The quantity of early upright mobilisation performed following upper abdominal surgery is low: an observational study

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Questions: How much upright mobilisation, particularly uptime, is performed in the first four days following upper abdominal surgery? In what part of the day is the greatest uptime achieved? Is length of stay related to uptime? Is there any difference in uptime in terms of postoperative factors? ***Design:*** Prospective observational study. ***Participants:*** Fifty patients who had undergone upper abdominal surgery after receiving standardised preoperative education and physiotherapy intervention on the first postoperative day. ***Outcome measures:*** An activity logger recorded uptime continuously for the first four postoperative days. Postoperative factors such as postoperative pulmonary complications, surgical attachments, pain relief, duration of anaesthesia, and intensive care admission were collected daily. ***Results:*** Total median uptime was 3.0 (IQR 8.2), 7.6 (IQR 11.5), 13.2 (IQR 26.6) and 34.4 (IQR 65.6) minutes for the first four postoperative days respectively. Morning uptime was greater than both afternoon uptime ($p = 0.001$) and evening uptime ($p < 0.001$). Uptime over the first four postoperative days predicted length of stay ($r^2 = 0.50$, $p < 0.001$). Uptime was not significantly less in those who developed postoperative pulmonary complications ($p = 0.08$ to 0.17). ***Conclusion:*** This is the first study to quantify upright mobilisation following upper abdominal surgery. The results show that the quantity of upright mobilisation performed is low. Given that uptime predicted length of stay, increasing early upright mobilisation may have a positive effect on reducing length of stay following upper abdominal surgery. **[Browning L, Denehy L, Scholes RL (2007) The quantity of early upright mobilisation performed after upper abdominal surgery is low: an observational study. *Australian Journal of Physiotherapy* 53: 47–52]**

Key words: Early Ambulation, Surgery, Motor Activity, Outcome Assessment (Health Care), Postoperative Complications, Length of Stay, Physiotherapy Techniques

Introduction

Early mobilisation is a widely practised and important component of postoperative care following open upper abdominal surgery. Its benefits were first reported in the 1940s when early mobilisation was observed to hasten recovery and reduce the incidence of postoperative pulmonary complications (Brieger 1983). There is no standard definition for early mobilisation, and it has been reported to include: moving in bed, sitting out of bed, standing, ambulating on the spot, hallway ambulation, and low intensity exercise (Dean 2006, Kirkeby-Garstad et al 2005). Mobilisation involving an upright position appears to be of greatest benefit in the early postoperative period with evidence of improvements in pulmonary function (Nielsen et al 2003). Upright mobilisation assists in the prevention of functional decline and may have a positive effect on depression and anxiety (Brooks-Brunn 1995).

In the past, the measurement of upright mobilisation has presented a challenge to the researcher. Upright mobilisation following upper abdominal surgery has been measured as the time taken to achieve mobility goals such as sitting out of bed, ambulating with assistance, or ambulating independently (Mackay and Ellis 2002, Olsen et al 1997). However, this method does not provide information about the quantity of upright mobilisation. While upright mobilisation may be quantified by direct observation, this is not practical for long periods of time or for large patient numbers. A recent innovation in the quantification of upright mobilisation has been the development of the Positional Activity Logger[(a)]. This activity logger records the quantity of time spent in an upright position – termed *uptime*. The device is worn on the thigh and senses changes in position via three mercury tilt switches. Data can be downloaded and analysed. The Positional Activity Logger is a modified version of the Uptimer, which has been shown to be a reliable and valid method of recording uptime in adults (Diggory et al 1994, Tran et al 1997). More recently, it has been used to produce normative data for uptime in children (Eldridge et al 2003a) and to compare uptime in children post open and laparoscopic appendicectomy (Eldridge et al 2003b).

Clinically, it is evident that uptime decreases significantly in the early postoperative period. However, uptime and its influence on outcomes following upper abdominal surgery have yet to be investigated. Therefore the research questions for this study were:

1. How much upright mobilisation, particularly uptime, is performed in the first four days following upper abdominal surgery?
2. In what part of the day is the greatest uptime achieved?
3. Is length of stay related to uptime?

Table 1. Criteria for diagnosis of a postoperative pulmonary complication. Diagnosis was confirmed when four or more of the following signs and symptoms were present.

- Chest radiograph report of collapse/consolidation
- Raised temperature > 38° C on two or more consecutive days
- SpO_2 < 90% on room air on two consecutive days
- Production of yellow or green sputum which is different to preoperative assessment
- An otherwise unexplained white cell count > 11×10^9/L or prescription of an antibiotic specific for respiratory infection
- Physician diagnosis of chest infection
- Presence of infection on sputum culture report
- Abnormal breath sounds on auscultation which differ from preoperative assessment

SpO_2 = pulse oximetry

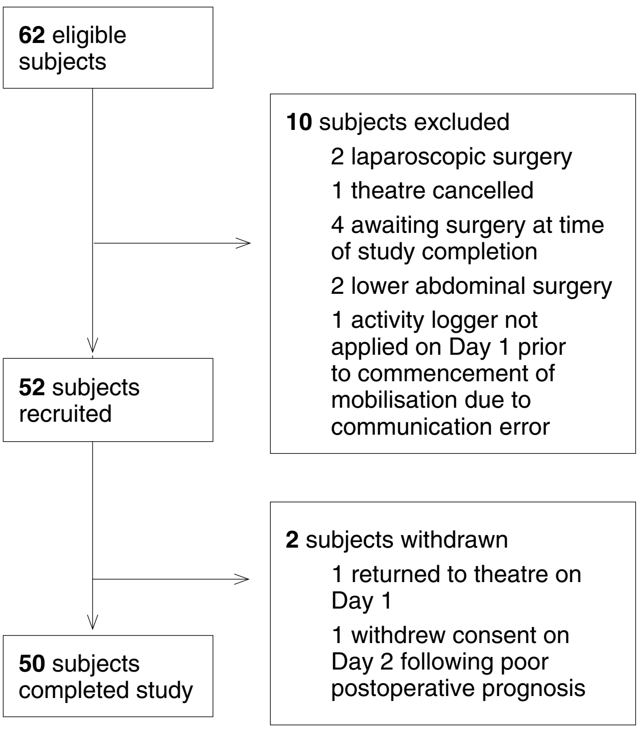

Figure 1. Flow of participants through the study.

Table 2. Characteristics of participants. Values are number (%).

Characteristic (unless otherwise specified)	Participants (n = 50)
Gender (male:female)	29:21
Age *(years)*, mean (SD)	61 (12)
Age ≥ 65	23 (46)
Cardiac disease	10 (20)
Respiratory disease	8 (16)
Smoking history	
Current	7 (14)
Non-smoker	23 (46)
Ex-smoker	20 (20)
Diagnosis of cancer	42 (84)
Body mass index *(kg/m²)*, mean (SD)	27.1 (4.3)
Pre-morbid mobility ≤ 1 km	6 (12)
Pre-morbid mobility ≤ 5 km	21 (42)
ASA status	
1	8 (16)
2	23 (46)
3	19 (38)
Incision type	
Laparotomy	38 (76)
Subcostal	12 (24)
Type of surgery	
Anterior resection	14 (28)
Hemicolectomy	7 (14)
Small bowel resection	8 (16)
Pancreatic resection/Whipples	7 (14)
Liver resection	4 (8)
Abdominoperineal resection	2 (4)
Gastrectomy	2 (4)
Oesophagectomy	1 (2)
Splenectomy	1 (2)
Cholecystectomy	2 (4)
Reversal of Hartmann's	2 (4)
Anaesthesia duration *(min)*, mean (SD)	186.6 (76.2)
Type of pain relief	
Epidural	23 (46)
PCA	26 (52)
Intramuscular	1 (2)
Intensive care admission	6 (12)
Length of stay *(days)*, median (range)	8 (3-121)

ASA = American Society of Anesthesiologists
PCA = patient controlled analgesia

4. Is there any difference in uptime in terms of postoperative factors?
5. What patient characteristics and postoperative factors are related to length of stay?

Method

Design: An observational study of upright mobilisation for the first four days following upper abdominal surgery was carried out. Preoperatively, participants were assessed and educated by a physiotherapist. Education included an explanation of the role of physiotherapy in the postoperative period, and the benefits of early upright mobilisation. A postoperative breathing exercise routine was taught and participants were encouraged to perform this hourly. A booklet containing the above information was provided to all participants. Within 24 hours of surgery, and prior to commencement of upright mobilisation, an activity logger was attached to the thigh where it recorded data continuously for the first four postoperative days before being removed on the morning of Day 5. Postoperatively, on Day 1, all participants were assessed and treated by a physiotherapist. The main objective of physiotherapy intervention was to commence upright mobilisation and revise the breathing exercise routine. Physiotherapy intervention did not occur routinely from Day 2 onwards. Participants reported by nursing or medical staff to have mobility limitations were assessed by the ward physiotherapist and the provision of gait aids was discussed with the principal investigator and provided where necessary. The Human Research Ethics Committee of The Royal Melbourne Hospital, Australia approved the study. Written informed consent was obtained from each patient prior to participation.

Participants: Patients undergoing elective upper abdominal surgery, defined as an incision above or extending above the umbilicus (Celli et al 1984), were recruited between November 2003 and October 2004. They were included if they were able to understand written and spoken English. Participants were withdrawn from the study if they required more than 12 hours of mechanical ventilation postoperatively, returned for further surgery within the first four postoperative days, withdrew consent, or required bed rest postoperatively for greater than 24 hours.

Measurement of upright mobilisation: Uptime was measured using the Positional Activity Logger. The battery-operated activity logger (90 x 54 x 18 mm) was adhered to the lateral aspect of the right thigh and recorded uptime when the thigh was in a position greater than 45 degrees to the horizontal axis (ie, during standing and walking). It was worn 24 hours a day and wrapped in cling wrap to enable the participant to shower. It was checked daily to ensure that continuous data recording was occurring. Following its removal, data were downloaded via an interface box using custom-designed software[a]. Data included total daily uptime (Day 1 to Day 4), daily sit to stand frequency (Day 1 to Day 4), single maximum uptime (Day 1 to Day 4), and uptime over three time intervals: morning (0800 to 1200 hours), afternoon (1200 to 1600 hours) and evening (1600 to 2000 hours). Only full day data were used. If the participant was discharged prior to Day 5, the activity logger was removed on the morning of discharge. If the activity logger was dislodged, inadvertently removed, or ceased to record, only full day data from the activity logger worn correctly was used.

Achievement of mobility goals was also recorded from nursing notes and self reporting. This involved recording the day that sitting out of bed, assisted upright mobilisation, and independent upright mobilisation commenced.

Measurement of postoperative factors: Postoperative factors were collected daily by the ward physiotherapist. Participants were assessed for signs and symptoms of a postoperative pulmonary complication using a standardised definition developed in previous research (Denehy 2001, Scholes 2005) (Table 1). Following confirmation of diagnosis of a postoperative pulmonary complication by the principal investigator, participants received additional physiotherapy intervention as determined by assessment findings. The frequency and type of intervention provided throughout hospital stay was recorded. The insertion and removal of surgical attachments such as epidural or intravenous infusions, nasogastric tubes or indwelling catheters was recorded daily. On each day the activity logger was worn, participants were asked to describe their pain relief during mobilisation as adequate or inadequate. Length of stay was recorded on discharge.

Data analysis: Descriptive analysis of the data was performed. Comparison of uptime on each postoperative day was performed using Wilcoxon Signed Rank tests. Multiple linear regression was used to describe the relationship between uptime (Day 1, Day 2, Day 3 and Day 4) and length of stay. Linear regression was also used to describe the relationship between length of stay and other patient characteristics and postoperative factors. In order to fulfil the assumptions of the regression analyses, logarithmic transformation (base 10) of the data was performed. However, zero uptime on Day 1 was a problem for logarithmic transformation and was dealt with by adjusting these values to be mid-way between zero and the smallest positive value (0.3 minutes) (Gordon 2005). Morning, afternoon and evening uptime were compared using Wilcoxon Signed Rank tests. Uptime in participants with and without postoperative pulmonary complications was compared using a Mann Whitney U test. Mann Whitney U tests were also used to compare uptime between participants with and without adequate pain relief, and between those with and without surgical attachments. Statistically significant differences were assumed when $p < 0.05$.

Results

Flow of participants through the study: Sixty-two patients were screened and fifty-two patients recruited (Figure 1). Two participants did not complete the study, therefore data are presented for fifty participants. Nine participants had incomplete activity logger data due to four participants being discharged prior to Day 5, two activity loggers being removed by the ward physiotherapist on Day 4, one being removed by the patient on Day 3 and two ceasing to record – one on Day 2 and one on Day 3. The characteristics of participants are presented in Table 2.

Upright mobilisation: Uptime is presented in Table 3. Uptime duration, maximum single uptime period, and sit-to-stand frequency increased each day over the four postoperative days ($p < 0.001$). Morning uptime was greater than both afternoon uptime ($p = 0.001$) and evening uptime ($p < 0.001$). However, afternoon uptime did not differ from evening uptime ($p = 0.11$).

Sitting out of bed commenced at a mean of 1.0 days (SD 0.2), assisted upright mobilisation at 1.8 days (SD 0.9) and independent upright mobilisation at 6.3 days (SD 8.8). On Day 1, 45 participants (90%) required assistance with upright mobilisation. This reduced to 26 participants (52%) on Day 3 and 11 participants (22%) on Day 5.

Relationship between uptime and length of stay: Uptime over the first four postoperative days predicted length of stay ($r^2 = 0.50$, $p < 0.001$). When analysed separately, uptime on Day 1 ($r^2 = 0.21$, $p = 0.001$), Day 2 ($r^2 = 0.15$, $p = 0.006$), Day 3 ($r^2 = 0.27$, $p < 0.001$), and Day 4 ($r^2 = 0.36$, $p < 0.001$) also predicted length of stay.

Difference in uptime for postoperative factors: Nine participants (18%) developed postoperative pulmonary complications. The day of a postoperative pulmonary complication diagnosis followed a bimodal distribution with three participants diagnosed on each of Day 2 and Day 5, and one participant diagnosed on each of Day 3, Day 4, and Day 6. Uptime tended to be lower in those who developed postoperative pulmonary complications (n = 9)

Table 3. Median (IQR) uptime for the first four postoperative days.

Uptime		Day 1 n = 50	Day 2 n = 49	Day 3 n = 45	Day 4 n = 41
Duration of uptime *(min)*	Daily total	3.0 (8.2)	7.6 (11.5)	13.2 (26.6)	34.4 (65.6)
	Morning	0.7 (4.0)	2.9 (6.9)	7.6 (9.9)	10.3 (15.2)
	Afternoon	0.4 (1.1)	0.6 (6.0)	1.2 (7.8)	8.6 (19.0)
	Evening	0.6 (2.3)	1.8 (4.5)	1.2 (8.2)	6.6 (12.3)
Maximum single uptime period *(min)*		2.1 (4.0)	3.4 (4.7)	5.9 (5.9)	8.2 (7.4)
Sit-to-stand frequency *(number/day)*		4 (4)	8 (10)	11 (11)	20 (27)

Morning = 0800 to 1200 hr, Afternoon = 1200 to 1600 hr, Evening = 1600 to 2000 hr.

when compared to remaining participants (n = 41). Median uptime was 1.7 minutes for those with postoperative pulmonary complications compared with 3.7 minutes for those without postoperative pulmonary complications on Day 1 ($p = 0.14$), 6.9 minutes compared with 8.8 on Day 2 ($p = 0.13$), 9.5 minutes compared with 18.6 on Day 3 ($p = 0.17$) and 16.5 minutes compared with 40.6 on Day 4 ($p = 0.08$).

The presence of surgical attachments led to significant reductions in uptime. On Day 2, the 45 participants with attachments recorded a median uptime of 7.1 minutes (IQR 9.6) compared to 67.1 (IQR 56.0) in the 4 participants who were attachment free ($p = 0.001$). On Day 3, median uptime was 11.5 minutes (IQR 16.3) in participants with attachments (n = 38) compared to 88.9 (IQR 59.1) in those who were attachment free (n = 7) ($p < 0.001$). On Day 4, median uptime was 24.4 minutes (IQR 29.8) in participants with attachments (n = 28) compared to 92.8 (IQR 83.5) in those who were attachment free (n = 13) ($p < 0.001$).

Participants who reported their pain relief as inadequate had significantly less uptime. On Day 1, median uptime was 1.9 minutes (IQR 3.4) in participants with inadequate pain relief (n = 14) compared to 4.7 (IQR 7.5) in participants with adequate pain relief ($p = 0.03$). On Day 2, median uptime was 3.6 minutes (IQR 7.0) in eight participants reporting inadequate pain relief compared to 9.7 minutes (IQR 9.7) in the remaining participants ($p = 0.01$). On Day 4, median uptime was 1.4 minutes (IQR 13.0) in five participants with inadequate pain relief compared to 14.0 minutes (IQR 32.5) in the remaining participants ($p = 0.01$).

Relation between length of stay and preoperative/ postoperative factors: Duration of anaesthesia ($r^2 = 0.18$, $p = 0.002$), intensive care admission ($r^2 = 0.31$, $p < 0.001$) and upright mobilisation greater than five metres on Day 1 ($r^2 = 0.10$, $p = 0.03$) predicted length of stay (Table 4).

Table 4. Participant characteristics and postoperative factors predicting length of stay. Logarithmic transformation was performed for all continuous variables.

	r^2	*p*
Participant characteristic		
Gender	0.01	0.57
Age	0.04	0.16
Body mass index	0.00	0.82
Respiratory disease	0.00	0.74
Cardiac disease	0.00	0.77
Smoking history	0.00	0.72
Premorbid mobility < 1 km	0.03	0.23
Postoperative factor		
ASA > 2	0.01	0.55
Duration of anaesthesia	0.18	0.002
Intensive care admission	0.31	<0.001
Mobilisation ≥ 5 m on Day 1	0.10	0.03
Uptime Day 1–4	0.50	0.001
Postoperative pulmonary complication	0.06	0.10
Type of pain relief	0.00	0.96

ICU = intensive care unit

ASA = American Society of Anesthesiologists

Discussion

This is the first study to quantify early upright mobilisation in patients following upper abdominal surgery. The low quantity of uptime recorded was unexpected. Similar studies conducted in other populations have reported much higher quantities of uptime. Tran and colleagues (1997) reported a mean daily uptime of almost four hours in 24 nursing home residents. This result appears even more remarkable when compared to the half an hour achieved on Day 4 in this study. Eldridge and colleagues (2003b) quantified uptime in 16 children on Day 2 post open appendicectomy as 91 minutes compared to 8 minutes on Day 2 in this study.

The low duration of uptime found in this study compels us to consider the factors influencing the quantity of mobilisation performed. With more than half the sample dependent on assistance to mobilise on Day 3, and a further 22% still dependent on Day 5, the quantity of mobilisation performed may have been influenced by the quantity of assistance provided. High levels of postoperative dependence appear characteristic of this patient group, with similar results reported in a study by Mackay and Ellis (2002) where 52% required assistance to mobilise on Day 5. In this study, assistance with mobilisation was primarily provided by nursing staff. Therefore, uptime by those requiring assistance would be influenced by the nurses' availability. It was common practice at the hospital for nurses to assist patients in walking to the shower each morning. This may explain why uptime was higher in the morning since nursing staff provided greater assistance with mobilisation during the time that personal hygiene tasks were completed. In addition, uptime was decreased when surgical attachments were present. Participants may have lacked the confidence to attempt upright mobilisation unassisted, rendering them dependent on assistance from hospital staff whilst surgical attachments remained *in situ*. Furthermore, the importance of effective pain relief in facilitating early mobilisation (Kehlet and Wilmore 2002) is supported by the finding in this study that participants with adequate pain relief had greater uptime than those without adequate pain relief.

This study found that daily uptime predicted length of stay, with uptime explaining 50% of the variation in length of stay. With duration of anaesthesia and intensive care admission also predicting length of stay, the impact of complex surgery and postoperative morbidity on length of stay must not be overlooked. However, the high correlation (Domholdt 2000) between uptime and length of stay raises the question of whether an increase in uptime could reduce length of stay. Hospital staff, including physiotherapists, may influence uptime by increasing assistance provided to dependent patients in the early postoperative period. Interventions that have the potential to reduce length of stay are of great importance to the health care system as they may reduce demand on hospital beds thereby allowing more surgery to be performed. Therefore, further research examining the effect of increased assistance with mobilisation on uptime and length of stay is warranted.

The evidence suggests that early mobilisation may reduce the incidence of postoperative pulmonary complications (Mackay et al 2005), but it remains unknown whether the quantity of upright mobilisation performed is a significant factor in preventing postoperative pulmonary complications. Participants in this study who developed postoperative pulmonary complications tended to have less uptime than those who did not. While it is logical that patients with postoperative pulmonary complications would mobilise less due to their illness, four out of the nine participants developed their postoperative pulmonary complications as late as Day 5 or Day 6. It is plausible that postoperative pulmonary complications in these participants developed because they were less active. However, it is difficult to draw conclusions due to the small number of postoperative pulmonary complications observed.

This study recorded uptime in patients from two surgical units at one hospital in Australia. The characteristics of the participants are similar to those examined in previous physiotherapy research of patients undergoing upper abdominal surgery (Chumillas et al 1998, Mackay et al 2005, Olsen et al 1997). The results reflect usual practice at the hospital at the time that the study was conducted. However practices may differ across hospitals and it is likely that the results may vary if the study was repeated in a different setting or at a different time.

A limitation of this study was the inability of the activity logger to measure time spent sitting out of bed or to delineate between standing and walking. As sitting out of bed is often incorporated into early mobilisation, a separate examination of its benefits is required. Higher intensity activities such as walking may have resulted in different outcomes than standing in one position. A future version of the activity logger (Positional Activity Logger Version 2) will have the ability to record time spent sitting out of bed and activity intensity, thus enhancing its value in measuring outcomes in future research.

Although every attempt was made by the researchers to ensure continuous recording of uptime, data were not complete in nine participants. It is possible that the four of these participants who were discharged prior to Day 5 would have achieved higher than average levels of uptime, thus affecting the overall result. In two participants, data recording was incomplete as the activity logger switched to reset mode whilst worn, which stopped all recording of data. This issue was discussed with the manufacturer who has rectified the problem.

In previous research examining the management of patients following upper abdominal surgery, upright mobilisation has been an included component of physiotherapy intervention (Chumillas et al 1998, Olsen et al 1997); however, the effect of upright mobilisation alone has received little attention. Further exploration of upright mobilisation as a treatment technique following upper abdominal surgery is warranted. Structured programs which provide increased mobilisation assistance and enhance uptime may positively influence postoperative outcomes in this patient group.

Footnotes: [(a)]Version 1. Gorman ProMed Pty Ltd, 54 Blackwood Street, Carnegie, VIC, 3163, Australia.

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