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Original Research

Feasibility of early postoperative mobilisation after colorectal surgery: A retrospective cohort study

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ABSTRACT

Background: Enhanced Recovery After Surgery (ERAS) guidelines advocate early postoperative mobilisation to counteract catabolic changes due to immobilisation and maintain muscle strength. The present study aimed to assess compliance to postoperative mobilisation according to ERAS recommendations.

Materials and methods: This is a retrospective cohort study on consecutive colorectal surgical procedures treated within an established ERAS protocol within a single center between May 2011 and May 2017. Demographics, surgical details, ERAS related items and surgical outcome were prospectively assessed in a dedicated database and compared between ambulant patients (at least 6 h out of bed at postoperative day (POD) 1) *vs.* patients not meeting the target (delayed mobilisation). Risk factors for decreased postoperative mobilisation were identified through multivariable logistic regression.

Results: 1170 patients were retained. 676 patients (58%) did not mobilise as recommended by ERAS protocol at POD1. Emergency operation (Odds Ratio (OR) 0.40; 95% Confidence Interval (CI) 0.18–0.91, p = 0.028), age > 70 years (OR 0.69; 95% CI 0.47–1.00, p = 0.050) and intraoperative total fluids > 2000 mL (OR 0.59; 95% CI 0.37–0.93, p = 0.025) were independent risk factors for delayed mobilisation. Patients with delayed mobilisation had significantly more overall (Clavien grade I–V) (55% *vs.* 29%, p= < 0.001), major (Clavien grade IIIb-V) (16% *vs.* 7%, p= < 0.001) and respiratory (12% *vs.* 4%, p= < 0.001) complications, as well as longer length of stay (12 ± 14 *vs.* 6 ± 7days, p= < 0.001).

Conclusions: More than half of patients did not mobilise as recommended by ERAS guidelines. Emergency surgery, advanced age and fluid overload were independent risk factors for delayed mobilisation, which was associated with increased postoperative complications.

1. Introduction

Together with nutritional preconditioning and minimal fasting time through the perioperative period, early postoperative mobilisation helps to face surgical stress response by preventing increased catabolism with consequent muscle loss [1–3]. Thus, the synergistic effect of these measures represents a backbone of Enhanced Recovery After Surgery (ERAS) programs. While early ambulation is supported by strong recommendation, evidence for concrete recovery targets is limited and feasibility of early mobilisation was rarely reported.

The present study aimed to study compliance with early postoperative mobilisation as set by the ERAS protocol and to identify risk factors impeding postoperative ambulation [1,4].

2. Material and methods

2.1. Patients

All consecutive adult colorectal surgical patients operated between May 01, 2011 and May 31, 2017 at a tertiary academic institution were included in this retrospective cohort study. All elective and emergent (since April 2012) procedures were performed within a standardized ERAS pathway [5,6]. This study was approved by the Institutional Review Board. Informed consent was obtained from every patient. All data was anonymized and de-identified prior to analysis and the study was conducted according to STROCSS criteria [7] and the declaration of Helsinki and registered under www.researchregistry.com.

Data was provided from a prospectively maintained database with the use of ERAS Interactive Audit System (EIAS). Demographic, surgical

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and ERAS related items were prospectively recorded by two dedicated clinical nurses. Accuracy of data entry was cross-checked by regular audits of the Institutional ERAS team. Age, gender, Body Mass Index (BMI), American Society of Anesthesiologists (ASA) and World Health Organisation (WHO) mobility performance scores and social habits like smoking or alcohol abuse (use of alcoholic beverages to excess as a regular practice) at the time of the procedure were assessed. Further were assessed preoperative malnutrition, defined as a Nutritional Risk Score ≥3 [8], immunosuppression (immunosuppressive medication at the time of surgery), preoperative chemo- or radiotherapy and diabetes mellitus. The underlying disease was classified as malignant disease, diverticulitis, inflammatory bowel disease (either Crohn's disease or ulcerative colitis), functional disorder or other benign pathologies, comprising surgeries other than specified above. Further were recorded past abdominal surgical interventions, regrouped as previous abdominal surgery.

Main procedures were either colectomies (left and sigmoidal, right or total), rectal resections including low anterior resection, proctocolectomy and abdominoperineal resection, and stoma procedures (either Hartmann reversal or loop ileostomy closure). Further recorded surgical details were approach (minimally invasive *vs.* open, with converted procedures assigned to the minimally invasive group according to the intention-to-treat principle), setting (elective *vs.* emergency, defined as any procedure performed during an unplanned hospital admission), operation duration and intraoperative blood loss.

2.2. Assessment of compliance to ERAS items

All items of the ERAS protocol [1] were systematically recorded, consisting of 19 pre-, peri- and postoperative ERAS measures. Mobilisation was patient-reported and daily cross-checked by nursing staff. Nursing staff was trained to supervise and promote achievement of mobilisation goals in every patient. Mobilisation was assisted by board-certified institutional physiotherapists if needed. Contact with physiotherapy staff was established pre-operatively through the outpatient consultation if deemed necessary by the treating surgeon.

Overall compliance was stratified with a cutoff of 70% according to recent reports [9,10].

Every individual modifiable pre- and intraoperative care item was further compared between the two groups (early mobilisation *vs.* delayed mobilisation). These items were: preadmission patient education, preoperative oral carbohydrate drinks, no oral bowel preparation, no preoperative long acting sedative medication, antibiotic prophylaxis, thrombo-prophylaxis, no abdominal drains, postoperative nausea and vomiting (PONV) prophylaxis (droperidol 1 mg, ondansetron 4 mg, bethamethasone 4 mg), hypothermia prevention (active warming by air blanket), intraoperative total fluid administration of < 2000 mL, fluid administration guidance, no prophylactic nasogastric tube (NGT) and intraoperative thoracic epidural analgesia (EDA).

2.3. Outcomes/study endpoints

Postoperative mobilisation (hours) was assessed for each patient at postoperative (POD) 1–3. The primary endpoint was the ability to be out of bed at least 6 h at POD 1, according to ERAS guidelines [1,4] and institutional standardized care maps (early mobilisation). All patients who did not meet these criteria were defined as patients with delayed mobilisation. Mobilisation according to guidelines was further assessed at POD 0 (mobilisation at all), POD 2 (mobilisation > 6 h) and POD 3 (mobilisation > 6 h) and stratified in 3 groups according to time period since ERAS implementation: 2011–2013 (early experience), 2014–2015 and 2016–2017 (late experience) to account for potential improvements. Uni- and multivariate factors associated with delayed mobilisation were identified among demographic, surgery-related and above mentioned modifiable pre- and intraoperative ERAS care items.

Clinical outcome was evaluated until 30 days postoperatively and compared between the two groups (early mobilisation *vs.* delayed mobilisation). Complications were classified according to the Clavien classification score [11] as any complication (Clavien I—V) and major complication (Clavien IIIb-V). Different individual complications were recorded: surgical complications (causal relationship between complication and surgical procedure established), infectious complications, cardiovascular complications (patients presenting with dysrhythmia and angina pectoris or myocardial infarction) and respiratory complications (including pneumonia, atelectasis and respiratory failure). Re-operation rates and length of hospital stay were assessed and compared between the two groups.

2.4. Statistical analysis

Descriptive statistics for categorical variables were reported as frequency (%), continuous variables as mean (standard deviation). Chi-square test was used to compare categorical variables. All statistical tests were two-sided and a level of 0.05 was used to indicate statistical significance. Variables with *P*-values ≤0.05 were then entered into a multivariate logistic regression (based on a probit regression model) to provide adjusted estimations of the odds ratio (OR). Items with an event rate of less than 10% were not retained for multivariate analysis. Data analysis was performed with the Statistical Software for the Social Sciences SPSS Advanced Statistics 22 (IBM Software Group, 200 W. Madison St., Chicago, IL; 60606 USA).

3. Results

3.1. Patients

A total of 1301 patients (774 male and 527 female) were eligible over the six-year inclusion period. The main outcome mobilisation time was assessed in 1170 patients (90%). Mean mobilisation time was 4.7 ± 2.6 h at POD 1, 5.5 ± 2.5 h at POD 2 and 5.9 ± 2.5 h at POD 3 (Fig. 1). Six hundred and seventy-six patients (58%) were not able to mobilise at least 6 h at POD 1 as recommended by ERAS protocol. Table 1 provides a demographical overview, while surgical details are displayed in Table 2.

Fig. 2 illustrates the percentage of ambulant patients according to guidelines (POD 0–3) and according to time period since ERAS implementation. Five hundred and twenty-five patients (45%) were able to get out of bed at all at the day of surgery (POD 0), 299 (61%) in the group early mobilisation at POD 1 *vs.* 226 (33%) in the group delayed mobilisation at POD1 (p= < 0.001). At POD 2, 674 patients (58%) were at least 6 h out of bed (92% of the group early mobilisation at POD 1 *vs.* 36% of the group delayed mobilisation at POD 1, p= < 0.001), while at POD 3, 807 patients (69%, 92% of the group early mobilisation

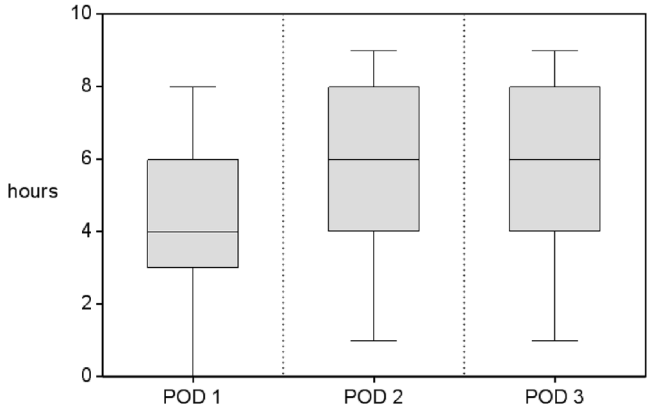

Fig. 1. Mobilisation time at different postoperative days.
Whisker plots illustrating mean mobilisation time at POD 1–3 of the entire cohort (n = 1170). POD – postoperative day.

Table 1
Demographics.

	All Patients (n = 1170)	Early mobilisation (n = 494)	Delayed mobilisation (n = 676)	P
Age (mean ± SD)	63 ± 15	61 ± 15	65 ± 16	**0.002**
Age > 70 years (%)	460 (39)	168 (34)	292 (43)	**0.002**
Gender (m:f)	636: 534	291: 203	345: 331	**0.009**
BMI (kg/m^2) (mean ± SD)	25.6 ± 5.1	25.7 ± 5.1	25.4 ± 5.1	0.342
ASA Group (1–2: 3–4)	979: 322	377: 117	452: 224	< **0.001**
Smoking (%)	248 (21)	103 (21)	145 (21)	0.828
Alcohol abuse (%)	122 (10)	49 (12)	73 (9)	0.627
Diabetes mellitus (%)	136 (12)	47 (9)	89 (13)	0.064
Preoperative malnutrition (%)	187 (16)	62 (13)	125 (18)	**0.006**
WHO performance score > 2 (%)	207 (18)	59 (12)	148 (22)	< **0.001**
Preoperative radiotherapy (%)	158 (14)	65 (13)	93 (14)	0.795
Preoperative chemotherapy (%)	170 (15)	66 (13)	84 (15)	0.356
Immunosuppression (%)	126 (11)	47 (10)	79 (12)	0.253
Previous abdominal surgery (%)	561 (48)	243 (49)	318 (47)	0.515
Underlying disease:				
Malignancy	740 (63)	314 (64)	426 (63)	0.849
Diverticulitis	165 (14)	70 (14)	95 (14)	0.955
Inflammatory bowel disease	69 (6)	31 (6)	38 (6)	0.639
Functional disorder	84 (7)	30 (6)	54 (8)	0.210
Other benign condition	112 (10)	49 (10)	63 (9)	0.731

Baseline demographic parameters of patients who mobilise > 6 h on POD1 (n = 494) and patients who mobilise < 6 h on POD1 (n = 676).
BMI – body mass index, ASA – American Society of Anesthesiology, WHO – World Health Organisation.
Age and BMI are presented as mean ± standard deviation. All others are frequency with percentage. Bold characters indicate significant values (p < 0.05).

at POD 1 *vs.* 53% of the group delayed mobilisation at POD 1, p = < 0.001) were compliant with recommendations.

3.2. ERAS compliance and modifiable pre-and intraoperative ERAS items

Seven hundred and fourty six patients (64%) presented an *overall* compliance of at least 70% (348 patients (70%) in the group fast mobilisation *vs.* 398 patients (59%) in patients with delayed mobilisation, p = < 0.001). Fig. 3 illustrates modifiable pre- and intraoperative ERAS items in both groups; fast mobilisation (494 patients) *vs.* delayed mobilisation (676 patients). Differences between the two groups were observed when comparing the following items: preadmission information (440 patients (89%) *vs.* 567 patients (84%), p = 0.013), no abdominal drains (414 patients (94%) *vs.* 497 patients (84%), p = < 0.001), intraoperative fluid administration of < 2000 mL (346 patients (70%) *vs.* 363 patients (54%), p = < 0.001) no prophylactic NGT (481 patients (97%) *vs.* 626 patients (92%), p = < 0.001) and intraoperative EDA (159 patients (32%) *vs.* 266 patients (39%), p = 0.014).

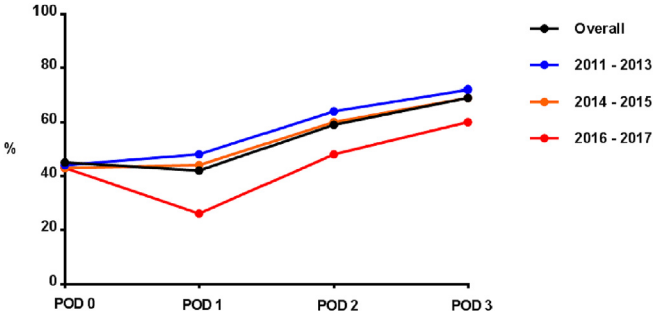

Fig. 2. Postoperative mobilisation according to time period.
Percentage of ambulant patients according to guidelines at different postoperative days (POD 0–3) and at different periods: overall (2011–2017, black line), 2011–2013 (blue line), 2014–2015 (orange line) and 2016–2017 (red line).
At POD 0, patients were supposed to leave bed at least once. At POD 1–3, patients were supposed to be out of bed at least during 6 h.
POD – postoperative day.

Table 2
Surgical parameter.

	All patients (n = 1170)	Early mobilisation (n = 494)	Delayed mobilisation (n = 676)	P
Surgical procedure:				
Left colectomy (%)	310 (26)	131 (26)	179 (26)	1.000
Right colectomy (%)	238 (20)	93 (19)	145 (22)	0.303
Total colectomy (%)	47 (4)	20 (4)	27 (4)	1.000
Rectal procedure (%)	234 (20)	79 (16)	155 (23)	**0.004**
Hartmann reversal (%)	69 (6)	28 (6)	41 (6)	0.803
Ileostomy closure (%)	253 (22)	143 (29)	110 (16)	< **0.001**
Other (%)	19 (2)	0 (0)	19 (3)	< **0.001**
Minimal invasive approach (%)	676 (58)	286 (58)	390 (58)	0.952
Conversion to open approach (%)	70 (10)	20 (7)	50 (13)	**0.015**
Emergency indication (%)	239 (20)	74 (15)	165 (24)	< **0.001**
Operation duration (min) (mean ± SD)	180 ± 90	167 ± 83	199 ± 98	< **0.001**
Operation duration > 180 min (%)	450 (38)	155 (31)	245 (44)	< **0.001**
Intraoperative blood loss (mL) (mean ± SD)	130 ± 200	110 ± 170	200 ± 310	< **0.001**
Intraoperative blood loss > 200 mL (%)	323 (28)	106 (22)	217 (32)	< **0.001**

Surgical procedures and parameters of patients who mobilise > 6 h on POD1 (n = 494) and patients who mobilise < 6 h on POD1 (n = 676).
Operation duration, intraoperative blood loss and length of incision are presented as mean ± standard deviation. All others are frequency with percentage. Bold characters indicate significant values (p < 0.05).

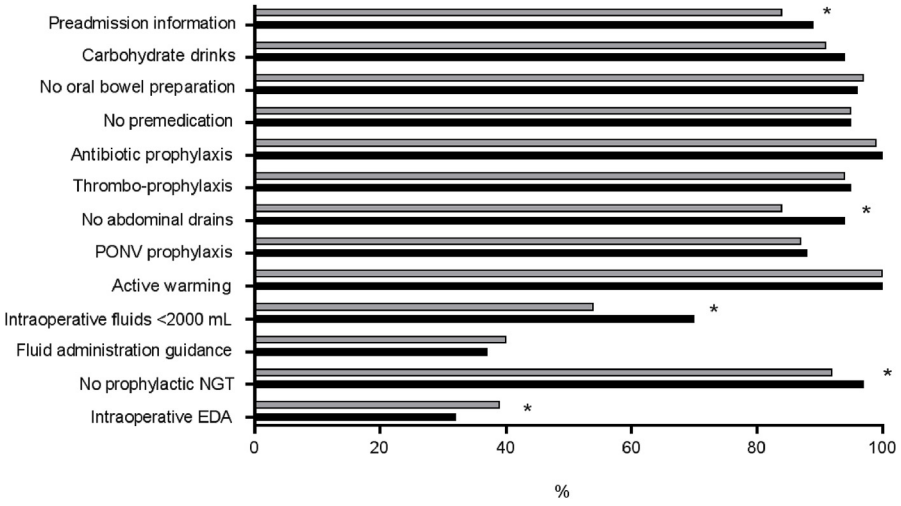

Fig. 3. ERAS compliance.
Comparison of compliance to modifiable pre- and intraoperative ERAS-related items among patients who mobilise > 6 h on POD1 (black bars) and patients who mobilise < 6 h on POD1 (grey bars).
Premedication = administration of long-acting sedative medication.
ERAS – Enhanced Recovery After Surgery, PONV – postoperative nausea and vomiting, NGT – nasogastric tube, EDA – epidural analgesia.
* indicates statistical significance (p < 0.05).

3.3. Factors associated with delayed mobilisation

Univariate demographic and surgical risk factors (p < 0.005) associated with delayed mobilisation are displayed in Tables 1 and 2.

Multivariate analysis retained emergency indication (Odds Ratio (OR) 0.40; 95% Confidence Interval (CI) 0.18–0.91, p = 0.028) and age > 70 years (OR 0.69; 95% CI 0.47–1.00, p = 0.050) as independent risk factors for delayed mobilisation, while stringent intraoperative fluid management (intraoperative total fluids < 2000 mL: OR 1.71; 95% CI 1.07–2.73, p = 0.025) correlated with early mobilisation (Fig. 4).

3.4. Outcome

Decreased mobilisation was associated with more overall (372/676 patients (55%) *vs.* 146/494 patients (29%), p= < 0.001) and major complications (110 patients (16%) *vs.* 34 patients (7%), p < 0.001). A correlation with surgical (176 patients (26%) *vs.* 64 patients (13%), p= < 0.001), infectious (148 patients (22%) *vs.* 53 patients (11%), p= < 0.001), cardiac (46 patients (7%) *vs.* 15 patients (3%), p = 0.004) and respiratory (81 patients (12%) *vs.* 19 patients (4%), p= < 0.001) complications was observed, and reoperation rate (90 patients (13%) *vs.* 25 patients (5%), p= < 0.001) was higher in patients with delayed mobilisation (Fig. 5) who also had a longer length of stay (12 ± 14 *vs.* 6 ± 7days, p= < 0.001).

4. Discussion

Fifty-eight percent of patients were not able to be out of bed during the recommended 6 h at the first postoperative day, as recommended by the ERAS protocol. This was not primarily due to seemingly obvious barriers such as comorbidities or the extent of surgery, but rather explained by intraoperative fluid overload, which was retained as modifiable independent risk factor for delayed mobilisation. The present study revealed significant associations between bed rest and postoperative complications.

Early postoperative mobilisation has several goals. First, muscle loss due to physical deconditioning can be minimized [12]. Second, bed rest exposes the surgical patient to thromboembolic complications [13]. Finally, postoperative ambulation has been associated with increased functional recovery, in particular by decreasing postoperative ileus through direct prokinetic effect [2]. Former reports have studied postoperative mobilisation patterns within an enhanced recovery protocol. A recent retrospective study retained 3 key elements associated with improved outcomes: laparoscopic approach, stringent perioperative fluid management and postoperative mobilisation [14]. A recent randomized controlled trial emphasized the importance of early ambulation, even though improved outcomes using staff-directed facilitation were not demonstrated [15]. Finally, a recent systematic review concluded that even though bed rest was harmful, most studies reporting on early mobilisation were of poor quality [16]. It is however important to emphasize that early mobilisation in included studies was not part of an established multimodal enhanced recovery concept [17]. Altogether, these studies support the following concept: early mobilisation needs to be embedded in a multimodal concept as recommended by ERAS, with highest possible adherence to *all* items of the protocol [9,10].

The present study evaluated the concept of early ambulation using a

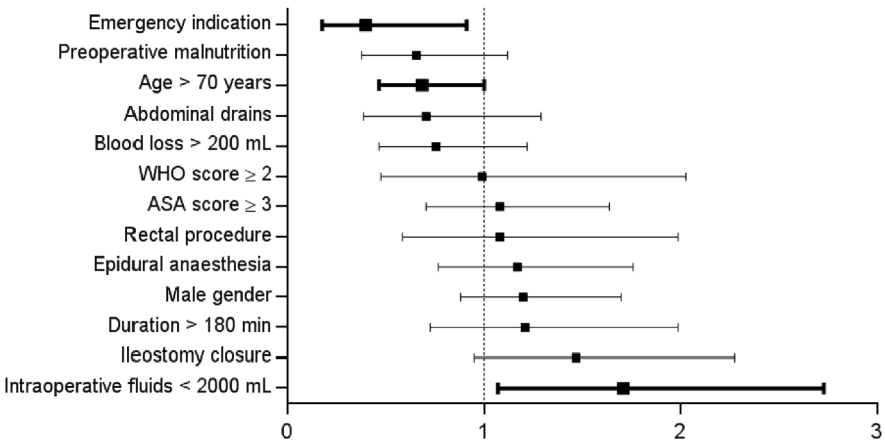

Fig. 4. Multivariate analysis.
Multivariate analysis of univariate factors with p < 0.05 associated with postoperative mobilisation. An Odds ratio of more than 1 is associated with factors that favour postoperative mobilisation. NGT – nasogastric tube, ASA – American Society of Anesthesiology, WHO score – World Health Organisation performance score.
Odds ratio, 95% Confidence Interval.
Significant items are highlighted in bold.

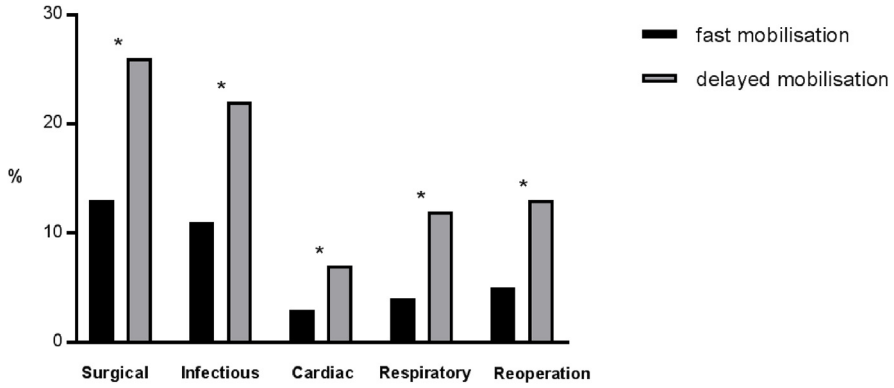

Fig. 5. Postoperative complications.
Comparison of surgical, infectious, cardiovascular and respiratory complications and reoperation rate among patients who mobilise > 6 h on POD1 (black bars) and patients who mobilise < 6 h on POD1 (grey bars).
* indicates statistical significance ($p < 0.05$).

different approach, since its retrospective design allowed to stratify between ambulant and less active patients. It was decided to compare these 2 groups at POD1, to account for potential bias when comparing patients at POD0 due to influence of morning or afternoon schedule of surgery. As a main result, over half of patients were not able to adhere to the ambitious mobilisation goals recommended by the protocol. Further, mobilisation goals were even less often achieved in recent time periods (2016–2017) (Fig. 2). This disappointing evolution might be explained by less stringent application of set mobilisation goals, contrarily to time periods closer to initial ERAS implementation with concomitant initial enthusiasm (2011–2015). This phenomena of decreased compliance and sustainability after the initial implementation period has been previously described [18]. On the other hand, it needs to be emphasized that mean mobilisation times were rather encouraging, reaching 4.5 h at POD 1 and almost the recommended 6 h per day thereafter (Fig. 1). Hence, significant postoperative mobilisation was achievable in most patients.

Without pretending straightforward causal associations, predisposing factors for decreased ambulation were looked for among modifiable ERAS items (Fig. 3). Due to reasons of low sample size, not every single item could be retained for the multivariate model. However, compliance differed among 5 items, starting with patient education, which emphasizes the importance to deliver clear instructions regarding postoperative mobilisation goals already in the outpatient clinic [19,20]. Only one variable was retained after multivariate analysis as independent risk factor: fluid overload. The concept of stringent fluid management has been shown to be of overwhelming importance [21,22]. Pre-operatively, patients are kept well hydrated (no bowel preparation, free clear liquids until 2 h preoperatively) which permits to pursue intraoperatively with well-adjusted “zero” fluid balance. Postoperatively, early resumption of a normal diet including liquids is aimed for to avoid unnecessary intravenous infusions and fluid overload. A recent large scale study assessed fluid management practice and association with postoperative recovery. Hospitals reporting high fluid balances had a significantly longer length of stay independently of patients' complexity and complications, similar to the results of the present study [22].

Further risk factors for decreased postoperative mobilisation were advanced age and emergency surgery. Even if mobilisation goals for elderly patients seem ambitious, previous reports demonstrated the safety, feasibility and beneficial effect of ERAS in this particular subgroup of patients [23,24]. Even though mobilisation goals were less often achieved by elderly patients, ambulation needs to be actively promoted to pre-empt the vicious cycle of decreased motivation, muscle loss and respiratory complications [25].

The present study revealed a significant correlation of early ambulation with postoperative outcomes. Obviously, many factors need to be considered and no cause-effect relation is pretended through this univariate comparison. However, previous reports have demonstrated similar associations, especially regarding respiratory and thromboembolic complications [26–29].

4.1. Study limitations

Several limitations of the present study need to be addressed beyond its retrospective design. Postoperative mobilisation was patient-reported, going along with inherent limitations. Second, some patients might have been able but not willing to go out of bed. However, reasons for patients' non-mobilisation were not recorded. Pre- and perioperative patient education and counselling regarding mobilisation goals might be particularly important for these patients [19,20]. Third, as previously mentioned, several elements might impact the main outcome “mobilisation at POD1”, including intraoperative complications impeding early ambulation. Thus, conclusions need to be drawn with caution. Finally, the present study included a wide range of diseases and surgical procedures, leading to a heterogeneous but unselected patient cohort (“all-comers”).

5. Conclusions

In conclusion, more than half of patients did not mobilise as recommended by the ERAS protocol on the first postoperative day. In these patients, postoperative morbidity and length of stay were increased. Avoidance of intraoperative fluid overload is likely to facilitate early ambulation.

Ethical approval

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Author contribution

FG: conception and design, analysis and interpretation, draftingBP: design, analysis and interpretation, critical revision DM: analysis and interpretation, critical revision VA: data acquisition, interpretation, critical revision DH: analysis and interpretation, critical revision ND: conception, interpretation, critical revision MH: conception and design,

analysis and interpretation, drafting.

Conflicts of interest

All authors have no conflict of interest to declare.

Trial registry number

www.researchregistry.com (UIN researchregistry 3161).

Guarantor

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Disclosure of interest

None Declared.

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