Quantification of physical activity parameters during inpatient therapy sessions of geriatric patients with hip and pelvic fracture. Retrospective study based on sensor monitoring.

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1. Introduction-Purpose

Physiotherapy and occupational therapy are currently described using the duration of treatment (days or weeks) and the frequency of the therapy sessions on a given day (on a daily or 3-to-5 days per week basis) multiplied by the minutes of a session (e.g. 30 or 45 minutes). The content is often ill-defined. The intensity is rarely reported. The finding hereinabove is mostly based on empirical observation. Physical therapy and other therapeutic intervention in rehabilitation settings tend to be a "Black Box". We only poorly quantify or even interpret gait parameters, sedentary time and other activities performed by the patients during supervised therapy sessions. Using digital technology some of these shortcomings can be overcome. The cumulative parameters of walking and activity bouts may be, for instance, the duration of walking, the time in an upright or lying/sitting position and the number of steps. In the study hereof , we analysed these parameters using digital sensors during single and group sessions of patients recovering from fragility fractures.

2. Methods

The present study is a secondary data analysis of a previous study (Kampe et al., 2021) that examined the improvement of physical activity (PA) and self-efficacy of fragility fracture patients. Changes in PA parameters were measured using the ActivPal3 sensor during the 1st and 3rd week of rehabilitation. One hundred four (n=104) patients participated (mean age 82.5 years). The examined parameters were calculated during therapeutic and non therapeutic time were the average number of steps, time in upright position, walking duration, walking intervals <10sec and the number of sit-to-stand transfers.

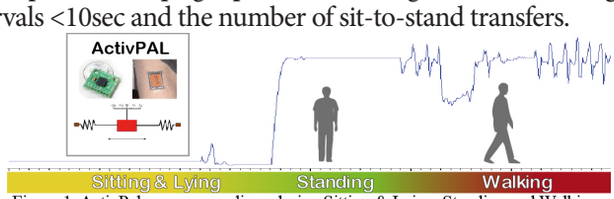

Figure 1: ActivPal sensor recordings during Sitting & Lying, Standing and Walking.

3. Statistic analysis

The analysis focused on the progression of different PA parameters between times of measurement. These were calculated according for both measurement days. Least-square means and mean differences with 95%-confidence intervals were calculated for each point in time. We performed the same approach for the duration of individual or group therapy. Statistical analyses were performed using SAS 9.4.

The original study protocol, consort diagram and baseline characteristic (Kampe 2021) were already published and were not re-analyzed. The project was approved by the Ethical Committee of University of Tübingen (application no. 241/2016BO1).

Table 1: Baseline characteristics

Parameter	Range	mean and(SD)
Short Orientation Memory Concentration Test	0-28	3.28 (2.75)
Gait Speed *	seconds	0.45 (0.16)
5 Chair Rise Test **	seconds	32.3 (15.1)
Short Physical Performance Battery	0-12	3.04 (2.04)
Rivermead Mobility Index	0-15	7.56 (2.54)
Falls efficacy Scale International Short FES-I)	0-28	15.8 (4.96)
Western Ontario McMasters Univ. Osteoarthritis Scale	0-20	14.3 (10.7)

* Gait speed at baseline was assessed from n = 89
** Chair rise time at baseline was assessed from n = 85

Results

Patients received therapy sessions of 90-120 minutes per day. More than 50% of their daily walking and stepping activity was achieved during this period. With this amount of walking most parameters increased significantly from baseline to the second measurement. The number of steps increased by 30%, the mean time in an upright position increased by 26% and the mean time spent walking increased by 49%.

Table 2: An overview of the results during therapeutic and non-therapeutic time

Parameters	Week 1 (T0)	Week 3 (T1)
Sit to stand transfers	❖ 10 ➢ 39 ✓ 51	❖ 13 ➢ 41 ✓ 57
Walking interval length	❖ 36 ➢ 9 ✓ 58	❖ 54 ➢ 11 ✓ 87
Walking intervals>10sec	❖ 13 ➢ 22 ✓ 37	❖ 23 ➢ 29 ✓ 55
Average Time spent per day [in h (min)]	❖ 2.5 [152.5] ➢ 21.0 [1260.8]	❖ 2.8 [168.8] ➢ 20.5 [1229.0]
Upright time	❖ 41 ➢ 130 ✓ 177	❖ 61 ➢ 155 ✓ 223
Average therapy units per day	3.32 (3)	3.63 (4)

❖ During therapies,
➢ Therapy free-time,
✓ Total

Table 3: Steps average per day during rehabilitation

Steps average [n] per day	Week 1 (T0)	Week 3 (T1)
Total	1344	2111
During therapies	473	906
Therapy-off time	803	1117
Transport to therapies	38	49
Transport from therapies	30	39

Table 4: Overview of PA parameters during single therapies

Average per day	Week 1 (T0)	Week 3 (T1)	Changes expressed in percentages (%)
Spending time [min (h)]	68.1 (1.1)	95.8 (1.6)	+41%
Number of therapy units [n]	1.6	2.1	+31%
Steps [n]	212	529	+150%
Uptime [min]	19.0	33.9	+78%
Walking intervals [sec]	20.1	33.6	+67%
Walking intervals > 10 sec [n]	6	14	+133%
Sit-Stand-Transfers [n]	5	8	+60%

Table 5: Overview of PA parameters during group therapies

Average per day	Week 1 (T0)	Week 3 (T1)	Changes expressed in percentages (%)
Spending time [min (h)]	110.5 (1.8)	101.0 (1.7)	-9%
Number of therapy units [n]	2.3	2.1	-9%
Steps [n]	342	527	+54%
Uptime [min]	29.6	36.7	+24%
Walking intervals [sec]	22.1	29.6	+34%
Walking intervals > 10 sec [n]	9	13	+44%
Sit-Stand-Transfers [n]	7	8	+14%

Patient walking intervals length increased by 43% in treatment time and 22% in non therapeutic time. The average length of the walking distance achieved per day increased to a total number by 43%. Furthermore the average time spent per day during therapeutic sessions was increased by 12% between the two measurements.

4. Discussion

Fragility fractures of octagenerions and nonagenerarions are sometimes considered as end-of-life events and treatment is considered futile. Many studies including the recent Cochrane Review on hip fracture rehabilitation (Handoll et al., 2021), tell a different story; that more than half of this population has a significant life expectancy and rehabilitation makes a difference in terms of disability, care home admission and mortality. As part of future trials and clinical services we trust a process evaluation shall include a quantified description of mobility during physiotherapy and other therapeutical interventions. To the best of our knowledge this is one of the first studies that quantified gait activities during therapeutic sessions using a sensor based approach. That means that the content, duration, frequency and intensity is required in order to describe the minimum, optimum and maximum gains of inpatient and outpatient rehabilitation programs. This can be considered as a landmark for future clinical trials and research activities in this field.

5. Conclusion

The positive changes observed in the results of the previous research are attributed herein to the physical activation in non therapeutic activities as treatments did not account for more than 50% of patient's PA in the Robert Bosch Krankenhaus clinic.

Limitations

ActivPAL3 and similar sensors did seem to underestimate the counting of slow walking steps (< 0.5 m/ sec). It is therefore thoughtful to include new sensors in future trials. We acknowledge that the chosen sample is not fully representative for geriatric rehabilitation.

Future perspectives

Future studies should report at least a minimum data set of PA and mobility parameters during supervised therapy sessions. While measurements such gait speed or Time Up-&Go represent capacity, they do not give insight into minimum or optimal levels of therapy. An extension of instrumented assessment to assess asymmetry, gait variability, stair climbing, turning and other parameters could be useful.

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References:

1. Kampe, K., Pfeiffer, K., Lindemann, U., Schoene, D., Taraldsen, K., Rapp, K.,Becker, C., Klenk, J., 2021. Change of physical activity parameters of hip and pelvic fracture patients during inpatient rehabilitation and after discharge: analysis of global and in-depth parameters. Eur Rev Aging Phys Act 18, 9. https://doi.org/10.1186/s11556-021-00261-1

2. Handoll, H.H., Cameron, I.D., Mak, J.C., Finnegan, T.P., 2021. Multidisciplinary rehabilitation for older people with hip fractures. Cochrane Database of Systematic Reviews. https://doi.org/10.1002/14651858.CD007125.pub2