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Review

The relationship between physical activity and post-operative length of hospital stay: A systematic review☆

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HIGHLIGHTS

- First systematic review to investigate the relationship between peri-operative physical activity and hospital length of stay.
- Multiple different sensors and outcome measures used to monitor physical activity.
- Significant negative relationship between physical activity levels post-operatively and length of hospital stay.
- Objective activity data collected by body worn sensors may be able to predict functional recovery post-operatively.

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ABSTRACT

Background: Recovery from surgery has traditionally been measured using specific outcome measures, such as length of hospital stay. However, advances in technology have enabled the measurement of continuous, objective physical activity data in the perioperative period. The aim of this systematic review was to determine the relationship between length of hospital stay and physical activity data for patients undergoing surgery.

Methods: A systematic search of EMBASE, Medline and the Cochrane Library, from inception until January 2017, was performed to identify all study designs that evaluated physical activity after surgery. Studies were included if a wearable sensor measured patient activity as an in-patient and the length of hospital stay was reported. Only English articles were included.

Results: Six studies with a total of 343 participants were included in this review. All the studies were prospective observational studies. Each study used a different sensor, with the commonest being a tri-axial accelerometer, and multiple different physical activity outcome measures were used, thereby prohibiting meta-analysis. Four of the studies demonstrated a relationship between physical activity levels and length of hospital stay, while two studies did not show any significant relationship.

Conclusion: The amount of physical activity performed post-operatively negatively correlates with the length of hospital stay. This suggests that objective physical activity data collected by body worn sensors may be capable of predicting functional recovery post-operatively.

1. Introduction

Traditionally recovery from surgery has been measured using specific outcomes measures for both short and long-term follow up. These include complication and readmission rates, re-operation rates, 30-day mortality and morbidity, with the most commonly used measure being length of hospital stay [1,2]. As well as these measures being standardised they are easily available, they do not require any extra input from the patient themselves, and are therefore easier to obtain and use. However, return to base line function will usually occur after the inpatient stay has been completed and will frequently run a varied course [3]. In this vein, more recent studies have used quality of life (QoL) questionnaires as surrogate functional outcome measures. These aim to assess when patients returned to normal life and function following surgery [4,5]. QoL questionnaires, which often detail activities of daily living, offer an insight into physical function but are often very subjective [6].

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Physical activity is an important component for recovery after surgery, both as a way to help reduce post-operative complications, e.g. pneumonia and venous thromboembolism [7], and as a marker of functional recovery [8]. Up until recently the ability to assess physical activity has mainly been through self-reporting questionnaires or physical function tests [9,10]. These tests tend to assess activity and function at one point in time only. However, advances in technology have led to the emergence of sensors that can measure objective physical activity unobtrusively and continuously over a longer period of time [11]. These small, light-weight, body worn sensors have been used in a variety of healthcare settings including during the peri-operative period [12–15].

To date there has been no consensus in the literature concerning a possible correlation between objective physical activity data and more traditional outcome measures, in particular, length of stay. Knowing whether accurate objective physical activity data correlate with less sophisticated outcome measures that are currently used would potentially give clinicians and researchers an extra tool to better understand and improve patient recovery. Specifically, it would help to answer whether activity sensors can be utilised during the acute post-operative period to detect patients at risk of a protracted recovery, with potentially poorer long term outcomes, thus highlighting the need for extra clinical input and care at an appropriate stage.

Therefore, the aim of this systematic review was to determine the relationship between objectively measured physical activity recorded by body worn sensors and the length of hospital stay in the acute inpatient setting.

2. Methods

2.1. Literature search

A systematic review was conducted in accordance with the guidelines for the "Preferred Reporting Items for Systematic Review and Meta-analyses" [16]. A literature search was performed using Medline, EMBASE and the Cochrane Library, from inception until January 2017, combining MESH and all-field search terms for "physical activity" AND "accelerometer" AND "postoperative". Detailed search criteria are presented in Appendix A. The full texts of original articles and relevant reviews were obtained. Additional studies relevant to this review were identified through reference lists.

2.2. Inclusion criteria

The search included any study that evaluated patients' physical activity or body movement in the perioperative period. Studies were included if the body movement was monitored by a wearable body sensor. Papers were only included if there was physical activity data available for the in-patient stay as well as hospital length of stay data. The search was restricted to articles written in English. Randomised controlled trials (RCTs), observational studies and case series were included. Study authors were contacted when extra data/information was required to be able to determine whether the study was eligible for inclusion.

2.3. Exclusion criteria

Studies involving children and adolescents were excluded. Studies where physical activity was only measured pre-operatively or post-operatively in the community were excluded. Studies where sensor equipment was placed on structural equipment only, e.g. on a wheelchair, on furniture or walls were excluded. Conference abstracts and single case reports were excluded.

2.4. Study selection

Two reviewers conducted the literature search and independently reviewed the titles and abstracts to select potentially relevant articles (A.A. and C.P) and a consensus was reached. Any discrepancies between reviewers were referred to a third reviewer (R.M.K.) before a final decision was made on inclusion. Endnote was used to manage the bibliographic searches.

2.5. Study quality

The quality of each selected article was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system [17]. The GRADE system classifies quality of evidence into four levels; high, moderate, low or very low. The design of study is evaluated along with evidence of study limitations, inconsistencies, indirectness, imprecision and publication bias [18]. This tool was utilised since it assesses the quality of randomised controlled trials as well as observational studies.

2.6. Data extraction

The following data were extracted: (1) study features including study design, number of patients, patient demographics; (2) activity sensor details including type of sensor, body placement, length of time sensor worn, sensor output measures e.g. time spent in activity level, Metabolic Equivalent of Tasks (METs) hours, number of steps, energy expenditure; (3) length of hospital stay.

3. Results

3.1. Search results

Initially 2147 potentially relevant titles were identified. After removal of duplicates 1805 titles and abstracts were screened and 1585 records were excluded (Fig. 1). Full texts were obtained for the remaining 220 studies. The inter-rater agreement between reviewers was good (kappa score 0.651, $p < 0.0005$). Eighteen eligible studies were found. Four studies included the full data necessary to meet the inclusion criteria of this review [19–22]. Authors of the remaining 14 studies were contacted in an attempt to obtain additional analyses or full data sets. Contact details for authors of 2 studies could not be obtained [23,24]. Of the authors we were able to contact, 1 provided additional data, but it transpired that no in-patient activity data had been recorded, only out-patient activity, and therefore the study was excluded from the review [25]. Two authors were unable to provide the study data [26,27], 2 study authors [28,29] sent us the extra data needed, while the remaining 8 authors did not respond to our communication [30–36]. Therefore, 6 studies were ultimately included in this review (Fig. 1).

3.2. Study design and quality

Using the GRADE tool to assess for study quality, all six studies were rated as low quality. This was due to the studies all being observational in nature with no evidence of a large magnitude of effect and the high possibility of confounders minimising any effects seen.

3.3. Study characteristics

The 6 studies included in this review were published between 2007 and 2016 with 4 different surgical cohorts. Two studies assessed cardiothoracic patient cohorts, 2 studies enrolled an orthopaedic patient cohort, 1 study included a general surgical