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Pain management in advanced cancer: physical activity as an outcome – accelerometer feasibility study

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ABSTRACT

Objective Cancer pain is a common distressing symptom. Numerical Pain Scales (NPS) assess pain but lack information about function and quality of life. This feasibility study assesses the use of triaxial accelerometers to measure function as an outcome measure in pain studies in advanced cancer.

Methods Advanced cancer participants were recruited from two palliative care services, with an average pain score of ≥3 on NPS. ActiGraph wGT3X-BT Accelerometers were worn for 1 week on the wrist. Patients recorded daily pain scores, Edmonton Symptom Assessment Scale (ESAS) scores, and their daily opioid use.

Results 24 participants were recruited. A total of 142 days of accelerometer data was collected (5.9 days/participant). The average daily step count was 5723.7. The average acceleration was 14.4 milligravity units/day. An average of 93 min/day total activity across all intensities was recorded. No correlation was seen between acceleration or average daily minutes in activity and total daily oral morphine equivalent, ESAS, 'average pain' score or 'worst pain' scores using spearman's correlation coefficients. Overall, participants were satisfied with the study.

Conclusions Accelerometers are a feasible method to measure activity as an outcome measure in advanced cancer. Further study is required to assess the impact of pain management strategies on function.

WHAT WAS ALREADY KNOWN?

⇒ Pain commonly impacts on function in advanced cancer.
⇒ Ability to function is one of the main goals of pain management.

WHAT ARE THE NEW FINDINGS?

⇒ Patients with advanced cancer function significantly less than healthy adults.
⇒ Triaxial accelerometers effectively measure function in this group.

WHAT IS THEIR SIGNIFICANCE?

a. Clinical
   – Function can be measured easily.
b. Research
   – Further studies into how pain impact's function.

INTRODUCTION

Triaxial accelerometers offer a way to measure activity and pain management in patients with advanced cancer. This new technology uses motion sensors to detect the body's acceleration in up to three planes (triaxial) and record physical function,[1] activity and sleep. It is lightweight and can be attached to the body or worn on the wrist and is an objective and accurate method of measuring activity for patients with advanced cancer.[2]

Studies suggest that two-thirds of patients with advanced cancer experience pain,[3] that 50% of these patients describe the pain as moderate or severe[3] and their main goal of pain management, is the ability to live normally and complete everyday tasks.[4] Many studies use Numerical Pain Scales to assess pain and its response to treatment[5] but these scales are unidimensional, only measuring severity, and not other aspects of pain. Self-reporting of pain and physical activity are subjective, rely on recall, are known to be inaccurate and prone to bias[6] and also significantly underestimates sedentary time.[7] Few studies exist that objectively measure physical activity in this patient group to provide accurate data about physical function in relation to pain management.

This study investigates the use of accelerometers to measure physical activity

in patients experiencing cancer-related pain and how activity correlates with pain and other symptoms.

METHODS

This study is a prospective, multicentre study of patients with advanced cancer and an average pain score of ≥3 (Numerical Rating Scale or NRS). Patients were recruited by the palliative care teams at two centres in Brisbane, via outpatient clinic, community services or the inpatient palliative care ward. There were no exclusion criteria.

The primary outcome was to assess the feasibility of using accelerometers to monitor pain in patients with advanced cancer. This was achieved if ≥60% of participants wore the accelerometer for ≥80% of the time during the 6-day trial period. Secondary outcomes included pain scores, total symptom scores and opioid dosing. The study was powered to define feasibility (20 participants).

Participants wore a commercial accelerometer (ActiGraph wGT3X-BT) on their wrists for 6–7 days. Baseline demographic data and total daily oral morphine equivalent (OME) doses was collected at day 0. Participants recorded daily pain relief usage, pain scores (brief pain inventory) and symptom scores (Edmonton Symptom Assessment Scale (ESAS)).

Statistical analysis

The accelerometer recorded raw acceleration in three axes and provided raw data in gravitational equivalent units (g) (1 g=9.81 m/s^2). Raw data were processed in R using the most up to date GGIR package, a widely used open-source code.[8] The vector magnitude of the three axes was used to calculate activity-related acceleration using Euclidian Norm minus 1 g [ENMO=√(x^2+y^2+z^2)−1]. Data were initially aggregated in 5 s time series and included if wear time was at least 600 min/day. Data were used to quantify overall physical activity expressed as acceleration in milligravity units (mg), as well as time spent in activities at different intensities. Active minutes were defined as activities with average acceleration >30 mg.

Daily acceleration and active minutes were correlated with daily scores for OME (mg), total ESAS, worst and average pain scores (0–10 on NRS) to produce scatterplots. Correlation was analysed using Spearman's correlation to produce spearman correlation coefficient with 95% CIs.

RESULTS

The recruitment period was extended (December 2018 to May 2021) due to the Coronavirus Pandemic. A total of 24 patients (online supplemental file 1) were recruited, with 142 days of accelerometer data recorded for those participants, equating to an average of 5.9 days per participant. An average 20.8 hours (SD: 5.2 hours) was recorded for each day of data; collecting a total of 2953.6 hours of accelerometer data.

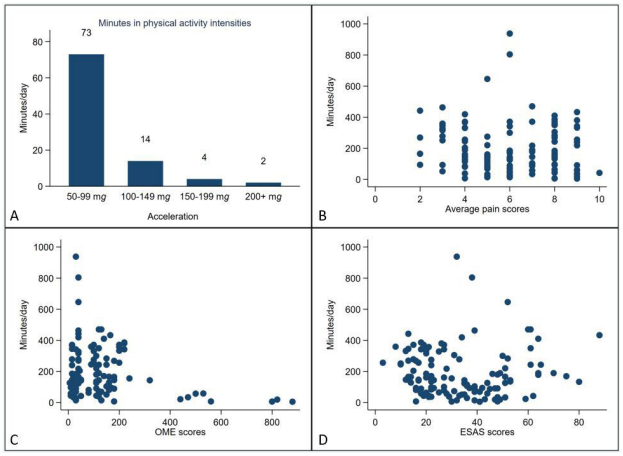

Figure 1 Daily minutes of physical activity compared with physical activity intensity and daily scores for pain, opioid use and symptoms. (A) average minutes in different physical activity intensities. (n=142 days) (<50 mg units is considered inactive); (B) correlation between daily average pain score and daily minutes in activity (Spearman's r=0.10; p=0.260); (C) correlation of oral morphine equivalent (OME) (total mg/day) with minutes in activity per day (Spearman's r=−0.05; p=0.630); (D) correlation between total daily Edmonton Symptom Assessment Scale (ESAS) scores and daily minutes in activity (Spearman's r=−0.14; p=0.109).

The average daily step count of participants was 5723.69, with a range from 1117 to 21 205 steps per day when incomplete days were removed. The average acceleration of participants was 14.4 milli gravity units (SD: 7.3) across all days. Most time during the day was spent inactive (including sleep time), with an average total activity time of 93 mi/day (figure 1). Most of the time spent active was in activities with an average acceleration between 50 and 99 mg (light intensity activity). Daily median duration of light intensity activity was 73 min. Using a cut-off from the healthy adult population, median moderate intensity activity was 20 min, with nearly three-quarters of this time in activity with an average acceleration of 100–149 mg. There was no activity of vigorous intensity recorded.

No correlation was seen between total daily OME dosing and either acceleration or minutes in activity (figure 1) (Spearman's r=−0.12; p=0.179 and Spearman's r=−0.0.05; p=0.630, respectively). A trend towards lower activity (both average acceleration and minutes in activity (figure 1)) at higher OME doses above 200 mg day was seen, but this was not statistically significant. No correlation was demonstrated between total symptom score (measured using ESAS) and either minutes in activity (figure 1) or acceleration.

The median average pain score at baseline was 4, with a range of 2–9 (0–10). Baseline median 'least pain' was 2 (range 0–9) and 'worst pain' was 6 (range 4–9). No correlation was seen between average pain score and acceleration (Spearman's r=0.10; p=0.261) or the number of daily minutes in activity (Spearman's r=0.10; p=0.260). The full range of activity was seen

at all pain scores, with the most minutes in activity seen with an average pain score of 6. There was also no correlation seen between daily 'worst pain' scores and average acceleration (Spearman's r=−0.09; p=0.298) or daily minutes in activity (Spearman's r=−0.11; p=0.237).

Overall participants were satisfied with the study, with 74% stating they were satisfied or mostly satisfied. Only one participant was somewhat dissatisfied with their involvement (patient global impression of change scale).

DISCUSSION

The primary outcome of assessing the feasibility of using accelerometers to measure activity in advanced cancer was achieved. The amount of accelerometer data collected per patient suggests it is acceptable for participants with advanced cancer to wear these devices. While other clinical studies[9] highlighted compliance as a major issue, it was not an issue in our study and patients reported a high level of satisfaction in wearing the device.

As expected, the daily average of active time is lower than the average healthy adult population (209 min/day),[10] and the average step count (5723.69) is consistent with prior studies.[11] Most of the activity was low intensity activity, and about half that of the healthy population (141 min/day).[10] Interestingly some participants had higher than average activity despite their disease state, living very active lives despite their pain and symptoms. Importantly, while the average activity is low, it was possible to capture this accurately using the accelerometer.

Opioid use (below 200 mg OME a day) appears to have little impact on activity levels. There is a trend for higher doses of opioids to be correlated with less activity; possibly due to a higher rate of sedative side effects, worse total pain or higher doses in response to pain control. The sample in this study is small and other disease or treatment factors have not been accounted for, so this trend is uncertain and worth investigating further.

Pain scores did not appear to impact level of function. Pain (highly subjective)[12] and symptom scores vary in the individual and between individuals with similar pathology.[13] The ability to measure a change in function might enable us to better understand the dynamic of pain and function in an individual patient.

The total symptom burden also does not appear to impact physical activity levels. Some patients function well despite high overall symptom burden. Our results align with another study that assessed quality of life and self-reported activity in palliative cancer patients, which also identified the association of higher activity with lower fatigue subscores.[14] The relationship between patient activity and specific symptoms or disease burden is complex, and further studies are needed to assess the impact of specific symptoms on function.

Patients with advanced cancer desire increased function with pain, and improved quality of life (known association with increased activity).[14] Examining the change in activity and pain levels before and after intervention with medications, and assessing toxicity of these medications could help guide which medications provide the most functional benefit to patients in pain, and appropriate dosing. Future studies using accelerometers could provide valuable information as to how best to achieve this for a patient group where function is particularly important.

CONCLUSIONS

Measuring pain using standard questionnaires and patient recall is subjective, inaccurate and prone to bias.[6] Accelerometers are a promising tool to measure activity in advanced cancer, to further understand how we can help maximise function and improve the quality of life in our patients. We demonstrated it is feasible to use accelerometers to measure activity in advanced cancer, however, correlation between pain, opiate use, total symptom distress scores and function cannot be drawn from this study.

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Contributors PG designed the study. PG and SL were responsible for recruitment and data collection. SL completed initial data analysis, with accelerometer and statistical analysis by GIM. SL wrote the initial draft of the paper with contributions by both PG and GIM.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Mater Human Research Ethic Committee (Brisbane Australia) HREC/17/MHS/131. Participants gave informed consent to participate in the study before taking part.

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Supplementary Table 1: Demographic and baseline data

Variables	**Participants** *n=24*
Gender	
Male	12 (50)
Female	12 (50)
Age	
Under 55	6 (25)
55-64	4 (16.7)
65 and over	14 (58.3)
Current Place of Care	
Private residence	22 (91.7)
Inpatient Oncology or Palliative ward	3 (12.5)
Married/living with partner	
Yes	12 (50.0)
No	12 (50.0)
Other, live in social support	
Yes	15 (62.5)
No	9 (37.5)
Community Support	
None	10 (41.7)
General Nursing	2 (8.3)
Palliative Care	6 (25)
Domestic	6 (25)
Other	2 (8.3)
Mobility aid use	
None	13 (54.2)
Walking Stick	6 (25)
4 Wheeled Walker	4 (16.7)
Other	1 (4.2)
Transport to clinic	
Drives self	5 (20.8)
Driven by someone	18 (75)
Public transport	3 (12.5)
Other	1 (4.2)
Metastatic disease	
Yes	21 (87.5)
No	3 (12.5)
Primary cancer	
Prostate	5 (20.8)
Breast	5 (20.8)
Lung	4 (16.7)
Gastro-intestinal	4 (16.7)
Melanoma	2 (8.3)
Urological	1 (4.2)
Gynaecological	1 (4.2)
Other	2 (8.3)
Current Treatment	
None	6 (25.0)
Chemotherapy	10 (41.7)

Hormone therapy	7 (29.2)
Bone strengthening	5 (20.8)
Immunotherapy	3 (12.5)
Number of medications, median (range)	11.5 (3-18)
Number of medications, mean (range)	11.23 (3-18)
Oral morphine equivalent dose in past 24 hours, median (range)	90mg (6-500mg)
Oral morphine equivalent dose in past 24 hours, mean (range)	122.29mg (6-500mg)
Use of other analgesia in past 24 hours (percentage)	75.0
HADS score, median (range)	13.45 (3-24)
Anxiety, median (range)	6.37 (0-12)
Depression, median (range)	7.08 (2-12)
Average pain score on day 1, median (range)	4.25 (2-9)

Data is presented as number (percentage) unless otherwise indicated.