery) protocol. The ERAS protocol concludes that patients should ambulate three times per day and be out of bed for 8 h from the first day after surgery [11]. However, mobilisation according to ERAS protocols has not been evaluated objectively, which is why the patients' level of mobilisation is unknown [12]. Consequently, the level of mobilisation that is feasible and effective for patients is also unknown. To increase physical activity, the use of behaviour change techniques such as goal-setting, self-monitoring, instant feedback and reward have shown to be promising [13,14]. Examples could be to use a pedometer or a smart phone application. However, patients in hospital are often deconditioned and elderly, and thus pedometers and apps could be too difficult for them to manage. Hence, there is a need for feasible and clinically relevant tools to support mobilisation, in hospital settings.

The Activity board is a tool based on techniques to support behaviour change [13,14]. It was originally developed to help inform patients who had thoracic surgery, and the medical staff, of the daily prescribed mobilisation. As far as we know, the Activity board has not yet been evaluated, which is why the aim of this study was to evaluate the Activity board as a standardised method to enhance mobilisation and postoperative recovery after abdominal surgery due to cancer.

Methods

Study design

This non-randomised controlled trial was conducted at Karolinska University Hospital in Stockholm. The study was approved by the local Medical Ethical Committee, with registration numbers 2012/2214–31/4 and 2016/484–32. The reporting is guided when relevant by the CONSORT extension for non-pharmacological treatments.

Population

Patients who were planned for abdominal surgery due to colorectal cancer, urinary bladder cancer, or suspicion of ovarian cancer, and who were 18 years or older were invited to participate in the study. Patients with colorectal or urinary bladder cancer received treatment according to modified ERAS protocols. The enrolment of patients took place between 1 January 2017 and 1 May 2018. After a decision on surgery had been taken, a registered nurse gave the patients written information about the study at a preoperative meeting. By a phone call, the patients also received oral information from a physiotherapist connected to the study. The day before surgery, the patients gave written consent to participate in the study.

Inclusion criteria were: expected time at hospital of at least three days; open or robotic assisted laparoscopic abdominal surgery; ability to walk and also to understand and talk Swedish. When it was not possible to use the Activity board, or when it had no possibility to impact on patient care due to postoperative events, patients were excluded from the study. Consequently, the exclusion criteria were preoperatively: neurological disorder; impaired cognition; pacemaker; palliative surgery. Furthermore, postoperative exclusion criteria were: restrictions on sitting; extended stay at the postoperative or intensive care unit, or at a ward that was not included in the study; length of stay of more than 14 days; or no activity monitor attached to patient.

Power was calculated based on one previous study and pilot data during study planning [10]. With a difference of 30 min time upright, estimated as clinically relevant, between the groups and a standard deviation of 60 min, at least 63 patients per group were required at 80% power, to detect a difference in a two-sided test, at a 5% level of significance.

Procedure

Standard treatment

All patients received preoperative information of the importance of early mobilisation after surgery and were often mobilised at the postoperative care unit and then further on the ward. They all received individual evidence based physiotherapy, including mainly mobilisation and breathing exercises, until discharge from the hospital.

The Activity board

The Activity board (Ming-it, Sweden), is a whiteboard that hangs on the wall close to the patient's bed. The board has different signs for various types of exercises and red/green magnets for goal to achieve and goal achieved, respectively (Fig. 1). Daily, the physiotherapist and the patient set goals on mobilisation, agreeing on the frequency and distance of the walks the patient should take, the frequency of sitting on the bedside or in a chair, and also the frequency of breathing exercises. After every goal is achieved, the patient turns a magnet from red to green, receiving instant feedback. In this way, due to self-monitoring, it is clear to the patient what has been done and what is left to do during the day. If all goals are achieved for one day, the patient gets a gold star as a reward. The treatment for the Activity board group included standard treatment plus the Activity board.

Care providers

Four physiotherapists who had worked within the acute postoperative setting between one and twelve years, and usually worked at the three hospital wards took part in the study. They received specific introduction and training before the study started with the aim to standardise how to work with the Activity board and combine it with individualised physiotherapy treatment. The physiotherapists were instructed to add the Activity board, or not, to their usual work. That the Activity board was introduced by the physiotherapist to the patient was noticed in the protocol. The adherence to individual daily goal-setting together with the patient

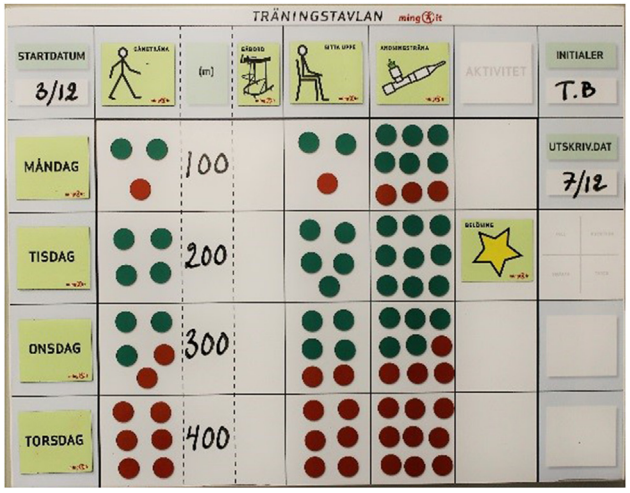

Fig. 1. The Activity board (Ming-It, Sweden)

was not assessed.

Allocation

With the purpose to strive for similarities with a randomised controlled trial, the two methods on the wards were alternated, one month at a time. In that way, the patients were randomly allocated due to the date they were admitted for surgery.

Assessments

Mobilisation – activity monitor

The validated activity monitor activPAL3 micro (PAL Technologies Ltd, Glasgow, UK), was used to measure mobilisation on the ward after surgery [15,16]. ActivPAL is a small device which, attached to the thigh, provides information based on position and acceleration of the body. The information is then transferred to body posture, transition between postures, stepping and stepping speed, and presented as different variables of mobilisation. The variables are: time spent sitting/lying, standing, stepping; numbers of step counts; and sit to stand transitions. A higher value of each mobilisation variable indicates a higher level of the patients' mobilisation. The Activity monitor is attached to the midline anterior part of the thigh with a dressing and does not provide feedback to the patient on mobilisation.

Since there was a need to separate time between sitting and lying, the patients had one activity monitor on the middle of the thigh and one caudal of the collarbone. Each monitor had written instructions and was attached with a dressing by a nurse or physiotherapist as soon as possible after surgery. Earlier studies have shown that the activPAL indicates standing instead of sitting/lying at elevation of 20° [17]. When attaching the monitor caudal of the collarbone, data indicate standing posture when the activPAL is elevated 20°. However, when the activPAL caudal of the collarbone is elevated 20°, the backrest on the bed is elevated 60°, depending on the anatomy of the thorax. Thereby, in this study, sitting is defined as a minimum of 60° elevation of the upper part of the body. To define sitting, data from the two monitors were used, as follows:

(Total wear time/day – (time standing, from thigh + time stepping, from thigh + time sitting/lying, from collarbone)).

The patients wore the activity monitors 24 h a day, except for showering, different x-ray examinations, or surgery. At discharge, or after a maximum of five days, the monitors were removed, and data for the first three postoperative days were used in the analysis [7]. A valid day was defined as a day with a minimum of 12 h activPAL wear time. To be included in the activPAL analysis all the first three postoperative days had to be valid. Consequently, patients who returned to the ward after 12.00 on the first postoperative day, or those who were discharged before day three at 12.00, were not included in the activPAL analysis. For each mobilisation variable, a mean value was calculated based on the first three postoperative days.

Postoperative outcomes

To measure postoperative outcomes, for example drains, bowel function, and length of stay, information was collected from the patients' medical records. Also, the questionnaire Postoperative Recovery Profile (PRP) was answered by the patients at discharge [18]. The PRP version for patients in hospital consists of 17 questions, and 17 points define a full recovery.

Statistical analyses

To describe and compare patient characteristics between the two groups, the Pearson's chi square or Fischer's exact test were used for categorical variables, and the independent *t*-test for continuous variables. To compare mobilisation as a mean over three days and for each day between the groups, the Mann-Whitney *U* test was used due to non-normally distributed data. The Mann-Whitney *U* test was followed by calculation of the effect size, according to Cohen's guidelines [19]. Furthermore, to compare the postoperative outcomes between the groups, the Pearson's chi square or Fischer's exact test was used for categorical variables, and the Mann-Whitney *U* test and calculation of effect size for the continuous variables. A two-sided P-value of less than 0.05 was considered statistically significant. To assess relationship between level of mobilisation and postoperative outcomes from the medical records, the Spearman correlation test was used. The statistical analyses were performed with IBM SPSS statistics version 24.

Results

Study population

In total, 133 patients were included in the study, mean (sd) age was 68.1 (12.3) years, the most common diagnosis was urinary bladder cancer (51.1%) and robotic assisted laparoscopic radical cystectomy was the most common surgery (47.4%). Comparing the two groups regarding characteristics, there were no differences except for American Society of Anaesthesiologists (ASA) classification, showing higher ASA score in the group using the Activity board, with differences at ASA score 1 and 2 (Table 1).

Mobilisation

In total 118 patients provided valid activPAL data. The mobilisation variables are presented over the first three postoperative days (Table 2). All variables except from sitting showed a difference between the two groups, in favour of the group using the Activity board, with medium effect size. Furthermore, results of mobilisation variables, presented for each day, are shown graphically (Fig. 2). All 133 patients wore the activity monitors but 15 patients did not fulfil the criteria to be included in the analysis of mobilisation variables. Hence, these 15 patients are still included in the postoperative outcome analyses, since they were allocated to one of the treatment groups.

Postoperative outcomes

The group with the Activity board had first flatus and first stool earlier in the postoperative period compared to the group with standard treatment, close to medium effect size. Furthermore, the group with the Activity board had a shorter length of stay at the hospital than the group with standard treatment, with small effect size. A significant correlation was shown between higher number of step counts and shorter length of stay ($p = 0.000$, $r_s = 0.324$). There were no differences between the two groups regarding when the patients left the postoperative care unit, the number of patients who had a short period in the intensive or postoperative care units for optimising, postoperative complications, the questionnaire on postoperative recovery, or the number of patients that were discharged to a rehabilitation ward. Also, no patients were treated with pulmonary drain, nephrostomy after surgery, or vacuum treatment due to open incision (Table 3).

Table 1
Demographic and clinical characteristics of study population (n = 133).

	Activity board n = 67	Standard treatment n = 66
Sex, n (%)		
Women	32 (47.8)	34 (51.5)
Age (years), mean (sd)	69.3 (11,4)	67.0 (13,1)
Body Mass Index (kg/m^2), mean (sd)	24.7 (3.5)	26.1 (5.2)
Other diseases[a], n (%)		
Cardiovascular disease	37 (55.2)	30 (45.5)
Diabetes	5 (7.5)	7 (10.6)
Respiratory disease	12 (17.9)	12 (18.2)
Smoking status, n (%)		
Never smoked	33 (49.3)	36 (54.5)
Quit due to surgery	7 (10.4)	2 (3.0)
Quit < 6 months	1 (1.5)	1 (1.5)
Quit > 6 months	26 (38.8)	27 (40.9)
Diagnosis, n (%)		
Urinary bladder cancer	35 (52.5)	33 (50.0)
Colon cancer	11 (16.4)	8 (12.1)
Rectal cancer	7 (10.4)	6 (9.1)
Ovarian cancer	14 (20.9)	19 (28.8)
Oncological treatment before surgery[b], n (%)	21 (31.3)	25 (37.9)
ASA-class, n (%)		P < 0.05
1	6 (9.0)	15 (22.7)
2	43 (64.2)	28 (42.4)
3	17 (25.4)	23 (34.8)
4	1 (1.5)	0 (0.0)
Surgery[c], n (%)		
Urological	35 (52.2)	33 (50.0)
Gastroenterological	18 (26.9)	16 (24.2)
Gynaecological	14 (20.9)	17 (25.8)
Surgical technique, n (%)		
Lower midline incision	10 (14.9)	18 (27.3)
Upper and lower midline incision	19 (28.4)	12 (18.2)
Robotic assisted laparoscopic	38 (56.7)	36 (54.5)
Epidural, n (%)	26 (38.8)	24 (36.4)
PCA, n (%)	15 (22.4)	16 (24.2)

Abbreviations: ASA = American association of Anesthesiologists; 1 = low comorbidity, 4 = high comorbidity.
PCA = Patient Controlled Analgesia, some patients had both Epidural and PCA.
[a] Supplementary file A.
[b] Supplementary file B.
[c] Supplementary file C.

Table 2
Mean levels of mobilisation, median (min-max), over the first three postoperative days.
Including the patients who had activity monitors at least 12 h all the three first days (n = 118)

	Activity board (n = 60)	Standard treatment (n = 58)	P-value	Effect size
Total monitor wear time, (min/day)	1440 (1200 - 1440)	1440 (1200 - 1440)	0.690	0.04
Lying in bed, (min/day)	1062 (528 - 1380)	1140 (168 - 1434)	0.019	0.22
Upright, (min/day)	78 (6 - 528)	42 (0 - 282)	0.006	0.26
Standing, (min/day)	60 (6 - 366)	42 (0 - 240)	0.010	0.24
Walking, (min/day)	18 (0–162)	6 (0 - 84)	0.002	0.29
Total upright[a], (min/day)	282 (60 - 774)	234 (12 - 1074)	0.048	0.19
Sitting[a], (min/day)	198 (30 - 606)	150 (6 - 942)	0.098	0.16
Steps, (n)	1057 (3 - 10433)	360 (0 - 6546)	0.001	0.31
Transitions from sit to stand, (n)	16 (4 - 70)	12 (1 - 61)	0.015	0.23

Min/day = minutes per day, Upright = standing + walking, Total upright = sitting + standing + walking, [a] n = 105 (55/50).
Effect size: 0.1 = small effect, 0.3 = medium effect, 0.5 = large effect.

Discussion

The evaluation of the Activity board as a standardised method to enhance mobilisation after abdominal surgery due to cancer, resulted in higher level of mobilisation in the group with the Activity board, compared to the group who received standard treatment. Furthermore, the group with the Activity board had first flatus and first stool sooner after surgery, and a shorter length of hospital stay, compared to the group with standard treatment. This study contributes to reduce the gap of evidence regarding mobilisation after abdominal surgery [20].

Standing time, stepping time, time upright, total time upright, step counts, and transitions between sitting and standing were all higher in the group with the Activity board. The patients who used the Activity board took almost three times more steps than the group with standard treatment, 1057 and 360 respectively, as mean values per day. In a study including 30 patients having laparoscopic abdominal surgery, the mean step count seven days after surgery was 2775 per day [21]. It is not possible to compare the studies completely; nevertheless it adds to existing research. In this study, many of the patients were treated according to modified ERAS protocols. However, none of the groups reached the mobilisation

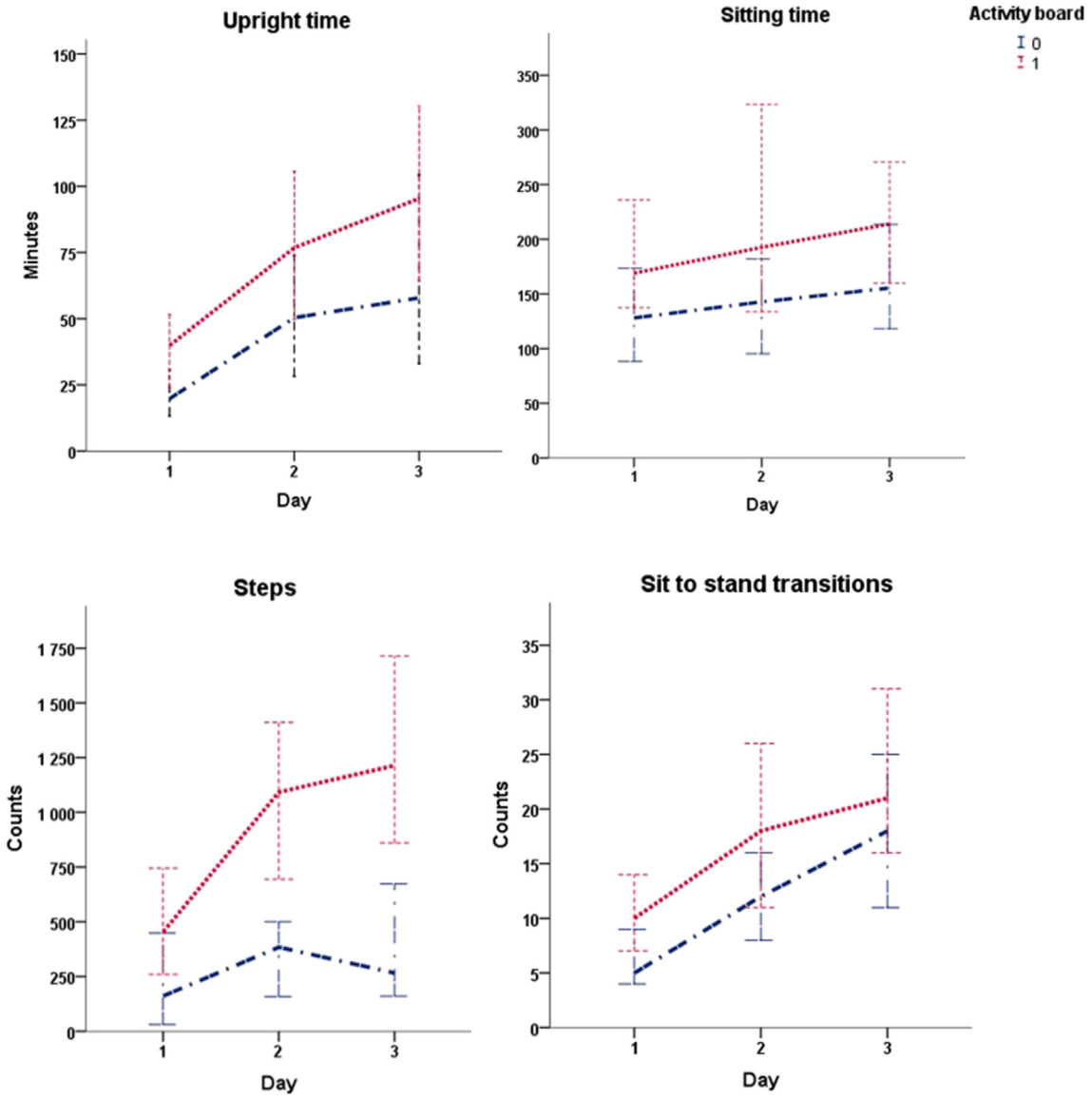

Fig. 2. Mobilisation variables, presented for each day, median (95 % CI) for the first three postoperative days. Including the patients who had accelerometer at least 12 hours all of the three first days (n = 118).

Table 3
Postoperative outcomes (n = 133).

	Activity board (n = 67)	Standard treatment (n = 66)	P-value	Effect size
Body temperature 38.5 °C or more, n (%)	7 (10.4)	11 (16.7)	0.322	
Ventricle drain, n (%)	8 (11.9)	11 (16.7)	0.468	
Abdominal drain, n (%)	1 (1.5)	0 (0)	1.000	
Reoperation, n (%)	1 (1.5)	2 (3.0)	0.619	
Time to first flatus (number of postoperative days), n[a]	2 (0 - 5)	2 (1 - 6)	0.006	0.24
Time to first stool (number of postoperative days), n[a]	3 (0 - 7)	4 (1 - 11)	0.003	0.28
Stool after discharge, or not described in medical record, n (%)	9 (13.4)	13 (19.7)	0.360	
Length of stay (days at hospital), n[a]	6 (3 - 13)	7 (3 - 14)	0.027	0.19
Rehabilitation, n (%)	44 (65.7)	42 (63.6)	0.857	
Postoperative Recovery Profile score[b], n[a]	4 (0 - 13)	4 (0 - 16)	0.750	0.03

[a] Presented as median (min-max).
[b] n = 109 (58/51), Effect size: 0.1 = small effect, 0.3 = medium effect, 0.5 = large effect.

levels recommended in the ERAS original protocol. The mean values over the first three postoperative days showed sitting time with a median of approximately 3 h per day, in both groups. One explanation could be that all the patients who needed assistance with mobilisation got mobilised to a chair, according to ERAS protocols. However, regarding walking, it is very likely that the patients who had an Activity board received more support with walking from the nurses. This stresses the need for education regarding the

impact walking might have on recovery.

Having the two methods at the same time in a ward was considered to possibly affect the results. The patients in the ward could exchange experiences regarding their care, and the nurses could see both groups of patients. Consequently, the two methods in the wards were alternated, one month at a time. Still, the patients who received standard treatment could potentially get more assistance with mobilisation from both the physiotherapists and medical staff, inspired by the Activity board. The adherence to the Activity board was measured indirectly with the activity monitor.

The physiotherapists were instructed to use the board in their usual patient treatment. This could lead to bias, regarding different approaches on how to work with the Activity board, depending on individual experience of working in the clinical setting. On the other hand, it could be a strength if the Activity board is feasible to use for physiotherapists with different qualifications. For future studies, the physiotherapists' adherence to how to use the Activity board should be measured.

Considering the postoperative outcomes, the differences regarding on what postoperative day the patients had their first flatus and first stool, and the length of stay, could be an effect of higher levels of mobilisation in the Activity board group. The importance of bowel movement and avoiding an ileus could not be stressed enough in this group of patients. Decreased peristalsis is common after abdominal surgery, and often leads to nausea and less food intake, followed by energy loss and thereby also decreased mobilisation [22]. Regarding length of hospital stay, a correlation was shown between higher number of step counts and shorter length of stay, but it could also be affected by parameters not assessed in this study.

The results of the PRP questionnaire showed that both groups had a median score of four, which is defined as 'not recovered at all' [18]. Also, more than 60% in both groups had a few days on a rehabilitation ward ahead of them when they answered the questionnaire. That the need for rehabilitation had already been decided could have influenced their responses.

A major strength of this study is that mobilisation was evaluated objectively with an activity monitor. The patients wore the activPALs 24 h per day after surgery, except for shower, x-ray investigations, or surgery. To avoid the risk that missing activPAL data is not random, a continuous wearing of the activity monitor is preferred [23]. In this study we strived for continuous wearing but in the acute hospital setting patient care had to be prioritised at the expense of activPAL data. Summarising, as a strength, most patients' data resulted in 24 h wear time.

To separate sitting from lying we used two activity monitors and combined the data. A previous study has also described sitting with the use of two activPALs, one on the chest and one on the thigh [17]. However, sitting was only described as sitting upright in a chair. In this study, a formula based on data from the two activity monitors was calculated to separate lying from sitting while in a hospital bed. The sitting data resulted in 12% missing data. As far as we know, sitting time has not been calculated in this manner before. To separate the activPAL variable sitting/lying into two remains to be investigated [24].

Use of the activPAL has been shown to be feasible in a frail elderly population, and it was also feasible to use in this study regarding patients' postoperative status [25]. However, to detect walking at a very low speed of 0.5 m/s or less is not always possible using the activPAL, and step counts at lower gait speed are likely to be underestimated [9,24,26]. This is a limitation with using the activPAL in this setting, where some of the patients affected by their medical condition, and possibly also age, walk slowly and carefully. However, as far as we know, there is not currently an activity monitor that is better in detecting a slow gait and which also measures body position.

Furthermore, the group who used the Activity board had preoperatively higher ASA-scores than the group with standard treatment, which means that more of the patients suffered from a higher grade of comorbidity. However, despite the higher ASA-scores, the patients had higher levels of mobilisation postoperatively compared to the standard treatment group, which could be important in considering future clinical implications. The Activity board seems to be a suitable tool for enhanced mobilisation even among frail patients.

Conclusion

The level of mobilisation after open or robotic assisted laparoscopic abdominal surgery due to cancer, in hospital settings, was enhanced by using the Activity board in terms of walking time and also numbers of steps. Furthermore, using the Activity board could result in first flatus and first stool sooner after surgery, and possibly a shorter hospital stay.

Declarations of interest

None.

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Appendices. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.ejso.2019.04.013.

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