Early intensive mobilization after acute high-risk abdominal surgery: a nonrandomized prospective feasibility trial

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Background: Mobilization after emergency abdominal surgery is considered essential to facilitate rehabilitation and reduce postoperative complications. The aim of this study was to evaluate the feasibility of early intensive mobilization after acute high-risk abdominal (AHA) surgery.

Methods: We conducted a nonrandomized, prospective feasibility trial of consecutive patients after AHA surgery at a university hospital in Denmark. The participants followed a predefined, interdisciplinary protocol for early intensive mobilization during the first 7 postoperative days (PODs) of their hospital admission. We evaluated feasibility in accordance with the percentage of patients who mobilized within 24 hours after surgery, mobilized at least 4 times per day and achieved daily goals of time out of bed and walking distance.

Results: We included 48 patients with a mean age of 61 (standard deviation 17) years (48% female). Within 24 hours after surgery, 92% of the patients were mobilized and 82% or more were mobilized at least 4 times per day over the first 7 PODs. On PODs 1–3, 70%–89% of the participants achieved the daily goals of mobilization; participants still in hospital after POD 3 were less able to achieve the daily goals. Patient reported that the primary factors limiting their level of mobilization were fatigue, pain and dizziness. Participants not mobilized independently on POD 3 (28%) had significantly ($p \leq 0.04$) fewer hours out of bed (4 v. 8 h), were less able to achieve the goals of time out of bed (45% v. 95%) and walking distance (62% v. 94%) and had longer hospital stays (14 v. 6 d) than participants mobilized independently on POD 3.

Conclusion: The early intensive mobilization protocol seems feasible for most patients after AHA surgery. For nonindependent patients, however, alternative mobilization strategies and goals should be investigated.

Contexte : On considère essentiel de mobiliser les malades après une intervention abdominale urgente afin de faciliter leur réadaptation et de réduire le risque de complications postopératoires. Le but de cette étude était d'évaluer la faisabilité d'une mobilisation intensive précoce après une chirurgie abdominale urgente à haut risque.

Méthodes : Nous avons procédé à un essai de faisabilité prospectif non randomisé auprès de malades consécutifs ayant subi une chirurgie abdominale urgente à haut risque dans un centre hospitalier universitaire du Danemark. Nous avons appliqué un protocole interdisciplinaire prédéfini pour une mobilisation intensive précoce pendant les 7 premiers jours postopératoires. Nous avons évalué la faisabilité en fonction du pourcentage de malades ayant été mobilisés au cours de 24 premières heures suivant la chirurgie, ayant été mobilisés au moins 4 fois par jour et ayant atteint les objectifs quotidiens fixés pour le temps passé hors du lit et une distance franchie en marchant.

Résultats : Nous avons inclus 48 malades âgés en moyenne de 61 ans (écart-type 17; 48 % de sexe féminin). Dans les 24 heures suivant la chirurgie, 92 % des malades ont été mobilisés et 82 % ou plus l'ont été au moins 4 fois par jour au cours des 7 premiers jours postopératoires. Aux jours postopératoires 1–3, 70 %–89 % des participants ont atteint les objectifs quotidiens de mobilisation; les malades encore hospitalisés 3 jours après l'intervention étaient moins en mesure d'atteindre les objectifs quotidiens. Aux dires des malades, les principaux facteurs ayant limité leur mobilisation étaient la fatigue, la douleur et les étourdissements. Les participants qui n'avaient pas bénéficié de l'intervention de mobilisation autonome au 3e jour postopératoire (28 %) avaient passé une nombre d'heures significativement moindre ($p \leq 0{,}04$) hors du lit (4 c. 8 h), étaient moins aptes à atteindre les objectifs en terme de temps passé hors du lit (45 % c. 95 %) et de distance parcourue en marchant

(62 % c. 94 %), et leur séjour hospitalier a été plus long (14 c. 6 j) comparativement aux malades soumis à l'intervention de mobilisation autonome au 3e jour postopératoire.

Conclusion : Le protocole de mobilisation intensive précoce semble faisable pour la plupart des malades après une chirurgie abdominale urgente à haut risque. Pour les malades non autonomes, toutefois, il faudra explorer d'autres stratégies de mobilisation et fixer d'autres objectifs.

Acute high-risk abdominal (AHA) surgery (i.e., major emergency abdominal surgery for intestinal obstruction, perforated viscus or bowel ischemia) is associated with high risks of postoperative complication, death and prolonged hospital stay, compared with elective abdominal surgery.[1–4] Enhanced recovery programs after AHA surgery have resulted in reduced mortality rates, fewer postoperative complications and shorter hospital stays.[3–6] Such programs include reducing time before surgery, early administration of antibiotics, optimization of fluid therapy, early pain relief, oral nutrition and mobilization.[4,7]

Pulmonary complications — such as atelectasis, pneumonia and hypoxia — are prevalent after abdominal surgery and are associated with several negative factors, including delayed mobilization.[1,7–13] Early and intensive mobilization after AHA surgery is therefore considered essential to reduce postoperative pulmonary complications and prevent loss of function.[7,14,15] However, feasibility and strategies of early and intensive mobilization after emergency abdominal surgery needs further exploration.[7,16,17]

We sought to evaluate the feasibility of a predefined, interdisciplinary protocol for early intensive mobilization during the first postoperative week after AHA surgery. We also sought to describe physical performance, health-related quality of life and factors limiting mobilization during the first week and upon discharge after AHA surgery.

Methods

Design and setting

We conducted a prospective, nonrandomized cohort study, designed as a feasibility trial to design potential future randomized controlled trials (RCTs). When planning and reporting this study, we followed the CONSORT 2010 statement, although we did not apply randomization.[18] Our main outcomes were the acceptability and feasibility of early intensive mobilization for both patients undergoing AHA surgery and the health care staff. To evaluate feasibility, we used prespecified progression criteria focused on adherence to a mobilization protocol. Nonadherence could lead to modification or adjustment of the intervention for a future RCT.[18,19]

Participants

We enrolled consecutive patients undergoing AHA surgery in the Department of Surgical Gastroenterology at the University Hospital of Hvidovre, Capital Region of Denmark, from September to December 2018. We screened all patients (aged ≥ 18 yr), undergoing major emergency gastrointestinal surgery, laparoscopy or laparotomy (including reoperation after elective gastrointestinal surgery). We excluded patients undergoing minor emergency gastrointestinal surgery (including appendectomy, cholecystectomy and simple herniotomy) or emergency gastrointestinal surgery without intervention (no abdominal pathology found), those not able to give informed consent to participate in the study within 48 hours after surgery or those without a Danish civil registration number (for legal reasons). We asked patients eligible for inclusion to participate immediately postoperatively and they gave written informed consent.

Intervention

The participants followed a standardized, optimized perioperative program, described previously.[3,8] The intervention for early intensive mobilization was predefined in a mobilization protocol for each postoperative day (POD) during hospital admission in the first week after AHA surgery and included basic activities such as getting in and out of a bed, rising from a chair, standing and walking (Table 1). The health care staff in the department — including physiotherapists, occupational therapists and nursing staff — were responsible for motivating and assisting the participants to achieve the predefined goals in the mobilization protocol during PODs 1–7. The health care staff continuously sought to assist participants with obstacles for mobilization (e.g., guiding participants with regards to pain management and rest). A physiotherapist saw participants daily in the first postoperative week, including weekends, to assist and motivate them in early intensive mobilization. In the afternoons and evenings, the nursing staff were primarily responsible for mobilization of the participants. The health care staff continuously documented the extent of mobilization during PODs 1–7 in the data recording sheets.

Physiotherapists also instructed participants in relation to respiratory therapy, including deep breathing exercises every hour and coughing techniques. Participants with respiratory problems such as mucus,

Table 1. The mobilization protocol describing the daily goals of mobilization and the 4 prespecified progression criteria of feasibility during the first postoperative week following acute high-risk abdominal surgery

Goal*	POD 1	POD 2	POD 3	POD 4	POD 5	POD 6	POD 7
Early mobilization, h	≤ 24	–	–	–	–	–	–
Mobilization per day	≥ 4	≥ 4	≥ 4	≥ 4	≥ 4	≥ 4	≥ 4
Time out of bed, h	≥ 1	≥ 2	≥ 3	≥ 4	≥ 6	≥ 6	≥ 6
Walking distance, m	≥ 10	≥ 25	≥ 50	≥ 100	≥ 200	≥ 300	≥ 400

POD = postoperative day.

*Early mobilization: mobilized at least to a sitting position on the bed. Mobilization per day: times participants are mobilized out of bed independently or by support of the health care staff per day. Time out of bed: time spent sitting, standing and walking.

pneumonia or atelectasis also received positive expiratory pressure or continuous positive airway pressure, when needed. Participants who were unable to get out of bed received instructions on how to apply in-bed exercises, with the aim of maintaining a certain level of activity to avoid muscle atrophy and benefitting cardiovascular function. After the first postoperative week, patients who were still not able to mobilize independently continued training and rehabilitation with a physiotherapist or occupational therapist, but not daily. Participants undergoing reoperation during the first week after the initial AHA surgery restarted the mobilization protocol, including data collection. Participants undergoing reoperation after POD7 followed the early intensive mobilization protocol again, but we included only data after the first AHA surgery.

Outcomes

Our main outcome was the feasibility of early intensive mobilization according to 4 predefined progression criteria, as specified in Table 1.

Health care staff evaluated patients' preoperative health and physical status using the American Society of Anesthesiologists (ASA, 1–5 points) classification,[20] the New Mobility Score (NMS, 0–9 points)[21] and Barthel Index (BI, 0–100 points).[22] The NMS evaluates self-reported walking ability before admission, including difficulties walking indoors, outdoors and during shopping. A score of 0 points indicates no walking ability at all and 9 points indicates no difficulties walking.[21] The BI evaluates ability to perform activities of daily living.[22]

After surgery, health care staff evaluated basic mobility daily using the Cumulated Ambulation Score (CAS);[23] ability to perform activities of daily living was again evaluated with the BI, and lower limb strength was evaluated with the 30-second chair stand test.[24] The CAS evaluates postoperative independence in ambulation, including the 3 basic activities of getting in and out of a bed; getting up from sitting to standing, and back from standing to sitting in a chair with armrest; and indoor walking with an appropriate walking aid, if necessary. A physiotherapist rated each CAS activity on a 3-item scale (0–2 points). A total CAS of 6 points indicates participants can mobilize independently in all 3 activities, whereas a CAS of less than 6 points indicates participants need some level of assistance with ambulation.[23]

We evaluated 24-hour physical activity in the first postoperative week (time spent lying, sitting, standing and walking) using 2 accelerometers (SENS motion, SENS Innovation Aps).[25] The first monitor was placed on the lateral distal side of the right thigh and the second monitor was attached to the chest, making it possible to differentiate between lying and sitting positions. The monitors were attached to the participants just after inclusion in the study and were removed at discharge or POD 8. We excluded data from the day of attachment and removal from the data analysis.

We asked all participants, independent of their physical activity level, to indicate the main factor limiting their level of mobilization according to a predefined list, including pain, dizziness or nausea, fatigue or exhaustion, monitoring and surgical equipment (e.g., epidural, catheter, intravenous infusion, surgical drains) and other factors (e.g., cardiovascular or respiratory dysfunction, motor blockade after epidural). The health care staff selected factors limiting mobilization if participants were not able to express a reason themselves.

A physician evaluated pulmonary complications (e.g., pneumonia, atelectasis, respiratory failure), scored according to the Clavien–Dindo classification.[26] Scores higher than 1 point indicated pulmonary complications requiring treatment during hospital admission (e.g., pharmacological treatment, treatment with continuous positive airway pressure).

Degree of pain and fatigue were evaluated using the Numeric Rating scale (0–10) and the Visual Analog Fatigue Scale (VAFS).[27] For the VAFS, participants were asked to place a marker on a 10-cm vertical line, indicating the level of fatigue before mobilization, from not at all fatigued (0 points) to extremely fatigued (10 points).

The participants' health-related quality of life before surgery and at discharge was evaluated using the index visual analogue scale (0–100) in the EQ-5D questionnaire (EQ-5D-VAS).[28]

Falls during the first week after surgery were registered as adverse events when executing early intensive

mobilization after AHA surgery. Only falls when mobilized with the health care staff were recorded.

Statistical analysis

In a feasibility study, formal sample size calculation is not required. We estimated that a sample size of about 50 patients undergoing AHA surgery was sufficient to explore the acceptability and practicalities of the intervention.

We determined the feasibility of early and intensive mobilization using counts and percentages, corresponding to how many participants achieved the 4 prespecified progression criteria on PODs 1–7, based on data from the data recording sheets completed by the health care staff and data from the accelerometers during patients' hospital stays. At time of this study, no clear guidance for developing percentage of progression criteria within feasibility studies was available.[29] We therefore used other studies that included progression criteria as guidance for this study.[18,30] We considered the intervention feasible if more than 80% of the participants achieved each of the 4 goals, and potentially feasible if 60%–80% achieved the goals with some small modifications to the intervention needed. If fewer than 60% of participants achieved the goals, we interpreted this to indicate the need for adjustment of the goals or the intervention. We determined acceptability of the intervention based on completion after enrolment, with a maximum expected drop-out rate of 20%.

We tested descriptive data for normal distributions by visual inspection of the Q-Q plot. We presented continuous data as means and standard deviations (SDs), when normally distributed. Ordinal or non-normally distributed data are presented as medians and interquartile ranges (IQRs) and nominal data are presented as frequencies.

We compared participants who were mobilized nonindependently (CAS < 6) or independently (CAS = 6) using independent *t* tests to compare age and CST, and a Mann–Whitney test to compare length of stay after surgery. We used Fisher exact tests to compare NMS and postoperative pulmonary complications, and the Pearson χ^2 test to compare ASA classification.

Finally, we used simple logistic regression analysis to determine the predictive value of independent variables for not achieving mobilization targets to 1 or more of the 3 predefined progression criteria on POD 5 (mobilized ≥ 4 times per day, time out of bed, walking distance). We presented results from the logistic regression analysis as odds ratio (ORs) with 95% confidence interval (CIs). We considered a *p* value less than 0.05 as statistically significant.

We stored study data online using Research Electronic Data Capture (projectredcap.org) and analyzed all data using IBM SPSS statistics for Windows (version 25).

Ethics approval

The study was approved by the capital regional committee on health research ethics of Denmark (H-18034444) and registered with the Danish Data Protection Agency (Ref: VD-2018–337) before recruitment. This study was also preregistered with Clinicaltrials.gov (NCT03662932).

Results

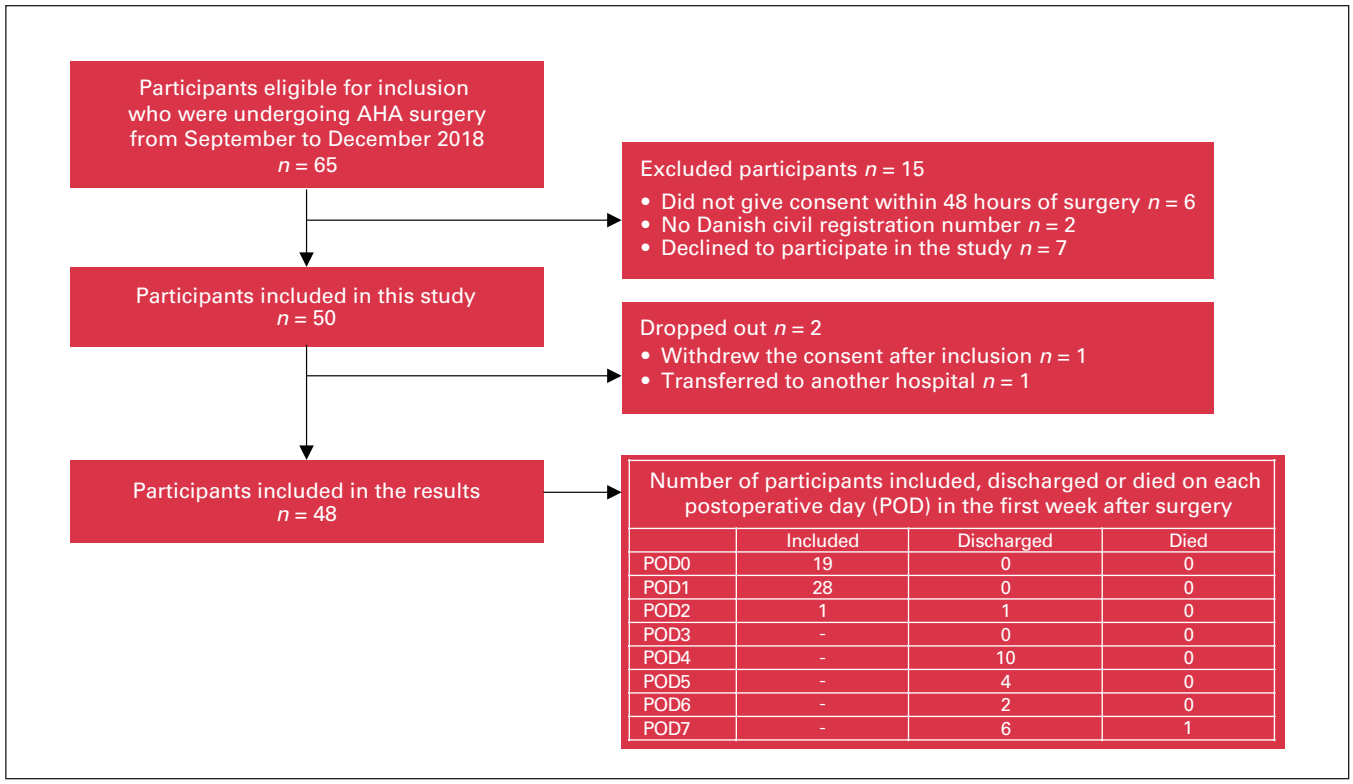
A total of 65 patients underwent AHA surgery during the inclusion period, of whom 50 patients were eligible for participation and enrolled. The inclusion and exclusion process are illustrated in Figure 1, and the characteristics of the 50 included participants are presented in Table 2. Only 2 participants (4%) dropped out after inclusion. The 15 patients not included were comparable to those included, with a mean age of 59.2 (SD 20.9) years (47% female).

Four participants died during their hospital stays (1 on POD 7 and 3 after POD 8), but data from all 4 were included in the feasibility analyses.

Feasibility of the intervention

Within 24 hours after AHA surgery, 92% of the participants were mobilized to at least a sitting position and 82% or more of patients still in hospital were mobilized out of bed a minimum of 4 times per day during the first postoperative week (Table 3). Correspondingly, the goals for time out of bed and walking distance were achieved for at least 81% and 85% of the participants on PODs 1–3 and PODs 2–3, respectively, while participants still in hospital on PODs 4–7 were less able to achieve the goals. We evaluated predictors of not achieving mobilization targets among participants still in hospital on POD 5, on which the smallest number of participants (45%) achieved all 3 progression criteria (Table 4). Being nonindependent (CAS < 6), having a low preoperative health status (ASA 3–5 points) and having a high degree of pain and fatigue were significant predictors of not achieving mobilization targets on POD 5. Correspondingly, 10 of the 31 participants still in hospital on POD 5 had low preoperative health status (ASA 3–5 points) and 9 (90%) of these participants had more difficulties achieving the goals of mobilization on POD 5.

Participants who were nonindependently mobilized (CAS < 6) had fewer hours out of bed and were less able to achieve the goals of time out of bed and walking distance on each POD compared with those who were independently mobilized (CAS = 6), as shown in Table 5.



Number of participants included, discharged or died on each postoperative day (POD) in the first week after surgery

	Included	Discharged	Died
POD0	19	0	0
POD1	28	0	0
POD2	1	1	0
POD3	-	0	0
POD4	-	10	0
POD5	-	4	0
POD6	-	2	0
POD7	-	6	1

Fig. 1. Flow diagram of study sample selection. AHA = acute high-risk abdominal surgery.

Postoperative outcomes

Postoperative physical performance was low during the first days after AHA surgery (Table 6). The primary factors that limited mobilization on POD 1 were pain and dizziness or nausea; fatigue was the primary limiting factor from POD 2 onward (Figure 2).

Participants who were nonindependently mobilized on POD 3 were significantly older (mean 71.3 [SD 11.9] yr v. 57.0 [SD 16.6] yr), more often needed assistance during walking before surgery (NMS < 9 points; n = 7 [54%] v. n = 2 [6%]), had lower preoperative health status (ASA > 2 points; n = 8 [62%] v. n = 5 [14%]), had lower postoperative physical function (mean no. of times standing up from chair (0.6 [SD 2.2] v. 6.6 [SD 4.7]) and had longer hospital stays after surgery (median 14 [IQR 11–22] d v. 6 [IQR 4–9] d) than independent participants ($p \leq 0.007$).

Ten participants (21%) developed a pulmonary complication after AHA surgery, including the 4 participants who died during the study period. Of the 13 participants who were nonindependently mobilized on POD 3, 6 (46%) developed pulmonary complications, compared with only 4 (11%) of the 35 participants who were independently mobilized (p = 0.016). During hospital admission, 14 participants had reoperations in the abdomen (7 during the first postoperative week), of whom 5 (36%) developed pulmonary complications, compared with 5 (15%) of the 34 participants who did not have reoperations (p = 0.103).

On the EQ-5D-VAS, participants rated their health-related quality of life at a median of 75 (IQR 50–85) points before surgery, which reduced to 60 (50–74) points on discharge after surgery.

No falls were recorded during hospital admission when mobilized with the health care staff.

Discussion

The present study shows that early intensive mobilization in the first postoperative week is feasible, safe and well tolerated by participants after AHA surgery. Although almost half of the participants depended on human assistance to mobilize on the first day after AHA surgery, and several participants had pain and dizziness that limited their ambulatory level, mobilization within 24 hours after AHA surgery was feasible. Thus, more than 80% of the participants were mobilized out of bed at least 4 times per day after POD 0. However, some participants, especially those mobilized nonindependently and those with low health status (ASA 3–5 points), had difficulties achieving the planned goals of time out of bed and walking distance. Significantly more nonindependently mobilized participants also developed postoperative pulmonary complications during hospital admission. This adds to the accumulated evidence that indicates that a low degree of physical activity during

Table 2. Participant characteristics

Variable	No. (%) of patients* $n = 48$
Age, yr, mean ± SD	60.9 ± 16.7
Sex	
Male	25 (52)
Female	23 (48)
Comorbidities	
None	26 (54)
Cardiovascular diseases	17 (35)
Respiratory diseases	11 (23)
Diabetes mellitus (type 1 and 2)	3 (6)
ASA physical status classification	
1–2 points (healthy or mild systemic disease)	35 (73)
3–5 points (severe systematic disease or moribund)	13 (27)
Preadmission functional performance	
CAS, points, median (IQR)	6 (6–6)
CAS = 6 points (independent basic mobility)	48 (100)
NMS, points, median (IQR)	9 (9–9)
NMS = 9 points (no walking difficulties)	39 (81)
BI, points, median (IQR)	100 (100–100)
BI = 100 points (independent in basic ADL) ($n = 47$)	39 (83)
Home care before surgery	9 (19)
Residential status	
Admitted from their own home	47 (98)
Discharged to their own home ($n = 44$)	42 (96)
Indication of surgery	
Intestinal obstruction	25 (52)
Perforated viscus	15 (31)
Other†	8 (17)
Type of operation	
Emergency laparotomy	37 (77)
Emergency laparoscopy	11 (23)
Epidural anestehsia	43 (90)
Reoperation during admission	14 (29)
Length of stay after surgery, d, median (IQR)	7 (4–14)
Postoperative pulmonary complication‡	10 (21)
30-day mortality	4 (8)

ADL = activities of daily living; ASA = American Society of Anesthesiologists; BI = Barthel Index; CAS = Cumulated Ambulation Score; IQR = interquartile range; NMS = New Mobility Score; SD: standard deviation.

*Unless indicated otherwise.

†Other diagnosis (e.g., diverticulitis, hemorrhage, ischemia).

‡Clavien–Dindo > 1 point.

hospital admission is associated with pulmonary complications after surgery, underlining the importance of early intensive mobilization and patients reaching an independent ambulatory status as soon as possible after AHA surgery.[8–13,31]

In this study, advanced age and laparotomy (compared with laparoscopy) were not single predictors of compliance to the mobilization targets on POD 5, as expected. Instead, poor health status before surgery and nonindependent mobilization contributed to noncompliance with mobilization targets, indicating that overall physiologic reserves are a major determinant of degree of mobilization.

The mobilization protocol used in this study prescribed more than 6 hours out of bed as a goal for mobilization on PODs 5–7, corresponding to study findings and guidelines for an elective enhanced recovery program in abdominal surgery.[32–35] In the present study, fewer than 70% of participants still in hospital on POD 4 and PODs 5–7 managed to achieve the goal of 4 and 6 hours out of bed, respectively. At the same time, the average time out of bed for all participants still in hospital was more than 7 hours on these days, indicating a considerable heterogeneity in the physical performance of participants still in hospital after POD 3. At this late stage of the postoperative period, almost none of the participants who were nonindependently mobilized achieved the goal of time out of bed; indicating that the goal of 6 hours out of bed may be too optimistic for these patients, which is supported by previous studies involving patients after emergency abdominal surgery that reported higher risk of delayed mobilization, compared with elective surgery.[9,34,36] Therefore, we suggest a different protocol for patients still in hospital after POD 3, by which those who are nonindependently mobilized have decreased goals of time out of bed and walking distance. The protocol does not need modification for independent patients in a possible future RCT.

The reported barriers for patients not achieving mobilization goals were fatigue, pain and dizziness. Interdisciplinary interventions aiming to reduce postoperative barriers are therefore important and must include, for example, multimodal pain relief, nutrition, antiemetics, rest at night and fluid therapy to reduce pain, fatigue, dizziness, nausea and orthostatic intolerance.[4,7] In particular, adaptation of pain regimes on the day of removal of epidural catheter — which was standardized on day 4 if the patient was not discharged earlier — seems important to avoid rebound pain, as a barrier to mobilization.[37]

Other studies have also reported that patients felt restricted by surgical drains, tubes, oxygen lines and continuous monitoring of vital signs during hospital admission.[8,10,36,38–40] To reduce these restrictions, easy access to appropriate walking devices (e.g., the high walking frame with wheels) may facilitate independent mobilization owing to decreased pain when mobilized this way and less insecurity secondary to symptoms of fatigue or dizziness. Furthermore, the walking devices are suitable for transporting all the surgical equipment (e.g., epidural, catheter, intravenous infusion, surgical drains, parental nutrition).

Participants not remembering how much they had been out of bed, their lack of motivation toward physical activity and their diminished health-related quality of life after AHA surgery may have also influenced the feasibility of mobilization during hospital admission in the present study.[38–41] Evidence suggests that using activity monitors so that participants can monitor their level of

Table 3. Feasibility of the mobilization protocol after acute high-risk abdominal surgery based on 4 prespecified progression criteria

	POD 1		POD 2		POD 3		POD 4		POD 5		POD 6		POD 8	
Goal	No. (%) of patients who achieved goal	Total	No. (%) of patients who achieved goal	Total	No. (%) of patients who achieved goal	Total	No. (%) of patients who achieved goal	Total	No. (%) of patients who achieved goal	Total	No. (%) of patients who achieved goal	Total	No. (%) of patients who achieved goal	Total
Mobilized ≤ 24 hours after surgery*	44 (92)	48	–	–	–	–	–	–	–	–	–	–	–	–
Mobilized ≥ 4 times per day †‡	14 (82)	17	37 (90)	41	39 (89)	45	32 (89)	36	28 (88)	32	25 (83)	30	19 (86)	22
Time out of bed†§	15 (88)	17	35 (85)	41	35 (81)	43	24 (69)	35	18 (58)	31	15 (52)	29	12 (55)	22
Walking distance*¶	33 (70)	47	40 (85)	47	40 (85)	47	26 (70)	37	22 (67)	33	21 (68)	31	17 (71)	24
Achieved all 3 progression criteria**	13 (77)	17	30 (75)	40	33 (77)	43	22 (63)	35	14 (45)	31	14 (48)	29	10 (48)	21

POD = postoperative day.

*Based on data from the data recording sheets completed by the health care staff.

†Based on data from the accelerometers (data from the day of attachment and removal were excluded; error occurred in 2 accelerometers and 2 others were thrashed by mistake, resulting in missing data for 4 participants).

‡Standing or walking for ≥ 4 separate periods during a day.

§Time out of bed: Sitting (> 45° elevation of the chest), standing and walking for ≥ 1 hour (POD1), ≥ 2 hours (POD2), ≥ 3 hours (POD3), ≥ 4 hours (POD4) and ≥ 6 hours (POD5–7).

¶Walking distance: walks ≥ 10 m (POD1), 25 m (POD2), 50 m (POD3), ≥ 100 m (POD4), ≥ 200 m (POD5), ≥ 300 m (POD6) and ≥ 400 m (POD7).

**Participants achieving all 3 goals (mobilized ≥ 4 separate periods during a day, time out of bed, walking distance).

Table 4. Odds of not achieving mobilization targets in 1 or more of the 3 predefined progression criteria on postoperative day (POD) 5*

Variable	OR (95% CI)
Age	
< 70 yr	Ref.
≥ 70 yr	0.409 (0.10—1.75)
Sex (Reference value: Woman)	
Male	Ref.
Female	1.429 (0.34–5.94)
Health status	
ASA 1–2 points	Ref.
ASA 3–5 points	14.625 (1.55–138.19)
Pre-illness function	
NMS = 9	Ref.
NMS < 9	1.128 (0.21–6.17)
Type of operation	
Laparoscopy	Ref.
Laparotomy	0.542 (0.08–3.51)
Diagnosis	
Obstruction	Ref.
Other diagnosis	0.313 (0.07–1.38)
Basic mobility on POD 5	
CAS = 6	Ref.
CAS < 6	14.625 (1.55–138.19)
Basic mobility on POD 1	
CAS = 6	Ref.
CAS < 6	7.500 (1.48–37.91)
Pain on POD 5	
NRS 0–4	Ref.
NRS 5–10	10.111 (1.05–97.00)
Fatigue POD 5 (VAFS, per point)	1.553 (1.04–2.33)

CAS = Cumulated Ambulation Score; CI = confidence interval; NMS = New Mobility Score; NRS = Numeric Rating Scale; OR = odds ratio; VAFS = Visual Analog Fatigue Scale.

*On POD 5, 17 participants of 31 did not achieve 1 or more goals of the 3 prespecified progression criteria (mobilized ≥ 4 times per day, time out of bed, walking distance).

physical activity from minute to minute can increase time out of bed and physical activity.[42,43] Such monitors, therefore, may be added to the mobilization program, especially for independent patients, being relevant for motivation and visual feedback on the amount of mobilization in daily practice during hospital admission, after discharge or in an RCT.

To explore the status of health-related quality of life in patients undergoing AHA surgery, we used EQ-5D-VAS. As anticipated, participant quality of life was reduced at time of discharge, compared with before undergoing AHA surgery (median 60 v. 75 points). In comparison, the mean EQ-5D-VAS scores in a healthy Danish population was 82.4 points (95% CI 81.5–83.4 points),[44] showing that patients undergoing AHA surgery may have diminished quality of life compared with a healthy population and that they experience reduced health-related quality of life at the time of discharge, in addition to reduced functional capacity. Accordingly, self-reported quality of life is an important follow-up outcome when evaluating the effects of interventions after AHA surgery in future studies.

Limitations

All participants were seen by a physiotherapist daily in the first postoperative week, including weekends, to assist and motivate to early intensive mobilization, while the nursing staff were primarily responsible for mobilization of the participants in the afternoons and evenings. However, because of missing data on walking distance in the recordings sheet, we are uncertain if the nursing staff mobilized the participants less than anticipated. The nursing staff hold a key position in supporting mobilization, as they

Table 5. Difference between independently and nonindependently mobilized participants

Variable	Nonindependently mobilized (CAS < 6)		Independently mobilized (CAS = 6)		*p* value
	No. (%) of patients who achieved goal*	Total	No. (%) of patients who achieved goal*	Total	
Time out of bed, h, mean ± SD					
POD 2	4.10 ± 3.36	11	7.43 ± 4.28	30	0.026
POD 3	4.02 ± 3.44	11	8.42 ± 4.38	32	0.004
POD 4	3.12 ± 2.26	12	9.04 ± 5.14	24	< 0.001
POD 5	3.18 ± 2.92	10	9.57 ± 5.75	21	0.003
POD 6	2.01 ± 1.54	8	9.07 ± 4.92	21	< 0.001
POD 7	3.28 ± 2.96	5	9.77 ± 5.06	17	0.014
Walking distance					
POD2 (≥ 25 m)	8 (53)	15	32 (100)	32	< 0.001
POD3 (≥ 50 m)	8 (62)	13	32 (94)	34	0.012
POD4 (≥ 100 m)	4 (31)	13	22 (92)	24	< 0.001
POD5 (≥ 200 m)	4 (36)	11	18 (82)	22	0.017
POD6 (≥ 300 m)	2 (25)	8	19 (83)	23	0.006
POD7 (≥ 400 m)	1 (20)	5	16 (84)	19	0.014
Time out of bed*					
POD 2 (≥ 2 h)	7 (64)	11	28 (93)	30	0.035
POD 3 (≥ 3 h)	5 (45)	11	30 (94)	32	0.002
POD 4 (≥ 4 h)	3 (27)	11	21 (88)	24	0.001
POD 5 (≥ 6 h)	3 (30)	10	15 (71)	21	0.052
POD 6 (≥ 6 h)	0 (0)	8	15 (71)	21	0.001
POD 7 (≥ 6 h)	1 (20)	5	11 (65)	17	0.135

CAS = Cumulated Ambulation Score; POD = postoperative day; SD = standard deviation.
*Unless indicated otherwise.

Table 6. Postoperative physical performance, degree of pain and fatigue after acute high-risk abdominal surgery

Variable	No. (%) of patients*†							
	POD 1 *n* = 47	POD 2 *n* = 47	POD 3 *n* = 47	POD 4 *n* = 37	POD 5 *n* = 33	POD 6 *n* = 31	POD 7 *n* = 24	Discharge *n* = 44
Time out of bed, h, mean ± SD	5.0 (4.6)[f]	6.5 (4.3)[e]	7.3 (4.6)[d]	7.2 (5.2)[b]	7.5 (5.8)[b]	7.1 (5.3)[b]	8.3 (5.4)[b]	–
Walking aid‡	40 (85)	39 (83)	35 (75)	30 (81)	22 (67)	19 (61)	15 (63)	7 (16)
CAS < 6 points (nonindependently mobilized)	21 (45)	15 (32)	13 (28)	13 (35)	11 (33)	8 (26)	5 (21)	1 (2)
CST, no. of times standing up from chair, mean ± SD	–	–	4.8 (4.9)[c]	–	4.0 (4.6)[a]	–	4.9 (6.0)	9.2 (5.4)[a]
BI, points, median (IQR)	–	–	–	–	–	–	95 (80–100)	100 (98–100)
NRS 5–10 points (moderate-to-high pain)	7 (15)	10 (21)	1430[a]	1439[a]	929[b]	930[a]	9 (38)	1 (2)
VAFS 5–10 points (moderate-to-high fatigue)	33 (75)[c]	32 (70)[a]	31 (67)[a]	29 (85)[c]	24 (77)[b]	20 (71)[c]	16 (70)[a]	23 (53)[a]

BI = Barthel Index; CAS = Cumulated Ambulation Score; CST = Chair Stand Test; IQR = interquartile range; NRS = Numeric Rating Scale; POD = postoperative day; SD = standard deviation; VAFS = Visual Analog Fatigue Scale.
*Unless indicated otherwise.
†Missing data for [a]*n* = 1, [b]*n* = 2, [c]*n* = 3, [d]*n* = 4, [e]*n* = 6 and [f]*n* = 30.
‡Uses a high walking frame (with wheels and upper body support), rollator or walking sticks.

spend so much time with the patients, but several studies have reported that heavy workload, attitudes about mobilization and limited availability of health care staff can be a barrier for mobilization.[17,38,39,41] Overall, heavy workload or missing registration of walking distance in the evening shift may have affected the result of feasibility of the goals of time out of bed or walking distance. This highlights the importance of identifying all barriers when tailoring the implementation of early intensive mobilization to each context and patient abilities.[39] Prioritizing and allocating physiotherapist resources in both the daytime and evenings could be an important strategy to ensure early and intensive mobilization after AHA surgery in the hospital ward, both in an RCT and in real-world clinical practice.

Falls are considered an adverse event when executing early and intensive mobilization, but only falls during mobilization with the health care staff were recorded

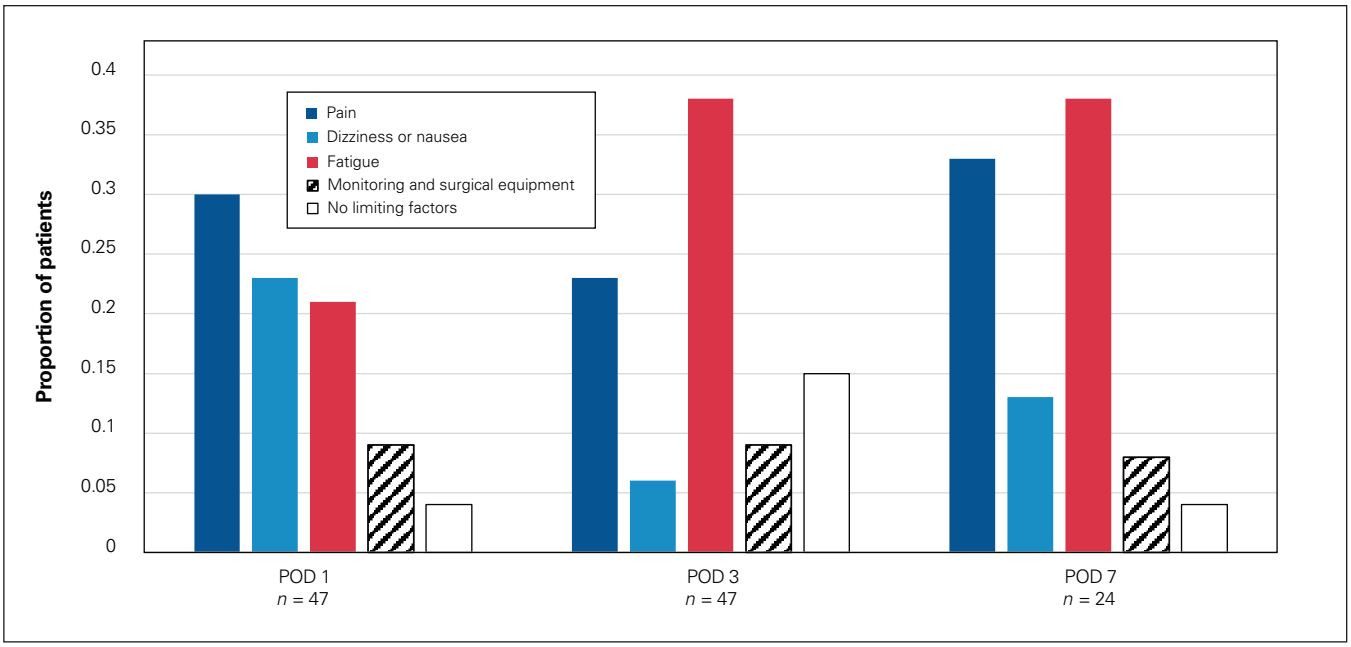


Fig. 2. Primary patient-reported factors limiting the level of mobilization in the first, third and seventh postoperative day (POD) after acute high-risk abdominal surgery.

systematically in the present study. However, we are aware of only 1 participant during the entire study period reporting a fall when unsupervised.

Conclusion

The early intensive mobilization protocol was well tolerated by patients undergoing AHA surgery, despite patients having significantly decreased physical function after their surgery. Patients who were nonindependently mobilized had difficulties achieving the goals of time out of bed and walking distance; interventions to reduce factors limiting mobilization for patients with a low ambulatory status are needed.

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