Predicting mobility in hospitalized adult patients

Master thesis

Physiotherapy Science

Program in Clinical Health Sciences

Utrecht University

Name student:	Mohammed Benali
Student number:	4200551
Date:	02-06-2018
Internship supervisor(s):	Dr. Karin Valkenet
Internship institute:	Research department of Rehabilitation, Physical Therapy Science & Sport
Lecturer/supervisor Utrecht University:	Dr. R. Zwitserlood

"ONDERGETEKENDE

Mohammed Benali,

bevestigt hierbij dat de onderhavige verhandeling mag worden geraadpleegd en vrij mag worden gefotokopieerd. Bij het citeren moet steeds de titel en de auteur van de verhandeling worden vermeld."

Examiner

Dr. M.F. Pisters

Assessors:

Dr. K. Valkenet

Dr. J. van der Net

Master thesis, Physical Therapy Sciences, Program in Clinical Health Sciences, Utrecht University, Utrecht, 2017

ABSTRACT

Background: Low mobility during hospitalization is common across all ages and is associated with functional decline. Factors influencing hospital mobility have been explored in several studies. However, the generalizability of these studies might be low due to differences in population samples and hospital environments. No previous study has investigated mobility in patients who are able to be independently active during hospitalization.

Aim/RQ: The purpose of this research was to examine which factors influence mobility in patients who are able to be independently active and also to develop a prediction model for mobility in hospitalized adult patients admitted to the Dutch University Medical Centre.

Methods: In this prospective observational, cross-sectional study, patients who were able to be independently active during hospitalization were included. Patients were excluded when receiving end-stage palliative care and when no verbal consent could be given. Outcome data consisted of hospital and personal related factors and were collected by behavioral mapping. Univariable and multivariable regression analyses were performed to explore the association of predictors with hospital mobility based on backward elimination criteria of $p \leq 0.20$. Additionally, the variance of mobility was described with R^2.

Results: A total of 186 participants were included with a mean age of 59 years. Sixteen factors were included in the univariable analyses. Based on the elimination criteria age ($B = 0.008$, $p<0.05$), surgical procedure($B = -0.107$, $p=0.02$) and the use of an assistive device ($B = -0.03$, $p=0.03$) were found to be a significant predictor on mobility and explaining 10% of the variance of mobility.

Conclusion: Despite the ability to be independently active, participants performed low mobility during hospitalization. Further research of hospital mobility should focus on the clinical practice and provide information that can be used in clinical decisions.

Clinical Relevance: An underlying phenomenon of low hospital mobility is existent. To understand the causes of low mobility, the UMCU Hospital in Motion project should focus on the perspectives of patients, family members and care workers since they play an important role in hospital mobility.

Keywords: Hospital mobility; Hospitalization; Early ambulation; Experienced health

INTRODUCTION

In the Netherlands, the issue of low hospital mobility has received considerable attention. Low mobility, resulting in activities that require very low Metabolic Equivalent (METs) expenditure, is very common during hospitalization and is associated with deep vein thrombosis, loss of muscle mass and mortality.[1-3] Observational studies by behavioral mapping show that hospitalized patients are inactive and stay mostly around their room and in bed.[4-6] To prevent adverse outcomes, hospitalized patients with a risk of low mobility should be identified at an early stage.[7-9]

Factors influencing mobility in hospitalized patients have been explored in several studies. In a grounded theory study, Brown et al., (2007) found that symptoms, restraining medical devices, lack of staff or ambulatory devices, fear of falling and lack of motivation all have a negative influence on hospital mobility.[10] Furthermore, age, severity of illness, medication consumption, low calorie intake and the use of canes or walkers prior to admission are highly associated with low hospital mobility.[11-13] Additionally, the environment is also a strong influencer on mobility.[12,14,15] Due to the differences in setting, ward environment, ward culture and country, the generalizability of many studies on this issue may be low.[10,16] De Wit et al.,(2005) examined differences in hospitalized patients in four European countries and found that in the countries with structured reactivation programs, patients were observed as being more active, more involved in social interaction and more often out of their room.[16]

Although most studies have been conducted on hospitalized elderly, recent findings show that low mobility during hospitalization is common in all ages.[17] The Dutch hospital population consists of 63% of adults aged 60 and younger but most study results are not representative for this population.[18] The prevalence of low mobility is high and even present in patients who are able to be independently active during hospitalization.[7,8] No study has investigated factors influencing hospital mobility in adult patients who are able to walk independently during hospitalization. Furthermore, some factors relating to mobility in hospitalized patients have been inconsistent and even contrary to earlier findings.[12,19,20] Knowing the factors and predicting the risk for low mobility at an early stage is essential in order to reduce adverse outcomes. A systematic review by Pashikanti and Von et al., (2012), found that care models that support early mobility were associated with positive outcomes for deep vein thrombosis, reduced length of stay and improved functional status in mixed-aged hospitalized patients.[21] As Visser et al, (2001) described, research into factors and prediction models are best applicable to the investigated population in that particular setting.[22] Therefore, the objective of this study is to examine which factors influence mobility in patients who are able to be independently active and to develop a prediction model for identifying patients at high-risk of low mobility, based on the predictors in hospitalized adult patients admitted to the Dutch University Medical Centre.

METHODS

This study is part of the "Dutch University Medical Centre of Utrecht (UMCU) Hospital in Motion"- project which is investigating movement behaviors and hopes to increase mobility in hospitalized patients.[23]

In the Hospital in Motion project, all patients admitted to the UMCU were assessed for inclusion. Patients were excluded when receiving end stage palliative care and when no verbal consent could be given due to a cognitive impairment, and if no relative could consent on their behalf. Patients identified as eligible were informed both verbally and in writing about the practical details of the study. All participants were adults without prescribed mandatory bed-rest and were willing to participate. The participants were informed that participation in the study was voluntary and withdrawal was possible at any time without stating a reason. The Hospital in Motion project was approved by the Research Ethics Committee (METC) of the UMCU under registration No. 16-250.

Outcome measurement:

Data was collected through behavioral mapping. Participants were observed in a fixed order every 10 minutes for a 1-minute period.[6] This was conducted in what is supposed to be the most active part of the day, between 9 AM and 4 PM. This mapping method is systematic, structured and has been used in similar studies.[4-6,16,17] Before observations, each unit was introduced to the observer and made aware that observations were being conducted. The observer recorded the participant's location, the person attending, the activity performed and the body posture. When two activities were performed in equal duration, the observer recorded the activity with the highest intensity. To obtain the variable in continuous value, these activities were converted into METs values. This was done from the updated 2011 Adult Compendium of Physical Activities and an additional resources database.[24,25] The Compendium is used globally to quantify the energy cost of physical activity in adults for research studies. Table 1 shows the 8 observed activities with the corresponding METs values.

Observations were made by physiotherapy students, who were instructed according to a standardized protocol, to systematically use the behavioral mapping method. During behavioral mapping, other predictors such as the ward environment, number of roommates, the use of urinary catheters or IVs were collected. Also the use of an assistive device, like a cane or walker, and complaints during mobility including tiredness, nausea, pain or fear, were collected. Clinical data such as gender, age and (planned) surgical procedures were collected from medical records.

Additional measurements:

The limitations in mobility and daily activity were measured by The Activity Measure for Post-Acute Care (AM-PAC). This questionnaire is validated for the Dutch hospital population and based on the activity limitations of the World Health Organization's

International Classification of Functioning, Disability and Health (ICF).[26] Inter-rater reliability for both the mobility and daily activity domains were excellent (ICC. 95% CI. 0.92. 0.82–0.96 and 0.90. 0.73–0.94).[27,28]

For the measurement of muscle strength, the JAMAR Hand Held Dynamometer (HHD) assessed the maximum grip force. Considering the ease of use, portability and size compared with isokinetic devices, the HHD is the best practical standard to provide an indication for the overall muscle strength in the clinical setting.[29] The inter-rater reliability was excellent in adults (ICC.95% CI. 0.85–0.98).[30] Maximum grip force was measured three times, with the highest reported value, in kilograms, as the main outcome. Participants performed the assessment with their dominant hand, in a seated position and with their shoulder adducted with elbows flexed at 90 degrees.[23]

Experienced health was assessed using the Subjectieve Beleefde gezondheidsschaal (SBG). This questionnaire was developed by Bloem et al., (2008) and measures the experienced health using the factors of acceptance and control.[31,32] The degree of acceptance and control are the main psychological factors that influence experienced health.[31] In eight questions the perceived experienced health (both mentally and physically) was assessed, with higher scores correlating to better experienced health outcomes. Answers can be transcribed into a ladder with steps numbering from 0 (not good) to 10 (the best) and into a 7-point scale ranging from 1 (fully disagree) to 7 (fully agree). Based on the Dutch cut-off scores, four types of people (quadrants) were differentiated (see appendix 1).

Additionally, 6 questions were asked regarding the influence of the environment on mobility during hospitalization (see appendix 2). The first question addressed the physical environment. The second and third questions addressed whether patients and their relatives received instructions or information about the importance of being active during hospitalization. The fourth and fifth questions addressed whether patients had been stimulated in the past two days by a nurse or physician to be active during hospitalization. In the last question patients were asked if they had exercised independently in the past two days in order to improve muscle strength or their condition. The participant could rate the questions on a 5-likert scale, ranging from 1 (strongly agree) to 5 (strongly disagree).

Study design:

This prospective observational, cross-sectional study used data extracted from the UMCU Hospital in Motion project. Inclusion criteria for the current analyses were patients who were able to be independently active during observations, defined by having a score of 3 or higher on the AM-PAC mobility question 5, i.e. little to no help needed for walking.

Table 1: observed activity and METs values	
Activity observed	**METs value**
1- Lying in bed (<30 degrees)	1.0
2- Sitting in bed (> 30 degrees)	1.3
3- Sitting on bedside	1.5
4- Sitting on (po) chair	1.8
5- Transfers	2.8
6- Standing	1.6
7- Walking	2.0
8- Exercising on bike,	6.8
9- other or not observed	-*
METs = Metabolic Equivalent;	

Data analyses

The Statistical Package for the Social Sciences for Windows (version 22.0; IBM. SPSS Inc., Chicago, IL, USA) was used for the statistical analysis. The characteristics of the study participants were described with descriptive statistics, including frequencies, means and standard deviations. To obtain the dependent variable, each activity, with the associated METs value, was counted during observation. These activities, transformed in SPSS, were added together to obtain a total amount of observed METs value. The total amount of observed METs values were then divided by the number of counted activities, in order to provide a mean Mets value over the course of the measurement day. Unobserved activities were excluded due to this technique. The dataset was scanned for patterns of missing values and if possible these values were retrieved from hard copies or medical records. This dataset had missing values, so for the independent variables a multiple imputation analysis was performed.[33] All collected variables were entered into the imputation model and five imputation datasets were generated. From these outcomes the pooled dataset was used for further analysis.[33] The sample size calculation was determined by a 1-10 ratio of events per variable.[34] A total number of 16 predictors were analyzed.

To explore the association of a single predictor on mobility, a univariable linear regression was performed on the predictors ward, number of roommates, the use of urinary catheters or IVs, the use of an assistive device, gender, age, reason for admission, (planned) surgical procedures, limitations of mobility and daily activity, experienced health and the influence of environment. A multivariable regression analyses was performed to construct a model that explains the best fit in variance (R^2) in hospital mobility.[34] Candidate predictors for the multiple regression analysis were selected based on the backward selection with a criterion of $P \leq 0.20$. This relaxed P-value criterion was chosen to reduce the risk of missing important variables in the model.[35] For the statistical analyses a P- value <0.05 was considered statistically significant. Where necessary, the independent t-test was used to interpret differences in hospital mobility that was influenced by participant characteristics.

RESULTS

A total of 269 participants were included for the UMCU Hospital in Motion project of whom 186 (70%) participants met the inclusion criteria for this study. The participant characteristics are displayed in table 2. The mean age of participants was 59 years with 120 (64%) of the participants being male. Hospitalization was not planned in 84 (45%) participants, while 77 (41%) participants had, or where waiting on, surgical procedures. The mean observed METs value over the day was 1.73 (SD=0.43). The majority of participants (75%) were able to walk with no assistive device.

Based on the Gauss–Markov theorem, the assumptions of linear regression were met.[36] Collinearity statistics for all of the predictors indicated that there was no multicollinearity within predictors. Results of the univariable and multivariable regression analyses are shown in table 3. Based on the univariable regression analyses the predictors, age (B=0.009, p <0.05), surgical procedures (B=-0.106, p 0.12), the use of IVs (B=-0.051, p 0.12), the use of a assistive device (B=-0.030, p 0.16) and the motivation of a nurse (B=0.047, p 0.17) were included for further analysis. Results of the multivariable regression analysis showed that age, surgical procedures and the use of a assistive device were statistically significant and were considered as predictors of mobility. Results of the independent t-test showed that patients with an age of 60 years or older, showed significant differences in mobility when compared with patients younger than 60 years (1.87 METs VS 1.59 METs, p<0.05). Also, patients with no surgical procedures or assistive device were observed in higher mobility than those who did underwent surgical procedure or used a assistive device (resp. 1.78 METs VS 1.65 METs and 1.74 METs VS 1.71 METs), see table 4. The multivariable regression model with the predictors age, surgical procedures and the use of a assistive device explained 10% of the variance in hospital mobility.

Table 2 Participants characteristics

Characteristics	**Mean ± standard deviation / n (%)**
Age	59.8 ± 16.5
Gender	
Male	120 (64%)
Female	67 (36%)
Planned Hospitalization	
No	83 (49%)
Yes	88 (51%)
Surgical procedures	
No	104 (56%)
Yes	83 (44%)
Number of roommates	
0	56 (30%)
1	61 (33%)
2	34 (18%)
3	26 (14%)
4	10 (5%)
METs	1.73 ± 0.43
Complaint when being active	
No complaints	72 (39%)
Tired	27 (14%)
Nauseous	8 (4%)
Pain	52 (28%)
Fear	2 (1%)
Other	24 (13%)
The use of urinary catheter	
No	153 (81%)
Yes	34 (19%)
The use of IV's	
No	119 (64%)
Yes, on the wall	3 (1%)
Yes, on wheeled pole	65 (35%)
The use of a walking device	
No assistive device	141 (75%)
Walking stick or crane	4 (2%)
Walker	4 (2%)
Tripod walker	4 (2%)
Rollator	5 (3%)
HHD	29 ± 14
SBG questionnaire	
Control	4.2 ± 1.46
Acceptance	4.1 ± 1.47

METs = Metabolic Equivalent; HHD Max = Hand Held Dynamometer Maximum force; AM – PAC = by The Activity Measure for Post-Acute Care; SBG = Subjectieve beleefde gezondheidsschaal

Table 3: Summary of the Univariable Regression Analyses of all predictors and a summary of the Multivariable Regression Analysis with the selection criteria of P ≤ 0.20

	Univariable analyses		Multivariable analyses	
Predictors	**Coefficients (*B*)**	**P- value**	**Coefficients (*B*)**	**P- value**
Age	0.009 (0.002)	0.000	0.008 (0.002)	0.000
Gender	-0.033 (0.075)	0.660		
Planned Hospitalization	0.022 (0.071)	0.752		
Surgical procedures	-0.106 (0.068)	0.121	-0.107 (0.060)	0.029
Number of roommates	-0.018 (0.027)	0.510		
Complaint when being active	0.021 (0.018)	0.245		
The use of urinary catheter	0.004 (0.105)	0.996		
The use of IV's	-0.051 (0.033)	0.127		
The use of a assistive device	-0.030 (0.021)	0.168	-0.038 (0.019)	0.037
HHD	0.002 (0.003)	0.611		
SBG- questionnaire				
Control	0.008 (0.025)	0.721		
Acceptance	-0.004 (0.023)	0.861		
AM- PAC				
Daily Activity	0.004 (0.009)	0.700		
Influence on mobility				
Environmental	0.008 (0.029)	0.798		
Motivated by nurse	0.047 (0.034)	0.170		
Motivated by physician	-0.004 (0.037)	0.918		
R^2	0.185		0.104	

METs = Metabolic Equivalent; HHD = Hand Held Dynamometer Maximum force;
AM – PAC = The Activity Measure for Post-Acute Care; SBG = Subjectieve beleefde gezondheidsschaal

Table 4: Independent t- test analyses on predictor age, elderly VS young hospitalized patients, Surgical procedure Yes VS No and the use of a assistive device Yes VS No

Predictor	**n=**	**METs**	**standard deviation**
Age			
>60 years	91	1.87	0.465
<60 years	96	1.59	0.338
Surgical procedure			
Yes	83	1.67	0.386
No	104	1.78	0.453
The use of a assistive device			
Yes	46	1.71	0.469
No	141	1.74	0.413

DISCUSSION

The objective of this study is to examine which factors influence mobility in patients who are able to be independently active and to develop a prediction model for identifying patients at high-risk of low mobility, based on the predictors in hospitalized adult patients admitted to the Dutch University Medical Centre. Based on the univariable regression analyses, age, surgical procedure, the use of IVs, the use of an assistive device and the motivation of a nurse were associated with mobility ($P \leq 0.20$) and were selected for further analyses. Results based of the multivariable showed that age was a predictor for hospital mobility. There was a statistical difference within age groups, $t(4.64) = 18.86$, $p < 0.05$, with participants aged 60 years and older more active than patients younger than 60. Findings of age as a predictor of mobility in hospitalized patients have been inconsistent. For example, Mudge et al., (2016) and Meesters et al.,(2018) found no statistical differences in mobility or physical activity between older and young hospitalized patients.[17,37] However, the majority of studies have found older age as predictor of low mobility.[3,12,20,38,39] Further results showed that surgical procedures was a predictor for hospital mobility. Results of the independent t-test showed that patients with no surgical procedures observed in higher mobility then those who underwent surgical procedures (1.78 METs VS 1.65 METs). This finding is in agreement with recent studies. For example, Baldwin et al., (2017) found that hospitalized patients with medical or surgical conditions were highly inactive whilst Meesters et al., (2018) found that nonsurgical patients were significantly more active in comparison with surgical patients, whilst hospitalized.[37,40] In a review, Dronkers et al., (2016) points out that impairment on cardiopulmonary and muscle function due to an surgical procedures could be a possible risk for low mobility.[41] Furthermore, the use of an assistive device was found as an predictor for hospital mobility. Results of the independent t-test showed that patients with no assistive device were observed in higher mobility then those who used a assistive device (1.74 METs VS 1.71 METs). This finding is in line with the accelerometer study of Fisher et al.,(2012), who found, in elderly hospitalized patients, that the use of a cane or walker was strongly associated with a reduced overall level of mobility.[11]

Further results showed that the participants in this study demonstrated low mobility when being hospitalized, with an average observed METs of 1.73 ± 0.43. Despite the inclusion of only "active" patients, the results of this study were in agreement with other observation and accelerometer studies.[4,6,8,42] This finding was unexpected and showed that low mobility is present in hospitalized patients regardless of mobility level or age. A possible explanation can be found in the level of experienced health, i.e. the experience of an individual pertaining to his state of health.[43] Results showed that the experienced health of the included participants was low and below the cut-off point of the general Dutch population, meaning that the included participants experienced little or no control over, or acceptance of, their sickness or disease.[32] In people with negative experienced health, such as mental fatigue or anxiety, a negative impact on mobility and physical energy can be determined.[44] This is shown in the

study of Zisberg et al., (2016) which found that patients with low hospital mobility exhibited higher anxiety symptoms then patients with high hospital mobility.[12]

Strength and limitations:

This study contributes to the rapidly growing area of hospital mobility research. No previous study has investigated mobility in adult patients who are able to be physically active during hospitalization. In comparison with similar conducted studies, this study had a relative large sample size.[4,6-8] This study has some limitations. Firstly, the behavioral mapping method did not cover the full spectrum of activity during hospitalization. Furthermore, the presence of an observer may have affected the mobility behaviors under observation.[16] This could account for the low level of observed mobility.[6] A solution to these problems is working with portable activity devices that could be worn throughout the day. Monitoring mobility with a device is far less time consuming than behavioral mapping and is recommended as a practical alternative for monitoring mobility.[45,46] Secondly, the observed activities were converted into METs values that were collected from the 2011 Compendium of Physical Activities.[24] These values could differ from hospitalized patients. A better way is working with formulae that can calculate more specific METs values on the basis of the length and weight of a person. Thirdly, although the predictors were selected based on theoretical or clinical understandings, this study did not cover all of the predictors that are associated with mobility in hospitalized patients. Fourth, the interpretation of this study results into clinical practice is challenging. This study used statistical significance in order to demonstrate association of predictors on mobility. For example, according to the model when a patient is a year older he or she is predicted to perform 0.008 METs more. This prediction with the corresponding METs value is difficult to turn into understandable language. Further research should focus on the clinical practice and provide information that can be used in clinical decisions.

Clinical importance

There is a perverse culture of low mobility and bed-rest in patients during hospitalization even when patients are physically able to move around safely. Most hospitalized patients never walk outside their rooms, probably due the fact that the hospital beyond the patient's room is seen as workspace for health care professionals, not a space for patients to walk or perform other activities.[47] The physical environment should be changed and patient mobility encouraged. This could be done with simple, cost-neutral adjustments. For example, the early removal of catheters and IVs could encourage hospital mobility.[13] Interventions to increase hospital mobility should include patients of all ages and tailored to the wishes, abilities and needs of individuals. The quality of treatment and involvement of the individual will increase when care is based on their wishes and needs.[48,49]

CONCLUSION

There is a growing awareness of the adverse outcome of low mobility during hospitalization. This study has justified this awareness and showed that both younger and older Dutch hospitalized patients perform low mobility regardless their mobility level. Of all the sixteen predictors, five were included in multivariable analyses, with age, surgical procedures and the use of an assistive device as significant individual predictors. These three predictors could be used for identifying patients who are at-risk for low hospital mobility. An underlying phenomenon is present in the hospital setting that ensures low mobility. To understand the causes of low mobility the UMCU Hospital in Motion project should focus on the perspectives of patients, family members and care workers since they play an important role in hospital mobility.

REFERENCES

1. Virtuoso Junior JS, Roza LB, Tribess S, et al. Time spent sitting is associated with changes in biomarkers of frailty in hospitalized older adults: A cross sectional study. *Front Physiol*. 2017;8:505. doi: 10.3389/fphys.2017.00505 [doi].

2. Brown CJ, Redden DT, Flood KL, Allman RM. The underrecognized epidemic of low mobility during hospitalization of older adults. *J Am Geriatr Soc*. 2009;57(9):1660-1665. doi: 10.1111/j.1532-5415.2009.02393.x [doi].

3. Zisberg A, Shadmi E, Sinoff G, Gur-Yaish N, Srulovici E, Admi H. Low mobility during hospitalization and functional decline in older adults. *J Am Geriatr Soc*. 2011;59(2):266-273. doi: 10.1111/j.1532-5415.2010.03276.x [doi].

4. Bernhardt J, Dewey H, Thrift A, Donnan G. Inactive and alone: Physical activity within the first 14 days of acute stroke unit care. *Stroke*. 2004;35(4):1005-1009. doi: 10.1161/01.STR.0000120727.40792.40 [doi].

5. Sjoholm A, Skarin M, Churilov L, Nilsson M, Bernhardt J, Linden T. Sedentary behaviour and physical activity of people with stroke in rehabilitation hospitals. *Stroke Res Treat*. 2014;2014:591897. doi: 10.1155/2014/591897 [doi].

6. Kuys SS, Dolecka UE, Guard A. Activity level of hospital medical inpatients: An observational study. *Arch Gerontol Geriatr*. 2012;55(2):417-421. doi: 10.1016/j.archger.2012.02.008 [doi].

7. Hastings SN, Sloane R, Morey MC, Pavon JM, Hoenig H. Assisted early mobility for hospitalized older veterans: Preliminary data from the STRIDE program. *J Am Geriatr Soc*. 2014;62(11):2180-2184. doi: 10.1111/jgs.13095 [doi].

8. Fisher SR, Kuo YF, Graham JE, Ottenbacher KJ, Ostir GV. Early ambulation and length of stay in older adults hospitalized for acute illness. *Arch Intern Med*. 2010;170(21):1942-1943. doi: 10.1001/archinternmed.2010.422 [doi].

9. Stolbrink M, McGowan L, Saman H, et al. The early mobility bundle: A simple enhancement of therapy which may reduce incidence of hospital-acquired pneumonia and length of hospital stay. *J Hosp Infect*. 2014;88(1):34-39. doi: 10.1016/j.jhin.2014.05.006 [doi].

10. Brown CJ, Williams BR, Woodby LL, Davis LL, Allman RM. Barriers to mobility during hospitalization from the perspectives of older patients and their nurses and physicians. *J Hosp Med*. 2007;2(5):305-313. doi: 10.1002/jhm.209 [doi].

11. Fisher SR, Graham JE, Brown CJ, et al. Factors that differentiate level of ambulation in hospitalised older adults. *Age Ageing*. 2012;41(1):107-111. doi: 10.1093/ageing/afr110 [doi].

12. Zisberg A, Syn-Hershko A. Factors related to the mobility of hospitalized older adults: A prospective cohort study. *Geriatr Nurs*. 2016;37(2):96-100. doi: 10.1016/j.gerinurse.2015.10.012 [doi].

13. Brown CJ, Roth DL, Peel C, Allman RM. Predictors of regaining ambulatory ability during hospitalization. *J Hosp Med*. 2006;1(5):277-284. doi: 10.1002/jhm.104 [doi].

14. Owen N, Sugiyama T, Eakin EE, Gardiner PA, Tremblay MS, Sallis JF. Adults' sedentary behavior determinants and interventions. *Am J Prev Med*. 2011;41(2):189-196. doi: 10.1016/j.amepre.2011.05.013 [doi].

15. Patterson TA, Basson M, Bravington MV, Gunn JS. Classifying movement behaviour in relation to environmental conditions using hidden markov models. *J Anim Ecol*. 2009;78(6):1113-1123. doi: 10.1111/j.1365-2656.2009.01583.x [doi].

16. De Wit L, Putman K, Dejaeger E, et al. Use of time by stroke patients: A comparison of four european rehabilitation centers. *Stroke*. 2005;36(9):1977-1983. doi: 01.STR.0000177871.59003.e3 [pii].

17. Mudge AM, McRae P, McHugh K, et al. Poor mobility in hospitalized adults of all ages. *J Hosp Med*. 2016;11(4):289-291. doi: 10.1002/jhm.2536 [doi].

18. Centraal Bureau voor de Statistiek. Gezondheid en zorggebruik; persoonskenmerken. http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=83005ned&D1=78-84&D2=0-13&D3=0&D4=l&HDR=G2,G3,T&STB=G1&VW=T. Updated 2017. Accessed 12-12, 2017.

19. Bodilsen AC, Pedersen MM, Petersen J, et al. Acute hospitalization of the older patient: Changes in muscle strength and functional performance during hospitalization and 30 days after discharge. *Am J Phys Med Rehabil*. 2013;92(9):789-796. doi: 10.1097/PHM.0b013e31828cd2b6 [doi].

20. Karlsen A, Loeb MR, Andersen KB, et al. Improved functional performance in geriatric patients during hospital stay. *Am J Phys Med Rehabil*. 2017;96(5):e78-e84. doi: 10.1097/PHM.0000000000000671 [doi].

21. Pashikanti L, Von Ah D. Impact of early mobilization protocol on the medical-surgical inpatient population: An integrated review of literature. *Clin Nurse Spec*. 2012;26(2):87-94. doi: 10.1097/NUR.0b013e31824590e6 [doi].

22. Visser, M.

Dwalingen in de methodologie. XXXIV. predictiemodellen stellen vaak teleur . 2001(Ned Tijdschr Geneeskd):1111-1112.

23. Bor P, van Delft L, Valkenet K, Veenhof C. Hospital in motion, a multidimensional implementation project to improve patients' physical behaviour during hospitalization, a study protocol. . 2018.

24. Ainsworth BE, Haskell WL, Herrmann SD, et al. 2011 compendium of physical activities: A second update of codes and MET values. *Med Sci Sports Exerc*. 2011;43(8):1575-1581. doi: 10.1249/MSS.0b013e31821ece12 [doi].

25. Mansoubi M, Pearson N, Clemes SA, et al. Energy expenditure during common sitting and standing tasks: Examining the 1.5 MET definition of sedentary behaviour. *BMC Public Health*. 2015;15:516-015-1851-x. doi: 10.1186/s12889-015-1851-x [doi].

26. Haley SM, Coster WJ, Andres PL, et al. Activity outcome measurement for postacute care. *Med Care*. 2004;42(1 Suppl):I49-61. doi: 10.1097/01.mlr.0000103520.43902.6c [doi].

27. Andres PL, Haley SM, Ni PS. Is patient-reported function reliable for monitoring postacute outcomes? *Am J Phys Med Rehabil*. 2003;82(8):614-621. doi: 10.1097/01.PHM.0000073818.34847.F0 [doi].

28. Geelen SJG, Valkenet K, Veenhof C. Construct validity and inter-rater reliability of the dutch activity measure for post-acute care "6-clicks" basic mobility form to assess the mobility of hospitalized patients. *Disabil Rehabil*. 2018:1-7. doi: 10.1080/09638288.2018.1471525 [doi].

29. Stark T, Walker B, Phillips JK, Fejer R, Beck R. Hand-held dynamometry correlation with the gold standard isokinetic dynamometry: A systematic review. *PM R*. 2011;3(5):472-479. doi: 10.1016/j.pmrj.2010.10.025 [doi].

30. Peolsson A, Hedlund R, Oberg B. Intra- and inter-tester reliability and reference values for hand strength. *J Rehabil Med*. 2001;33(1):36-41.

31. Stalpers J. *Psychological determinants of subjective health*. Nyenrode Business Universiteit; 2009.

32. Bloem S. *Beleving als medicijn : De ontwikkeling van een algemene subjectieve gezondheidsmaat : Van conceptualisatie tot instrument*. S.N.; 2008.

33. Janssen KJ, Vergouwe Y, Donders AR, et al. Dealing with missing predictor values when applying clinical prediction models. *Clin Chem*. 2009;55(5):994-1001. doi: 10.1373/clinchem.2008.115345 [doi].

34. Royston P, Moons KG, Altman DG, Vergouwe Y. Prognosis and prognostic research: Developing a prognostic model. *BMJ*. 2009;338:b604. doi: 10.1136/bmj.b604 [doi].

35. Moons KG, Royston P, Vergouwe Y, Grobbee DE, Altman DG. Prognosis and prognostic research: What, why, and how? *BMJ*. 2009;338:b375. doi: 10.1136/bmj.b375 [doi].

36. Wooldridge JM. Gauss-markov theorem. In: *Introductory econometrics: A modern approach*. 5th ed. South-Western Cengage Learning; 2013:349.

37. Meesters J, Conijn D, Vermeulen HM, Vliet Vlieland T. Physical activity during hospitalization: Activities and preferences of adults versus older adults. *Physiotherapy Theory*

and Practice. 2018:1-11. https://doi.org/10.1080/09593985.2018.1460429. doi: 10.1080/09593985.2018.1460429.

38. Zisberg A, Shadmi E, Gur-Yaish N, Tonkikh O, Sinoff G. Hospital-associated functional decline: The role of hospitalization processes beyond individual risk factors. *J Am Geriatr Soc*. 2015;63(1):55-62. doi: 10.1111/jgs.13193 [doi].

39. Sallis R, Roddy-Sturm Y, Chijioke E, et al. Stepping toward discharge: Level of ambulation in hospitalized patients. *J Hosp Med*. 2015;10(6):384-389. doi: 10.1002/jhm.2343 [doi].

40. Baldwin,Claire, van Kessel,Gisela, Phillips,Anna, Johnston,Kylie. Accelerometry shows inpatients with acute medical or surgical conditions spend little time upright and are highly sedentary: Systematic review. *Physical Therapy*. 2017;97(11):1044-1065. doi: 10.1093/ptj/pzx076 [doi].

41. Dronkers J, Witteman B, van Meeteren N. Surgery and functional mobility: Doing the right thing at the right time. *Tech Coloproctol*. 2016;20(6):339-341. doi: 10.1007/s10151-016-1487-6 [doi].

42. Brown CJ, Redden DT, Flood KL, Allman RM. The underrecognized epidemic of low mobility during hospitalization of older adults. *J Am Geriatr Soc*. 2009;57(9):1660-1665. doi: 10.1111/j.1532-5415.2009.02393.x [doi].

43. Bloem S, Stalpers J. Subjective experienced health as a driver of health care behaviour. . July 2012(Nyenrode Research Paper no. 12-01).

44. Lieberman HR. Cognitive methods for assessing mental energy. *Nutr Neurosci*. 2007;10(5-6):229-242. doi: 10.1080/10284150701722273 [doi].

45. Kramer SF, Cumming T, Churilov L, Bernhardt J. Measuring activity levels at an acute stroke ward: Comparing observations to a device. *Biomed Res Int*. 2013;2013:460482. doi: 10.1155/2013/460482 [doi].

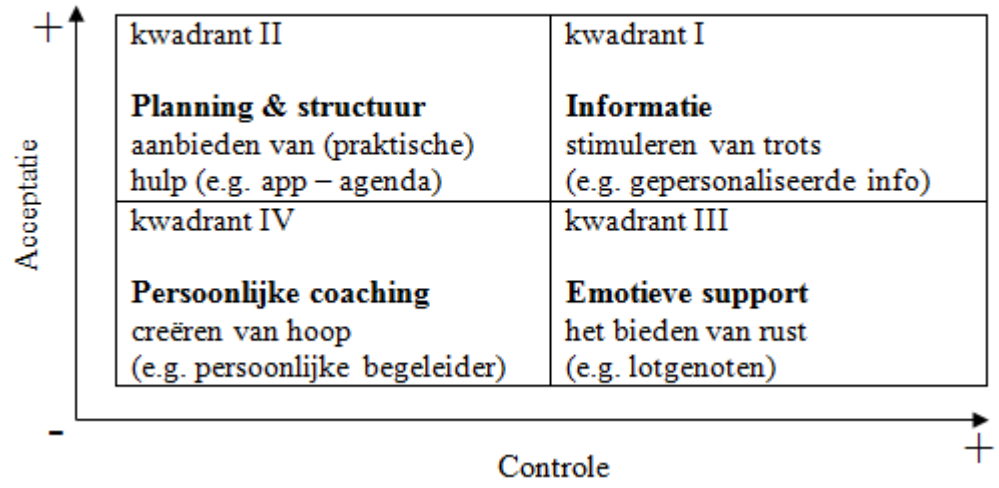
46. Berlin J,E., Storti K,L., Brach J,S. Using activity monitors to measure physical activity in free-living conditions. *Physical Therapy*. 2006;86(8):1137-1145. doi: 10.1093/ptj/86.8.1137 [doi].

47. Greysen SR. Activating hospitalized older patients to confront the epidemic of low mobility. *JAMA Intern Med*. 2016;176(7):928-929. doi: 10.1001/jamainternmed.2016.1874 [doi].

48. Pyky R, Jauho AM, Ahola R, et al. Profiles of sedentary and non-sedentary young men - a population-based MOPO study. *BMC Public Health*. 2015;15:1164-015-2495-6. doi: 10.1186/s12889-015-2495-6 [doi].

49. Rhodes RE, Mark RS, Temmel CP. Adult sedentary behavior: A systematic review. *Am J Prev Med*. 2012;42(3):e3-28. doi: 10.1016/j.amepre.2011.10.020 [doi].

APPENDIX 1: Four quadrants of the SBG questionnaire, based on the Dutch cut of score.



Antwoordschaal:
1 = volledig mee oneens t/m 7 = volledig mee eens

Vragen:

Controle

1. Ik heb zelf veel invloed op mijn gezondheid
2. Ik heb het gevoel dat ik zelf grip heb op mijn gezondheid
3. Mijn gezondheidstoestand heb ik voor een groot deel zelf in de hand

→ score controle (1 + 2 + 3) / 3

Acceptatie

4. Ik heb vrede met hoe mijn gezondheid is
5. De manier waarop ik nu lichamelijk en/of geestelijk kan functioneren is voor mij acceptabel
6. Ik accepteer mijn gezondheidstoestand zoals die is

→ score acceptatie (4 + 5 + 6) / 3

Controle laag: score ≤ 5.36
hoog: score > 5.36
Acceptatie laag: score ≤ 4.96
hoog: score > 4.96

APPENDIX 2: 6 additional questions regarding the influence of environment, nurse and physician.

Stellingen:

Omgeving stimulerend?	Uitleg over bewegen (patient)	Uitleg over bewegen (naasten)	VPK heeft bewegen gestimuleerd	Arts heeft bewegen gestimuleerd	Patient heeft zelfstandig geoefend

Instructies:

IN HOEVERRE BENT U HET EENS MET DEZE STELLINGEN:

Ik vind de omgeving op de afdeling stimulerend om te bewegen.

U heeft voldoende uitleg of informatie gekregen over het belang van bewegen rondom uw ziekenhuisopname.

Uw naasten (partner/familie/mantelzorgers) hebben voldoende uitleg of informatie gekregen over het belang van bewegen rondom uw ziekenhuisopname.

U bent de afgelopen twee dagen gestimuleerd door een verpleegkundige om lichamelijk actief te zijn (bedoeld wordt zoveel mogelijk uit bed, zitten en lopen).

U bent de afgelopen twee dagen gestimuleerd door een arts om lichamelijk actief te zijn (bedoeld wordt zoveel mogelijk uit bed, zitten en lopen).

U hebt de afgelopen twee dagen zelfstandig oefeningen gedaan om uw spierkracht en/of conditie te verbeteren (dus zonder begeleiding van een therapeut of verpleegkundige).

SAMENVATTING

Achtergrond: Lage ziekenhuismobiliteit komt voor in alle leeftijden en is geassocieerd met ongunstige uitkomsten. Om deze uitkomsten te voorkomen, moeten patiënten met een risico op lage ziekenhuismobiliteit worden geïdentificeerd. Veel studies zijn gepubliceerd met betrekking tot ziekenhuismobiliteit. Tegenstrijdige bevindingen worden gevonden en de generaliseerbaarheid is laag. Ook zijn de meeste onderzoeken uitgevoerd bij ouderen, terwijl recente bevindingen aantonen dat lage ziekenhuismobiliteit gebruikelijk is in alle leeftijden.

Doel: Onderzoeken welke factoren de mobiliteit beïnvloeden bij patiënten die zelfstandig actief kunnen zijn en een voorspellingsmodel ontwikkelen voor het identificeren van risicopatiënten voor lage mobiliteit bij gehospitaliseerde volwassen patiënten die zijn opgenomen in het Universitair Medisch Centrum Utrecht.

Methoden: Deze prospectieve observationele, cross-sectionele studie maakt deel uit van het UMCU in beweging project. Patiënten die zelfstandig actief konden zijn, werden opgenomen in deze studie. Patiënten werden uitgesloten bij het ontvangen van terminale palliatieve zorg en wanneer geen mondelinge toestemming werd gegeven. Uitkomstgegevens werden verzameld door middel van behavioral mapping. Univariabele en multivariabele regressieanalyses werden uitgevoerd om de associatie van voorspellers op ziekenhuismobiliteit te exploreren. Daarnaast werd de R^2 beschreven op basis van een achterwaartse eliminatiecriteria met een p-waarde van ≤ 0,20.

Resultaten: Totaal zijn er 186 patiënten geïncludeerd met een gemiddelde leeftijd van 59 jaar. Zestien factoren werden opgenomen in de univariabele analyses. Op basis van de eliminatiecriteria kwamen leeftijd (B = 0,008, p <0,05), operatie (B = -0.107, p = 0.02) en het gebruik van een hulpmiddel (B = -0.03, p = 0.03) als significante voorspellers uit de multivariabele analyse. Deze predictoren voorspellen 10% van de variantie van de ziekenhuismobiliteit.

Conclusie: Ondanks het vermogen om actief te zijn, voerden de patiënten in dit onderzoek lage mobiliteit uit tijdens de ziekenhuisopname. Verder onderzoek naar ziekenhuismobiliteit moet gericht zijn op de klinische praktijk, waarbij de resultaten kunnen worden gebruikt bij klinische beslissingen.

Klinische relevantie: Om de belemmeringen voor lage mobiliteit te begrijpen, moet het UMCU in beweging-project zich richten op de perspectieven van patiënten, familieleden en hulpverleners, aangezien zij een belangrijke rol spelen in de ziekenhuismobiliteit.

Keywords: Hospital mobility; Hospitalization; Early ambulation; Experienced health