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Short communication

Quantifying postoperative mobilisation following oesophagectomy

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Abstract

Objective Early mobilisation is in integral component of postoperative recovery following complex surgical procedures such as oesophageal cancer resections, however evidence to guide early mobilisation protocols in critical care settings is limited. Furthermore, little is known about actual mobilisation levels postoperatively. This study quantified postoperative mobilisation post- oesophagectomy and investigated barriers to mobility.
Design Prospective observational study.
Setting Postoperative critical care setting in a tertiary care referral centre for oesophagectomy.
Participants Thirty participants (mean age 65 (SD 7) years, n = 19 males) scheduled for oesophagectomy.
Main Outcome Measures The primary outcome, postoperative physical activity, was measured objectively using the Actigraph GT3X+. Medical records were examined for a range of outcomes including medical status, pain scores and physiotherapy comments to identify factors which may have influenced mobility.
Results During postoperative day (POD) 1–5, participants spent the majority of time (>96%) sedentary. Participation in light intensity activity was low but did increase daily from a median of 12 (IQR 19) minutes/day on POD1 to a median of 53 (IQR 73.25) minutes/day on POD5 $p < 0.001$), with a corresponding increase in daily step count. Haemodynamic instability was the most common reason reported by physiotherapists for either not attempting mobility or limiting postoperative mobilisation levels.
Conclusions These data demonstrate that despite daily physiotherapy, there are multiple challenges to postoperative mobilisation. Haemodynamic instability, likely related to thoracic epidurals, was the key limitation to early mobilisation. Goal-directed mobilisation in collaboration with the multidisciplinary team may play a considerable role in overcoming modifiable barriers to postoperative mobilisation.

Keywords: Oesophagectomy; Early ambulation; Physiotherapy techniques; Postoperative care

Introduction

Early mobilisation is an important component of postoperative recovery [1,2]. Mobilisation covers a spectrum of activities spanning passive and active range of movement, bed mobility, bedside activities, transfers and ambulation [3] with the primary goal of reducing postoperative morbidity, particularly postoperative pulmonary complications, and shortening hospital length of stay (LOS). While there is a strong physiological rationale underpinning this hypothesis [4], evidence to support these effects in surgical cohorts is conflicting [1,3] and there is a lack of research to guide clinical implementation of early mobilisation protocols. The ill-effects of prolonged immobilisation including skeletal

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muscle weakness [5], functional decline [6] and cognitive disturbance [7] are widely acknowledged and therefore best practice for postoperative management recommends that mobilisation be commenced as early as possible.

Oesophagectomy remains the only curative intervention for oesophageal and oesophagogastric-junctional cancers. This complex procedure involving upper laparotomy usually in combination with thoracotomy and one lung anaesthesia, is associated with a relatively high postoperative risk [8]. Oesophagectomy care is typically centralised to high-volume centres with multidisciplinary expertise, thus lowering hospital mortality and postoperative morbidity [9]. Within high-volume centres, a standardised enhanced recovery after surgery (ERAS) approach aiming to optimise pre-operative status, reduce postoperative complications and accelerate recovery through defined, integrated multidisciplinary team care [10], is increasingly applied. Early mobilisation implemented according to a structured mobilisation regime, is an integral component of ERAS for all major surgeries, including oesophagectomy, however mobilisation goals vary [10,11] and clinical judgement based on patient assessment is often required [12].

Despite recommendations to encourage early mobilisation, daily postoperative mobilisation levels following thoracotomy and laparotomy are strikingly low [13–15], while patient mobilisation following oesophagectomy is unknown. Postoperative mobilisation can be limited by many factors including pain, insufficient cardiovascular reserve, presence of attachments and postoperative analgesia [13,16,17]. Identifying barriers to postoperative mobilisation and designing strategies to overcome modifiable factors is key to integrating early mobilisation into multidisciplinary ERAS pathways. The aim of this study was to objectively examine activity during postoperative days (POD) 1 to 5 in patients undergoing oesophagectomy and to examine factors influencing mobilisation in this setting.

Methods

Study design

This study was designed as a longitudinal observational study. All patients scheduled for oesophagectomy between July 2014 and August 2015 at the Oesophageal and Gastric Cancer Centre at St James's Hospital, Dublin, Ireland, a high-volume national centre [9], were eligible for inclusion. Participants were recruited and consented pre-operatively from the upper gastrointestinal review clinic. Post operatively, participants were fitted with an activity monitor, worn from POD1 to 5. Ethical approval was granted from the hospital research ethics committee (approval number 2014/01/List 1) and participants provided written informed consent. This study is reported in accordance with the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines.

Clinical treatment

All participants were treated according to standardised care pathways involving either multimodal therapy or surgery only. Patients with locally advanced disease received either pre- and postoperative chemotherapy [18] or neoadjuvant chemoradiation [19]. Surgical resection, involving either transthoracic en-bloc oesophagectomy (2-stage or 3-stage) or transhiatal oesophagectomy, was performed at least 6-weeks post neoadjuvant therapy. Postoperatively, patients were immediately extubated and admitted to a monitored bed, normally the high dependency unit (HDU). Patients were transferred to the ward on POD3 or when medically suitable. The institutional ERAS protocol included early enteral feeding via jejunostomy, removal of chest drains on POD2 and contrast study for anastomotic integrity on POD4. Postoperative analgesia was managed using thoracic epidural analgesia (TEA). Physiotherapy interventions, commencing from POD1, included airway clearance techniques and early mobilisation. Early mobilisation goals were determined individually for each patient by the treating physiotherapist following assessment. Suitability to mobilise was determined based on standard assessment of medical status, cardiovascular reserve and respiratory reserve [20]. While mobilisation target distances were not prescribed, mobilisation was encouraged from POD1. This study represents the first audit of early mobilisation practice.

Outcome measures

Physical activity and daily step count was measured using the Actigraph GT3X+ (Actigraph LLC, Pensacola, Florida, USA). The Actigraph is a small, lightweight device containing an accelerometer and a pedometer which has been extensively studied for its validity and reliability, and is accurate for measuring step counts for a range of age-groups [21]. The monitor uses vector magnitude data from all three axes and assigns a number from 0 to 3 to distinguish whether an individual is not wearing the monitor, is sitting, lying or standing. Pilot analysis in preparation for this work demonstrated that, when worn at the right anterior superior iliac spine, the inclinometer correctly coded a range of sedentary and light intensity behaviours with the following accuracy; sitting 72%, standing 72%, right side lying 83%, marching on the spot (coded as standing) 78% and walking (coded as standing) 100% [22].

The Actigraph was attached on the lateral aspect of each participant's hip on the right side by the treating physiotherapist using adhesive tape prior to first physiotherapy intervention on POD1 and was removed on the morning of POD6. Attaching the monitor using adhesive tape ensured optimal hygiene, positioning and patient safety. There were no issues with patient comfort, tolerance or adherence with the monitor. Physical activity data were downloaded to the Actilife software and categorised into activity domains using established algorithms, which categorised vector magnitude counts per minute (CPM) into sedentary (0 to 99 CPM), light (100 to 2019 CPM), moderate (2020 to 5998 CPM) and vigorous (≥5999 CPM) intensity activity [23]. Absolute step counts were quantified daily using the pedometer data. Records were examined 12:00 on POD1 until 08:00 on POD6.

Clinical data

Demographic and clinicopathologic data were gathered from medical charts. Daily physiotherapy records were maintained prospectively and audited retrospectively by a physiotherapist not involved in patient care. The following data were extracted: number of daily physiotherapy visits, details of mobilisation episodes, reasons for not mobilising patients and duration of physiotherapy visit.

Data analysis

Data were analysed by using IBM SPSS Statistics version 22 (SPSS, IBM Corporation, NY). Normality of continuous variables was checked by the Shapiro–Wilk test. Normally distributed data were presented as means (standard deviation (SD)) and non-normally distributed data as medians (interquartile range (IQR)). Daily minutes spent in light intensity activity and daily step count data were log-transformed to a normal distribution for data analysis. Categorical variables were presented as frequency (percentage). Open-text physiotherapy comments were examined by content analysis to identify factors influencing participation. A one-way repeated measures analysis of variance (ANOVA) was conducted to compare log transformed daily minutes spent in light intensity activity on each postoperative day from POD1 to POD5 and total daily step counts from POD1 to POD5. Significance was taken at $P < 0.05$.

Results

Following pre-operative screening of 39 patients, 36 participants consented, and 32 proceeded to oesophagectomy. Postoperative physical activity (Actigraph) data were not collected on two participants due to logistical restrictions and therefore 30 participants were included in the final analysis. The majority of patients were treated using multimodal therapy ($n = 24$) and transthoracic oesophagectomy was the most common surgical approach ($n = 25$). Demographic details are displayed in Table 1.

Table 1
Clinicopathologic characteristics.

Clinicopathologic characteristics	
Demographics	
Age (years)	63 (8)
Gender	
Male	19 (63%)
Female	11 (37%)
Height (cm)	168.1 (7.9)
Weight (kg)	73.2 (12.5)
Clinical details	
Tumour histology	
Adenocarcinoma	20 (67%)
Squamous cell carcinoma	10 (33%)
Neoadjuvant therapy	
CROSS	17 (57%)
MAGIC	7 (23%)
None	6 (20%)
ASA score	
1	5 (17%)
2	20 (67%)
3	5 (17%)
Operative details	
Surgical approach	
2-stage oesophagectomy	17 (57%)
3-stage oesophagectomy	8 (27%)
Transhiatial oesophagectomy	6 (20%)
Surgery duration (median hours)	5.0 (0.8)
Postoperative recovery	
Hospital length of stay (median days)	17.5 (14)
Critical care length of stay	4 (3.25)
No. of patients discharged to the ward during POD1 to 5	18 (60%)
No. of patients intubated[a]	4 (13%)
Postoperative complications	
Pulmonary complications	12 (40%)
Anastomotic leak	0
Vocal cord paralysis	1 (3%)
Chyle leak	2 (7%)
Wound infection	3 (10%)
Atrial fibrillation	6 (20)
In-hospital postoperative mortality	0

Data is presented as mean (SD) for normally distributed and as median (interquartile range) for non-normally distributed data. Categorical data is presented as frequency (percentage). ASA = American Society of Anesthesiologists. CROSS = neoadjuvant chemoradiation protocol [Carboplatin and Paclitaxel with concurrent radiotherapy, 41.4Gy/23Fr, over 5 wks]; MAGIC = pre- and postoperative chemotherapy protocol [Etoposide, Cisplatin, Fluorouracil or Capecitabine].

[a] Three patients were intubated for <24 hours and therefore did not mobilise for one postoperative day and one patient was intubated from POD3 to POD5 and therefore did not mobilise for two postoperative days during the study period.

Postoperative mobilisation

All patients were transferred to a critical care unit postoperatively ($n = 20$ to the HDU and $n = 10$ to the intensive care unit) and were reviewed by a physiotherapist on the morning of POD1. From POD1 to 5, patients received a median of 6 (range 3 to 9) physiotherapy visits (total of 172 physiotherapy visits). The median total physiotherapy direct patient contact time for each patient over this period was 85 (22.5) minutes.

Patients were assessed for suitability to mobilise on every documented physiotherapy visit. On POD1, physiotherapy interventions involved mobilisation during 27/42 patient visits ($n = 15$ transfer bed to chair; $n = 4$ bedside marching; $n = 8$ ambulation (range mobilised 20 to 200 m)). During postoperative recovery, patients mobilised with a physiotherapist on 24/37 patient visits on POD2, 29/37 patient visits on POD3, 26/34 patient visits on POD4 and 15/22 visits on POD5. Distances mobilised ranged from 10 to 400 m.

Patients spent >96% time per day sedentary from POD1 to POD5. The median number of minutes spent engaging in light intensity activity was low (Table 2) but increased daily (Fig. 1a). Similarly, total step counts were low but increased daily (Fig. 1b). Daily minutes in light intensity activity correlated strongly and positively with daily step count ($r > 0.70$, $P = 0.000$). Participants completed no moderate or vigorous intensity activity postoperatively.

Factors influencing mobilisation

Of the total 172 physiotherapy visits, mobility was not attempted on 51 occasions. The most common reason determining unsuitability to mobilise was use of inotropic medication ($n = 9$ visits). The second most common reason was patient refusal, typically due to fatigue/feeling unwell ($n = 6$), followed by low blood pressure on POD1 ($n = 5$ visits) (Table 3).

Factors limiting the quantity of mobilisation achieved during treatments with physiotherapy were examined for the 136 documented mobilisation events. Postural hypotension during mobilisation was the most common reason for limiting or terminating mobilisation ($n = 12$ visits). Further, on two occasions the surgical team advised that mobilisation be limited due to low baseline blood pressure. Patient reported pain was the second most common reason for limiting mobilisation ($n = 5$) followed by the presence of multiple surgical and medical attachments ($n = 5$).

Discussion

The key finding from this paper is that despite daily encouragement to mobilise, daily mobilisation levels were low, limited most particularly by low blood pressure often in association with inotropic support. Haemodynamic instability characterised by use of inotropic medication and orthostatic hypotension are the most common factors cited by physiotherapists for either not attempting or limiting mobilisation. Results provide an original objective quantification of postoperative mobilisation from POD1 to POD5 and consistent with reports from other major surgeries [14,15,24], identify the challenges to early mobilisation following complex resection.

Postoperative mobilisation, utilised therapeutically as a form of light intensity exercise, is prescribed to take advantage of the acute effects of exercise and upright positioning on the oxygen transport system [4,25]. Due to acute postoperative cardiopulmonary dysfunction, low intensity exercise is associated with significant metabolic demand [26] and enhances oxygen transport along multiple stages of the oxygen-transport pathway [4]. Unsurprisingly therefore, in the current study light intensity activity was the most common activity domain achieved by patients, ranging from a median (IQR) of 12.0 (19.0) minutes on POD1 to 53.0 (73.25) minutes on POD5 (median daily steps count: POD1 80.0 (167.0) to POD5 474.5 (542.5)). While these activity levels appear low, they are comparable to other reports [14,15,24]. Browning et al. reported total daily uptime, ranging from a median of 3.0 (8.2) minutes on POD1 to 34.4 (65.6) minutes on POD4 following upper abdominal laparotomy [15]. Similarly, Agostini et al. reported median step counts ranging from 170 (290) steps on POD2 to 233 (577) steps on POD3 following thoracotomy and lung resection [24]. While early mobilisation is advocated in postoperative recovery, evidence to guide the timing or quantity of mobilisation for physiological benefit is lacking [11]. The results of this study and others suggest that even with physiotherapy input, there are considerable challenges to postoperative mobilisation.

Low blood pressure and the related use of inotropic medication to maintain a stable blood pressure ($MAP = 65$ mmHg), were the major factors restricting attempts to mobilise. Orthostatic hypotension, principally related to epidural analgesia [17,27], is one of the biggest challenges impeding progression of postoperative mobilisation [27,28]. In line with best practice [11], patients in the current study received postoperative TEA, where postural hypotension arising from sympathetic blockade leading to peripheral vasodilation, is a known side effect [27]. Epidural analgesia is associated with a higher incidence of postoperative hypotension compared to either intramuscular analgesia or patient controlled analgesia following major surgery [29]. However, the association between TEA-induced hypotension and ability to ambulate is unclear. Gramigni and colleague [27], identified that while both mean arterial blood pressure <70 mmHg in supine and intraoperative blood loss >500 mls were independent predictors of postoperative mobility, there was no association between TEA-induced reduction in blood pressure and ambulation in 161 patients following thoracic or abdominal surgery [27]. Furthermore, studies have reported lower pain scores during postoperative mobilisation in patients managed with TEA compared to patients managed with intravenous opioids [30,31], however the relationship with actual quantity of mobilisation achieved was not reported. Together, results suggest that while TEA does lower blood pressure, this is not the sole limiting factor to postoperative ambulation.

Accordingly, use of inotropic medication to regulate blood pressure, typically with TEA, is indicative of haemodynamic instability [10,32] and therefore in the current study this was the most common reason cited by physiotherapists for not attempting to mobilise. While patients on low-doses of inotropes can ambulate [32], this requires arterial blood pressure monitoring and therefore in some instances, physiotherapists in the current study mobilised patients with bedside marching to access the cardiovascular system monitoring.

Table 2
Daily light intensity activity scores and total daily step counts.

	POD1[a]	POD2	POD3	POD4	POD5	*P*-value
Light intensity activity (minutes/day)	12 (7 to 26)	15 (9 to 27)	24 (13 to 53)	38 (18 to 60)	53 (21 to 91)	$P < 0.001$
Total daily step counts (steps/day)	80 (46 to 210)	119 (74 to 199)	159 (90 to 363)	199 (116 to 326)	474 (302 to 825)	$P < 0.001$

All data are presented as median (interquartile range). POD = postoperative day. *P*-value represents change in activity patterns from POD1 to POD5.
[a] Data for POD1 presented for the afternoon only.

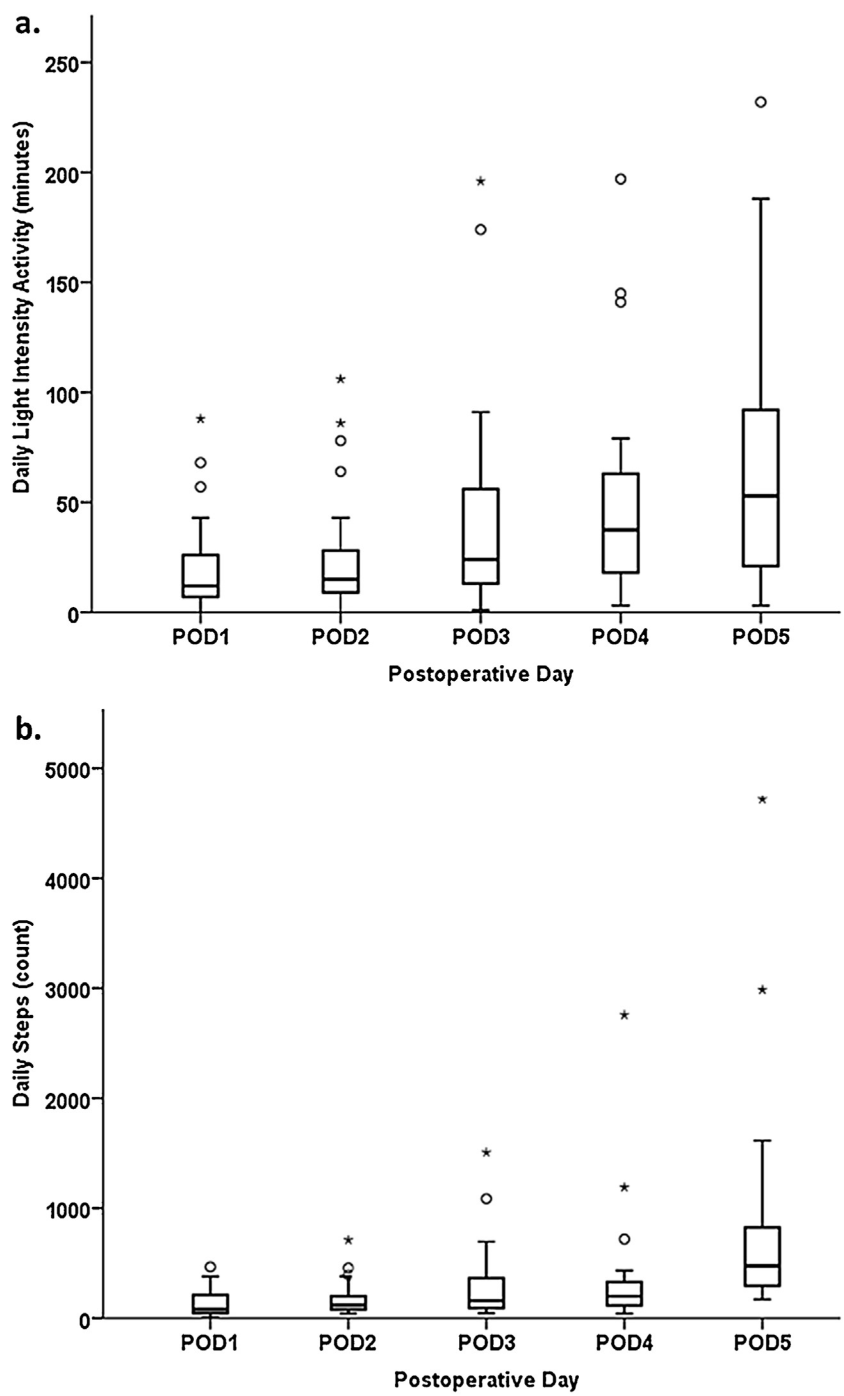

Fig. 1. Postoperative activity levels. (a) Time spent in light intensity activity on each postoperative day. (b) Total daily step count on each postoperative day.

Table 3
Physiotherapist reported factors limiting mobilisation attempts and participation.

	POD1	POD2	POD3	POD4	POD5	Total
Factor limiting mobilisation being attempted						
Inotropic medication	6	1	2			9
Patient refusal	1	4	1			6
Low blood pressure	5					5
Pain	1	3				4
Cardiac instability		3	1			4
Environmental factors (staffing, lack of equipment)	1	1	2			4
Patient intubated			2	1		3
Patient drowsy/asleep	1	1		1		3
Medically unwell			1		1	
Already sitting out of bed with nursing staff	2					2
Reason not documented	1	2		3	1	7
Factors limit mobilisation progression						
Postural low blood pressure	6	4	1	1		12
Pain	2		1	1	1	5
Attachments	3	1		1		5
Inotropic medication	1		1	1		3
Oxygen desaturation when mobilising	1		1	1		3
Patient unsteady	1	1		1		3
Patient fatigued		1	2	1	1	5
Surgical team advised patient medically unsuitable to mobilise due to low resting blood pressure	2					2
Adverse cardiac response to mobilisation			1	1		2
Environmental factors (staffing, lack of equipment)		1	1			2

Data are presented as counts per day. The total number of limiting factors exceeds the number of mobilisation attempts/non-attempts due to more than one documented reason for limited mobilisation. POD = postoperative day.

Pre mobilisation assessment of blood pressure in supine, sitting and standing may help determine suitability to ambulate [27,32] however there is a clear need to develop strategies to mobilise or exercise patients who experience haemodynamic instability. Other modes of postoperative exercise such as bedside cycling may have potential. Bhatt et al. reported that in comparison to matched historic controls ($n = 30$), patients who exercised postoperatively according to a low intensity twice daily exercise programme using a pedal cycle ergometer ($n = 30$) experienced lower rates of respiratory infection and shorter hospital LOS following major abdominal surgery [33]. In a larger study of critically ill patients in medical and surgical ICU ($n = 90$), Burtin et al. reported that daily cycle ergometry resulted in longer walking distance, greater muscle strength and enhanced functional well-being at hospital discharge compared to standard critical care respiratory physiotherapy [34]. There is considerable potential for this approach to enhance postoperative exercise participation and further research to inform therapeutic exercise parameters is warranted.

Other barriers to mobilisation identified include pain, patient refusal, environmental factors related to staffing and presence of attachments. These barriers are consistent with previous reports [14,16,24] and can be addressed by adequate postoperative analgesia, timely removal of attachments, early discharge to non-critical care environments and pre-operative education [10,35]. Interprofessional collaboration and teamwork is critical to achieving mobility goals [3,36–38] and the value of a goal-directed approach to early mobilisation, with multidisciplinary collaboration, needs to be considered. While an ERAS approach to postoperative mobilisation was encouraged in the current study, daily mobilisation goals were not defined. In contrast, critical care mobilisation protocols that include daily mobilisation targets and interprofessional communication, are associated with greater postoperative mobilisation [3,36], shorter critical care LOS [3,36,37] and better physical function [3,37]. This study was completed as part of an institution audit to inform the integration of early mobilisation into our institutional ERAS pathway for oesophagectomy, most particularly to inform barriers to mobilisation. Goal directed mobilisation targets and the provision of two daily physiotherapy visits have been introduced as a result of this work. Physiotherapy leaders have provided training to junior colleagues and other professions and multidisciplinary management of postoperative hypotension is prioritised. Future work will examine the impact of this on postoperative mobilisation.

There were a number of limitations to this work. Firstly, the sample size was small limiting data analysis. The sample however was recruited from a high-volume centre that is representative of modern postoperative approach to oesophagectomy care. Secondly, physiotherapy notes were reviewed from medical records and the limitations of retrospective data analysis apply. Thirdly, this study focuses on physiotherapy-led postoperative mobilisation and does not consider nurse-led mobilisation or the barriers experienced by this profession. Most particularly, results are likely to underestimate nurse-led edge of bed activity and bed-to-chair transfers on POD1 and hence the reported percentage of patients who sat out of bed on POD1 (71%; $n = 21/30$) is lower than in other reports [38]. The use of 24-hour accelerometry to objectively quantify postoperative activity is a particular strength as it captures all postoperative movement and does not rely on patient-reported or professional-reported subjective records.

In conclusion, despite physiotherapy-led interventions to promote early mobilisation following oesophagectomy, postoperative mobilisation is challenged by issues with low blood pressure and postural hypotension. Future work on postoperative therapeutic exercise prescription parameters is required.

Ethical approval: Ethical approval for this work was granted by the SJH/AMNCH Research Ethics Committee (REC Reference: 2014/01/list1/2014/02/list6).

Conflicts of interest: None declared.

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