6-1-2023

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10.1111/resp.14451
Peddle-McIntyre, C. J., Muruganandan, S., McVeigh, J., Fitzgerald, D. B., Straker, L., Newton, R. U., ... & Lee, Y. C. G. (2023). Device assessed activity behaviours in patients with indwelling pleural catheter: A sub-study of the Australasian Malignant PLeural Effusion (AMPLE)-2 randomized trial. Respirology, 28(6), 561-570. https://doi.org/10.1111/resp.14451

Received: 20 September 2022 | Accepted: 19 December 2022

DOI: 10.1111/resp.14451

ORIGINAL ARTICLE

Official Journal of the Asian Pacific Society of Respirology
Respirology APSR WILEY

Device assessed activity behaviours in patients with indwelling pleural catheter: A sub-study of the Australasian Malignant PLeural Effusion (AMPLE)-2 randomized trial

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Funding information
Cancer Council Western Australia; Sir Charles Gairdner Research Advisory Group

Associate Editor: Ioannis Kalomenidis;
Senior Editor: Lutz Beckert

Abstract

Background and Objective: Device-assessed activity behaviours are a novel measure for comparing intervention outcomes in patients with malignant pleural effusion (MPE). Australasian Malignant PLeural Effusion (AMPLE)-2 was a multi-centre clinical trial where participants with MPE treated with an indwelling pleural catheter were randomized to daily (DD) or symptom-guided (SGD) drainage for 60-days. Our aim was to describe activity behaviour patterns in MPE patients, explore the impact of drainage regimen on activity behaviours and examine associations between activity behaviours and quality of life (QoL).

Methods: Following randomization to DD or SGD, participants enrolled at the lead site (Perth) completed accelerometry assessment. This was repeated monthly for 5-months. Activity behaviour outcomes were calculated as percent of daily waking-wear time and compared between groups (Mann–Whitney *U* test; Median [IQR]). Correlations between activity behaviour outcomes and QoL were examined.

Results: Forty-one (91%) participants provided ≥1 valid accelerometry assessment (DD$n = 20$, SGD $n = 21$). Participants spent a large proportion of waking hours sedentary (72%–74% across timepoints), and very little time in moderate-to-vigorous physical activity (<1% across timepoints). Compared to SGD group, DD group had a more favourable sedentary-to-light ratio in the week following randomization (2.4 [2.0–3.4] vs. 3.2 [2.4–6.1]; $p = 0.047$) and at 60-days (2.0 [1.9–2.9] vs. 2.9 [2.8–6.0];

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This study was previously presented at the International Conference on Ambulatory Monitoring of Physical Activity and Movement in 2019.

$p = 0.016$). Sedentary-to-light ratio was correlated with multiple QoL domains at multiple timepoints.

Conclusion: Patients with MPE are largely sedentary. Preliminary results suggest that even modest differences in activity behaviours favouring the DD group could be meaningful for this clinical population. Accelerometry reflects QoL and is a useful outcome measure in MPE populations.

KEYWORDS
accelerometry, advanced cancer, cancer, indwelling pleural catheter, physical activity, pleural effusion

INTRODUCTION

Malignant pleural effusion (MPE) is a build-up of fluid and cancer cells in the pleural space causing debilitating breathlessness and pain. MPE heralds a poor prognosis with limited treatment options.[1] The key goal of management is to alleviate symptom burden and allow patients to take part in their normal daily activities for as long as possible.

Patient-reported outcome measures are important for informing clinical research and practice, particularly in palliative cancer populations.[2] Recent development and validation of a visual analogue scale (VAS) of breathlessness[3] has advanced the field but still retains shortcomings. It is inherently subjective, limited by language and communication barriers, patient recall,[4,5] ceiling effects and changes in perceptions of breathlessness over time.[5] Often patients adapt their lifestyle to avoid breathlessness which is not reflected with any breathlessness score.[6] New outcome measures that reflect the goals of care are needed to advance MPE research and clinical care.

Measurement of activity behaviours of patients is an attractive outcome for MPE studies. Advances in digital wearable technologies allow precise measurement of activity behaviours, and are increasingly used in clinical trials.[7] Accelerometry analysis provides measurement of the time patients spent sedentary (e.g., inactive; sitting/lying down), in light activity (e.g., shopping, walking within home) and moderate-to-vigorous physical activity (MVPA; e.g., brisk walk to running or swimming)[8] as well as the patterns of activity accumulation. We have previous demonstrated that MPE patients are largely sedentary, and that activity levels reflect differences in performance status and survival categories,[9] as well as clinical endpoints such as sarcopenia status.[10,11]

Indwelling pleural catheter (IPC) is an established management option for MPE that significantly reduces lifetime hospital admission days and need for further pleural intervention, compared with talc slurry pleurodesis.[12] The Australasian Malignant PLeural Effusion (AMPLE)-2 trial was a multicentre randomized trial designed to compare different IPC drainage regimens in MPE patients.[13] Here we report on accelerometry assessment of activity behaviours captured in participants from the lead centre of the trial. Our aim is to describe the physical activity patterns, to explore the impact of daily drainage regime on activity behaviours, and to interrogate correlations between physical activity levels, quality of life (QoL) and breathlessness measures in patients with IPC for MPE.

SUMMARY AT A GLANCE

Accelerometry is a novel patient-centred outcome measure. Malignant pleural effusion patients are mostly sedentary. Those undergoing daily drainages of indwelling pleural catheter could have a better activity behaviour profile compared to those doing symptom guided drainages. A lower proportion of sedentary time was associated with better quality of life.

METHODS

Setting and study participants

Participants enrolled at the lead site (Sir Charles Gairdner Hospital, Perth, WA, Australia) were offered accelerometery assessment. Ethics and governance approvals were obtained from the primary site Sir Charles Gairdner and Osborne Park Health Care Group Human Research and Ethics Committee (2014–079). Written informed consent was obtained from all participants.

Procedures

Detailed procedures and eligibility criteria have been reported previously.[13,14] Briefly, following IPC insertion, drainage was performed with the goal to drain to dryness. Following drainage, participants were randomized (1:1) to either daily (DD) or symptom-guided drainage (SGD) via their IPC for 60-days (primary outcome assessment). Following randomization, the first accelerometery assessment was initiated on the day of discharge from hospital. Participants were asked to wear the device on their hip for a 7-day continuous wear protocol and record non-wear time in a logbook. Follow-up assessment occurred every 30-days following randomization

for 5-months. Medical and demographic information was collected from medical chart review.

Outcomes

Activity Behaviours were assessed by accelerometers (Actigraph GT3X+; Actigraph, Pensacola, FL) worn on the hip continuously for 7-days, programmed to record raw data at a frequency of 30 Hz. Data were reduced to vertical axis movement counts per 60-s epoch. Accelerometer data were processed in SAS (version 9.4, SAS Institute, Cary, NC) using an established algorithm.[15] A valid day was defined as ≥8-h of waking wear time.[16] All variables were calculated per day and then averaged across all valid days for each patient. Common cut off points were used to classify sedentary behaviour, light activity and MVPA.[17,18] Bouts of sedentary and physical activity behaviours were classified using established criteria.[19] Results are presented as percent of waking wear time. Sedentary-to-light ratio was defined as the percentage of waking hours spent sedentary divided by the percentage of waking hours spent in light activity. Higher numbers indicate a higher proportion of time spent sedentary relative to light activity.

QoL was assessed using the EuroQoL-5 Dimensions-5 Levels (EQ-5D-5L)[20,21] and EQ-VAS pre-IPC insertion, at randomization and monthly up to 5-months. Each domain (i.e., mobility, self-care, usual activities, pain/discomfort, anxiety/depression) was graded by the participant from 1 (no problem) to 5 (worst). EQ-VAS was assessed using 100 mm lines anchored with 'best quality of life' at 0 mm and 'worst quality of life' at 100 mm. The EQ-5D-5L index score was derived from the five dimensions to reflect health state,[22] with higher scores representing better QoL.

The breathlessness score was measured by use of a validated VAS.[3,12,23] A line anchored with 'best breathing' at 0 mm and 'worst breathing imaginable' at 100 mm. The scores were recorded pre-IPC insertion, at randomization and daily for 60-days, then weekly up to 5-months in a logbook. All scores were measured by recording the average of the readings of two independent assessors.

Statistical analysis

Statistical analyses were conducted using Statistical Package for the Social Sciences (Version 25, IBM Corporation, Somers, NY). Data are reported using mean and standard deviation, or median and interquartile range (IQR) when not normally distributed. Normality of the distribution for outcome measures was tested using the Kolmogorov–Smirnov test. Within-group comparisons were performed using the Wilcoxon Signed-Rank Test. Between-group comparisons were performed using the Mann–Whitney *U* test. Spearman Rank Order Correlations (*r*) were used to assess correlation between variables. An alpha of 0.05 was used to determine statistical significance. No adjustment was made for multiple comparisons, but all analyses carried out are presented.

RESULTS

Participant flow through the accelerometry assessment timepoints is reported in Figure 1. Briefly, of the 45 participants enrolled at the lead site, 41 (91%) agreed and provided at least one valid accelerometry assessment. Regarding accelerometry protocol compliance, average waking wear time for the whole group at each time-pointed ranged from 13.0 to 13.9 h per day across the six-assessment time-points (Table S1 in the Supporting Information). There were no significant differences between groups at any timepoint for waking wear time or number of valid days recorded (Table S1 in the Supporting Information).

Baseline characteristics are presented in Table 1. The majority of participants were male ($n = 24$) and median age was 68 [IQR 60–74] years. The most common underlying malignancy was mesothelioma ($n = 19$, 46%) followed by lung cancer ($n = 12$, 29%). Most participants (67%) had an Eastern Cooperative Oncology Group Performance status of 0 to 1. Majority (64%) presented with a large pleural effusion (i.e. fluid occupying >50% of the hemithorax).[24]

Cross-sectional analysis of physical activity and sedentary behaviour

At the first accelerometry assessment following randomization, as an average across valid days, participants spent a median of 9.4 h sedentary (72% of waking hours), 3.3 h in light activity (26% of waking hours). The median sedentary to light ratio was 2.7. Participants spent a median of 3 min/day in MVPA, equating to less than 1% of waking hours.

Activity behaviour outcomes are presented in Table 2. At the first accelerometry assessment measured in the 7-day period following randomization, compared to the SGD group, the DD group had a more favourable sedentary-to-light ratio ($p = 0.047$), and significantly better QoL (EQ-5D-5L index score; $p = 0.009$), less breathlessness ($p = 0.007$; Table S1 in the Supporting Information). At 60-days, the DD group spent significantly more time per day in light activity ($p = 0.040$), resulting in a lower sedentary-to-light ratio ($p = 0.016$) and reported better QoL (EQ-5D-5L index; $p = 0.014$). Throughout the remaining assessment timepoints, compared to the SGD group, the DD group continued to have a better activity profile and lower breathlessness scores, although differences were not statistically significant.

Longitudinal analysis of physical activity and sedentary behaviour

One participant had missing post-randomization data. Considering the remaining 24 participants (DD = 11, SGD = 13), there were no statistically significant within group changes in activity behaviours for either group (Table 3). However, between-group differences indicated a more favourable activity behaviour profile for the DD group

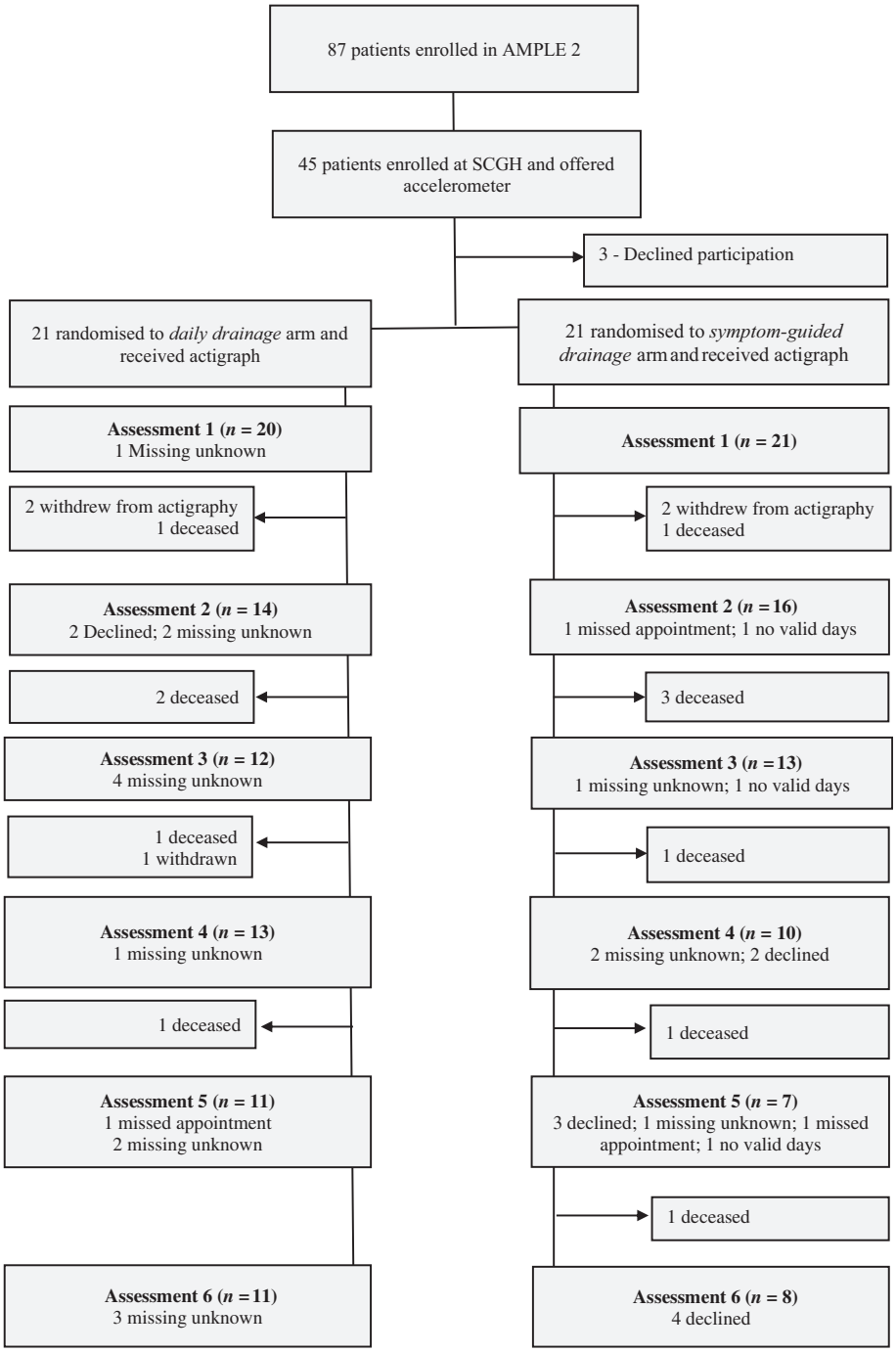

FIGURE 1 Participants flow through the trial assessments.

at 60-days with less time spent sedentary (66% [63–74%] vs. 74% [73–85%]; $p = 0.034$), and more time in light activity (33% [26–34%] vs. 24% [15–27%]; $p = 0.016$). There were no differences in time spent in MVPA ($p = 0.469$).

The DD group spent a lower percentage of daily wear-time time in prolonged sedentary bouts (defined as 30–60 min) compared to the SGD group (median 12% [10–18%] vs. 20% [14–24%]; $p = 0.034$) and a higher percent of daily wear-time in bouts of light activity of 5–10 min (median 9% [7–11%] vs. 6% [3–8%]; $p = 0.005$; Figure 2). There were no other statistically significant differences between groups.

Association between activity behaviours, QoL and breathlessness

Activity behaviours (i.e., sedentary-to-light ratio and prolonged sedentary bouts) were related to QoL and breathlessness across multiple timepoints (Table 4). All statistically significant correlations indicated that less time spent in prolonged sedentary bouts and a lower proportion of time spent sedentary were associated with better QoL. Considering the relationship between domains of QoL and activity behaviours, mobility and EQ-5D-5L index were frequently related, and self-care and usual activities were occasionally related.

TABLE 1 Baseline demographic and clinical characteristics

	Total ($n = 41$)	Daily drainage ($n = 20$)	Symptom-guided drainage ($n = 21$)
Age (years)[a]	67 (60–74)	67 (58–72)	68 (61–76)
Men	23 (56%)	11 (60%)	12 (57%)
Type of primary malignancy			
Mesothelioma	19 (46%)	10 (48%)	9 (43%)
Non-mesothelioma			
Lung	12 (29%)	5 (24%)	7 (33%)
Ovarian	6 (15%)	4 (19%)	2 (10%)
Other	4 (10%)	1 (5%)	3 (14%)
Times since primary diagnosis (days)[a]	58 (18–500)	42 (12–219)	70 (28–716)
Times since MPE diagnosis (days)[a]	34 (13–143)	23 (5–68)	44 (15–189)
Trapped lung	12 (29%)	5 (25%)	7 (33%)
Previous pleural intervention	37 (91%)	16 (80%)	21 (100%)
ECOG PS			
0–1	30 (73%)	16 (80%)	14 (62%)
≥2	11 (27%)	4 (20%)	7 (38%)
Comorbidities			
Respiratory	14 (34%)	5 (25%)	9 (43%)
Cardiac	10 (24%)	5 (25%)	5 (24%)
Depression	5 (12%)	3 (15%)	2 (10%)
Anxiety	2 (5%)	1 (5%)	1 (5%)
Diabetes	6 (17%)	3 (15%)	3 (14%)
Smoking status			
Current	15 (37%)	8 (40%)	7 (33%)
Former	16 (39%)	9 (45%)	7 (33%)
Non-smoker	10 (24%)	3 (15%)	7 (33%)
Effusion size grade[b]			
Small (0–1)	1 (2%)	0 (0%)	1 (5%)
Moderate (3)	13 (32%)	5 (25%)	8 (38%)
Large (4, 5)	27 (64%)	15 (75%)	12 (57%)
Cancer treatment			
Currently on chemotherapy	3 (7%)	0 (0%)	3 (14%)
Previous radiotherapy	6 (14%)	2 (10%)	4 (19%)
Previous chemotherapy	13 (33%)	6 (30%)	7 (33%)

Note: Data presented as *n* (%).
[a]Median (IQR).
[b]Grade 1 to blunting of the costophrenic angle; grade 2 to fluid occupying less than 25% of the hemithorax, grade 3 to fluid occupying 25%–50%, grade 4 to fluid occupying 51%–75% and grade 5 to fluid occupying more than 75%.

While domains of pain/discomfort, anxiety/depression and breathlessness were largely not related to activity behaviours.

DISCUSSION

In this study, we demonstrated that physical activity levels in patients with MPE were low at every time-point assessed. Those who received DD spent less time in sedentary behaviour and more time in light activities in the 7-days following randomization, and at 60-days. Activity behaviour parameters, particularly low-intensity and sedentary time, correlated with QoL subscales at multiple timepoints. The findings lend further support to the value of actigraphy in clinical and research settings for MPE intervention.

A key goal in the treatment of people with MPE is to manage symptoms to allow patients to engage in desired physical activities of daily life. Overall, study participants spent a large proportion of waking hours sedentary (72%–74% across assessment timepoints), and no time in MVPA. This is very similar to our previous reports in MPE

TABLE 2 Activity behaviours across assessment timepoints

Outcomes	Total	Daily drainage	Symptom-guided drainage	Between group difference
Assessment 1; Post-randomization	($n = 41$)	($n = 20$)	($n = 21$)	
Sedentary time (%)	72% (68–80)	71% (66–76)	75% (69–86)	0.100
Light activity (%)	26% (20–31)	29% (23–32)	23% (14–30)	0.064
Sedentary-to-light ratio	2.7 (2.2–4.1)	2.4 (2.0–3.4)	3.2 (2.4–6.1)	0.047*
Assessment 2; 30 days	($n = 30$)	($n = 14$)	($n = 16$)	
Sedentary time (%)	72% (65–7)	70% (62–74)	72% (69–89)	0.170
Light activity (%)	26% (21, 32)	29% (25, 35)	25% (11, 29)	0.088
Sedentary-to-light ratio	2.7 (2.1–3.7)	2.5 (1.8–2.9)	2.8 (2.4–8.5)	0.146
Assessment 3; 60 days	($n = 25$)	($n = 12$)	($n = 13$)	
Sedentary time (%)	73% (66–77)	68% (63–76)	74% (73–85)	0.073
Light activity (%)	26% (21–33)	31% (24–34)	24% (15–27)	0.040*
Sedentary-to-light ratio	2.8 (1.9–3.4)	2.0 (1.9–2.9)	2.9 (2.8–6.0)	0.016*
Assessment 4; 90 days	($n = 23$)	($n = 13$)	($n = 10$)	
Sedentary time (%)	71% (69–65)	70% (67–73)	75% (68–76)	0.154
Light activity (%)	28% (24–31)	30% (26–32)	25% (24–28)	0.094
Sedentary-to-light ratio	2.6 (2.2–3.1)	2.3 (2.1–2.6)	3.0 (2.5–3.3)	0.107
Assessment 5; 120 days	($n = 19$)	($n = 11$)	($n = 7$)	
Sedentary time (%)	72% (68–76)	71% (66–73)	75% (68–81)	0.189
Light activity (%)	27% (24–31)	27% (26–27)	25% (19–31)	0.160
Sedentary-to-light ratio	2.7 (2.2–3.2)	2.6 (2.1–2.7)	3.0 (2.2–4.4)	0.160
Assessment 6; 150 days	($n = 19$)	($n = 11$)	($n = 8$)	
Sedentary time (%)	74% (66–79)	70% (66–76)	78% (67–85)	0.117
Light activity (%)	26% (21–31)	30% (23–33)	21% (15–27)	0.069
Sedentary-to-light ratio	2.8 (2.2–3.8)	2.2 (2.0–3.2)	3.6 (2.4–5.7)	0.058

Note: Data presented as Median (IQR); Physical Activity provide % is percent of waking wear time.
*$p < 0.05$.

populations,[9,10] as well reports in lung cancer.[25] However it is higher than other cancer groups,[8] cancer survivors (e.g., 66% waking hours spent sedentary),[26] and older adults.[27] Considering these low levels of physical activity, interventions that can make even modest shifts towards a more active profile could be beneficial.

A further finding is that daily drainages of MPE via IPC could allow MPE patients to spend less time sedentary and more time in light intensity activities, resulting in a more favourable activity behaviour profile. Considering the low levels of physical activity in this patient population, even small differences between groups, ranging from 2% to 8% of sedentary time, could be meaningful. Those doing daily drainage at home (by carer or community nurse) spent less time in prolonged sedentary bouts of 30–60 min, and this equated to 55 fewer minutes per day spent in prolonged sedentary bouts at 60-days compared to the SGD group. The DD group spent more time in light activity bouts of 5–10 min which could reflect better engagement in daily living tasks.

We also found that accelerometry outcomes in MPE are correlated with important aspects of QoL. Device-assessed physical activity has previously been reported as associated with QoL in cancer populations.[28,29] Similar to findings in lung cancer,[25,30] we found sedentary and light activity time were associated with multiple domains of QoL, particularly mobility, over 120-days. Light activity participation has been previously identified as an important predictor of mobility disability.[31] This further supports that interventions that allow for increased light activity could positively impact QoL in patients with MPE.

Identification of suitable outcome measures that are patient oriented and clinically relevant has been a challenge in MPE research. Accelerometry reflected QoL and could be a useful tool to provide additional information about how treatment regimens impact daily living of patients. Measuring activity behaviours in intensities and metrics such as sedentary-to-light ratio, prolonged bouts of sedentary time, or short bouts of light activity could be particularly relevant for this population.

Accelerometry appears feasible for long-term measurement of activity behaviours in MPE. This study provides novel evidence of the feasibility and value of repeated accelerometry measures this palliative population. When interpretating results of the current study it is important to consider that the median survival for MPE is 9 to 12-months. On average these participants were 2-months from diagnosis on entry

TABLE 3 Analysis of physical activity profile of those with day-1 and day-60 assessments

	Post-randomization ($n = 24$)			60 days ($n = 24$)			Within group difference	
	DD ($n = 11$)	SG ($n = 13$)	Between group difference p-value	DD ($n = 11$)	SG ($n = 13$)	Between group difference p-value	DD	SG
Sedentary	68% (66–71)	72% (69–80)	0.052	66% (63–74)	74% (73–85)	0.034*	0.657	0.552
Light	30% (29–33)	25% (20–31)	0.060	33% (26–34)	24% (15–27)	0.016*	0.447	0.650
MVPA	1% (0–2)	0% (0–2)	0.434	0% (0–0)	0% (0–2)	0.469	0.286	0.249
Sed bouts <5 min	11% (10–13)	11% (6–14)	0.543	13% (8–14)	8% (7–12)	0.041*	0.722	0.600
Sed bouts 30–60 min	13% (11–18)	16% (12–21)	0.505	12% (10–17)	20% (14–24)	0.008**	0.722	0.101
Light activity bouts 5–10 min	10% (8–13)	9% (9–14)	0.977	9% (8–12)	6% (3–7)	0.002**	0.448	0.196
Light activity bouts 10–20 min	4% (3–5)	2% (0–4)	0.077	4% (3–7)	3% (0–4)	0.040*	0.790	0.552

Note: All activity behaviour data presented as % waking wear time—Median (IQR).
Abbreviations: DD, daily drainage; MVPA, moderate and vigorous physical activity; SG, symptom guided drainage.
*$p < 0.05$.
**$p < 0.01$.

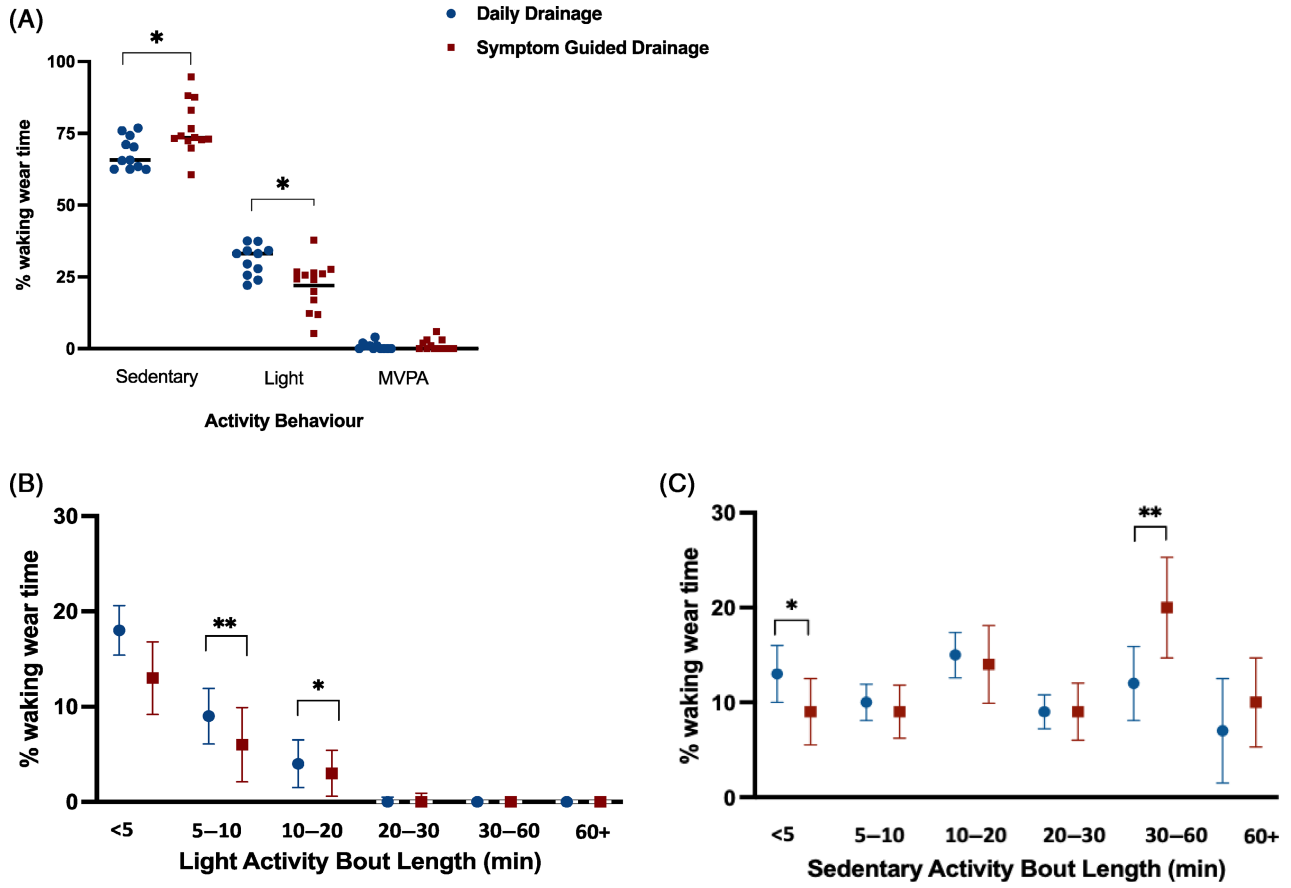

FIGURE 2 At 60-days, compared to the symptom-guided drainage group, the daily drainage group spent (as a percent of waking-hours) (A) less time sedentary and more time in light activity; (B) more time in short sedentary bout of <5 min and less time in prolonged sedentary bouts of 30–60 min and (C) more time in light activity bouts of 5–10 and 10–20 min. *$p < 0.05$, **$p < 0.01$, MVPA, moderate-to-vigorous physical activity.

into the study. Attrition due to patient decline and death, as we saw here, is well documented in supportive care intervention studies in palliative populations.[32] While compliance to accelerometry protocol was acceptable when worn, participation in accelerometry assessment was not optimal throughout our assessment time-points. Beyond loss to follow-up due to death, the main reason for missing data was withdrawal from wearing the device and unknown

TABLE 4 Correlations between activity behaviour outcomes, QoL and breathlessness

Time point	Activity behaviour outcome	Mobility	Self-care	Usual activities	Pain/ discomfort	Anxiety/ depression	EQ-5D-5L index value	Breathlessness
Post-randomization	Sedentary-to-light ratio	0.48**	0.33*	0.49**	0.47**	0.13	−0.55**	0.29
	Sedentary bouts 30–60 min	0.44*	0.23	0.33*	0.32*	0.28	−0.51**	0.17
30 days	Sedentary-to-light ratio	0.55**	0.68**	0.37*	0.24	−0.08	−0.43*	0.39*
	Sedentary bouts 30–60 min	0.64***	0.74***	0.40*	0.17	0.02	−0.51**	0.38*
60 days	Sedentary-to-light ratio	0.30	0.41*	0.14	−0.05	−0.08	−0.39	0.36
	Sedentary bouts 30–60 min	0.29	0.16	0.23	0.25	0.13	−0.48*	0.29
90 days	Sedentary-to-light ratio	0.49*	0.21	0.04	0.04	−0.06	−0.22	0.04
	Sedentary bouts 30–60 min	0.46*	0.23	0.16	−0.05	0.02	−0.29	0.03
120 days	Sedentary-to-light ratio	0.53*	0.22	0.23	0.33	−0.08	−0.54*	0.44
	Sedentary bouts 30–60 min	0.47*	0.16	0.19	0.28	−0.17	−0.45	0.53*
150 days	Sedentary-to-light ratio	0.24	0.09	0.17	0.27	−0.30	−0.24	0.24
	Sedentary bouts 30–60 min	0.05	−0.07	0.08	0.13	−0.19	−0.06	0.10

Note: Spearmans Rank Order Correlations (*r*); all activity behaviour outcomes presented as a percent of waking wear time.
Abbreviation: EQ-5D-5L, EuroQoL-5 Dimensions-5 Levels Quality of life Index.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

reasons. Resistance to wearing accelerometers for 7-days has been reported as a main reason for older care-home residents declining assessment.[33]

Physical activity levels for general populations can vary significantly across 7-days.[34] However, considering the limited life span, high symptom burden and low levels of physical activity and occupational employment in MPE populations, differences across days of the week might not be relevant.[35] Data in other populations support 3–5 days of wear time with no requirement for weekend days.[35–37] Our group successfully used a 3-day wear protocol for a prospective observational study of people with mesothelioma.[11] Work to determine optimal wear time in MPE is needed to reduce patient burden and facilitate accelerometry assessment in research and clinical practice.

This work has limitations. This is a small sub study conducted at one site of a RCT, and therefore is limited by potential for bias and confounding. We did not adjust for potential confounders that could be important in the interpretation of this data (e.g., chemotherapy treatment status). Groups were balanced for QoL, breathlessness and most medical and demographic factors. However, compared to the SGD group, the DD group had fewer participants with poor performance status (38% vs. 20%, respectively), and participants were closer to diagnosis of their MPE (Median 44 vs, 23 days). These, as well as other possible confounders not measured in this study, could have contributed to between group differences. It is possible that groups had differences in physical activity prior to having the IPC inserted. Due to clinical constraints and ethical considerations (i.e., patients with high symptoms of breathlessness and pain), delayed fluid drainage to allow for measurement of physical activity was not possible. These between group differences should be viewed as preliminary. Future adequately powered studies are required to investigate the effects of drainage protocols, as well as other treatments, on activity behaviour outcomes in MPE populations. Finally, the type of accelerometer used in this study does not distinguish between sitting and standing sedentary activities, which could be important in this group.

In conclusion, we suggest that accelerometry reflects QoL and is a useful tool for assessing subtle but potentially important differences between groups following different treatment regimens, specifically drainage protocols in MPE. Further work is necessary to improve feasibility by optimizing wear time and continuing to test the utility of accelerometry as an outcome measure in MPE populations.

AUTHOR CONTRIBUTION

Carolyn J. Peddle-McIntyre: Conceptualization (lead); data curation (supporting); formal analysis (lead); investigation (equal); methodology (equal); project administration (supporting); resources (supporting); writing – original draft (lead); writing – review and editing (lead). **Sanjeevan Muruganandan:** Conceptualization (equal); data curation (lead); formal analysis (supporting); investigation (lead); methodology (equal); project administration (lead); writing – original draft (supporting); writing – review and editing (equal). **Joanne McVeigh:** Data curation (equal); formal analysis (equal); software (lead); validation (equal); writing – review and editing (equal). **Deirdre B. Fitzgerald:** Data curation (equal); investigation (equal); project administration (equal); writing – review and editing (equal). **Leon Straker:** Formal analysis (supporting); software (equal); writing – review and editing (equal). **Robert U. Newton:** Conceptualization (supporting); methodology (supporting); resources (supporting); software (supporting); supervision (supporting); writing – review and editing (equal). **Kevin Murray:** Formal analysis (equal); methodology (supporting); visualization (supporting); writing – review and editing (equal). **Yun Chor Gary Lee:** Conceptualization (equal); formal analysis (equal); funding acquisition (lead); investigation (equal); methodology (equal); project

administration (supporting); resources (lead); supervision (lead); writing – review and editing (equal).

ACKNOWLEDGEMENTS

Research funding: This study was funded by the Cancer Council of Western Australia and the Sir Charles Gairdner Research Advisory Group. Open access publishing facilitated by Edith Cowan University, as part of the Wiley – Edith Cowan University agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST

None declared.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on reasonable request from the corresponding author. The data are not publicly available due to privacy and ethics restrictions.

HUMAN ETHICS APPROVAL DECLARATION

This study was approved by the Sir Charles Gairdner and Osborne Park Health Care Group Human Research and Ethics Committee (2014–079). Informed consent was sought and received from all participants.

Clinical trial registration: ACTRN12615000963527 at https://www.anzctr.org.au/

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Peddle-McIntyre CJ, Muruganandan S, McVeigh J, Fitzgerald DB, Straker L, Newton RU, et al. Device assessed activity behaviours in patients with indwelling pleural catheter: A sub-study of the Australasian Malignant PLeural Effusion (AMPLE)-2 randomized trial. Respirology. 2023;28(6):561–70. https://doi.org/10.1111/resp.14451