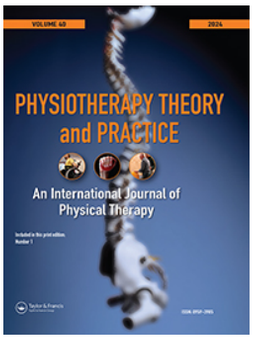

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Inpatient physical activity across a large university city hospital: a behavioral mapping study

Karin Valkenet PT, PhD [a,b], Prue McRae PT, MSc [c], Elja Reijneveld PT, MSc [b], Marielle Jans PT, PhD [d], Petra Bor PT, MSc [a], Lotte van Delft PT, PhD [a], Daniel L. Young PT, DPT, PhD [e], and Cindy Veenhof PT, PhD [a,b]

[a]Department of Rehabilitation, Physical Therapy Science and Sports, University Medical Center Utrecht, Utrecht University, Utrecht, Netherlands; [b]Research Group Innovation of Mobility Care, University of Applied Sciences Utrecht, Expertise Center Innovation of Care, Utrecht, Netherlands; [c]Internal Medicine Research Unit, Royal Brisbane and Women's Hospital, Herston, Australia; [d]Institute of Mobility Studies, University of Applied Sciences Utrecht, Utrecht, Netherlands; [e]Department of Physical Therapy, University of Nevada, Las Vegas, Nevada, NV, USA

ABSTRACT

Background: Physical inactivity is common during hospitalization. Physical activity has been described in different inpatient populations but never across a hospital.
Purpose: To describe inpatient movement behavior and associated factors throughout a single university hospital.
Methods: A prospective observational study was performed. Patients admitted to clinical wards were included. Behavioral mapping was undertaken for each participant between 9AM and 4PM. The location, physical activity, daily activity, and company of participants were described. Barriers to physical activity were examined using linear regression analyses.
Results: In total, 345 participants from 19 different wards were included. The mean (SD) age was 61 (16) years and 57% of participants were male. In total, 65% of participants were able to walk independently. On average participants spent 86% of observed time in their room and 10% of their time moving. A physiotherapist or occupational therapist was present during 1% of the time, nursing staff and family were present 11% and 13%, respectively. Multivariate regression analysis showed the presence of an intravenous line (p = .039), urinary catheter (p = .031), being female (p = .034), or being dependent on others for walking (p = .016) to be positively associated with the time spent in bed. Age > 65, undergoing surgery, receiving encouragement by a nurse or physician, reporting a physical complaint or pain were not associated with the time spent in bed (P > .05).
Conclusion: As family members and nursing staff spend more time with patients than physiotherapists or occupational therapists, increasing their involvement might be an important next step in the promotion of physical activity.

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Behavioral mapping; physical activity; hospital; inpatients

Introduction

A low amount of inpatient physical activity is common during hospitalization (Baldwin, van Kessel, Phillips, and Johnston, 2017; Fazio et al., 2020; Zisberg et al., 2015). Patients spend up to 83% of their time lying in bed, even when there is no medical reason to stay in bed (Brown, Redden, Flood, and Allman, 2009; Mudge et al., 2016; Pedersen et al., 2013; van de Port, Valkenet, Schuurmans, and Visser-Meily, 2012). As a result, patients frequently develop functional decline which is associated with complications like pneumonia, urinary tract infections, increased length of stay, institutionalization, mortality, and recovery that extends for months to years (Boyd et al., 2008; Brown, Redden, Flood, and Allman, 2009; Portegijs et al., 2012).

To address this problem, there is a need to identify enablers and reduce barriers to inpatient mobilization in hospitals. While several qualitative studies reported patient factors, like having symptoms or a catheter that may influence physical activity during hospital stay (Brown et al., 2007; Kalisch, Landstrom, and Williams, 2009; Koenders et al., 2020), quantitative studies of patient mobility have focused on specific patient groups (Anaker et al., 2017; Bernhardt, Dewey, Thrift, and Donnan, 2004; Covinsky et al., 2003; Koenders et al., 2021). Insight into patient behavior, related to physical activity across a hospital, is needed to establish an objective and comprehensive picture of the mobility culture throughout hospitals. Therefore, the aims of this study were to describe inpatient movement behavior across a large university hospital, and to explore factors associated with the proportion of time patients spent in bed.

CONTACT Karin Valkenet k.valkenet@umcutrecht.nl Department of Rehabilitation, Physical Therapy Science and Sports, University Medical Center Utrecht, Utrecht University, Heidelberglaan 100, Utrecht, CX 3584, Netherlands

Methods

Design and setting

This prospective observational study was performed at the University Medical Center Utrecht in the Netherlands, a university city hospital with the capacity for more than 800 adult inpatients. The study protocol (no. 16–250) was approved by the Medical Ethics Committee of the University Medical Center Utrecht. No funding was received for this study.

Participants

Patients were eligible for inclusion if they were aged ≥18 years and were admitted to a clinical ward of the hospital. Patients were excluded if they were admitted to the Intensive Care Unit (ICU); had a cognitive impairment defined as an acute disorder of attention and cognition (e.g. delirium); were on strict bedrest orders; were receiving end-of-life care; or were planned for discharge on the day of data collection. Verbal informed consent was obtained from all participants.

Study procedures

Since September 2016, as part of a program to assess and improve movement behavior across the hospital, direct patient observations were planned on all non-ICU wards every six months to assess and evaluate movement behavior over time. The day before the observations were planned, a physiotherapist-researcher compiled a list of eligible patients after consulting the head nurse of the ward being observed. Patients on the list were approached for participation by the physiotherapist-researcher. A maximum of eight patients could be included per ward, per observation day. Inclusion stopped when eight patients wanted to participate, or when no more eligible patients were available. Participants were informed that the activities during an average day in the hospital were being observed, they were not told exactly what was recorded.

Direct patient observations

Observations were performed according to a behavioral mapping method (Bernhardt, Dewey, Thrift, and Donnan, 2004; Valkenet, Bor, van Delft, and Veenhof, 2019). Participants were observed at set intervals over one day of their hospital admission. Per participant, a 1-min observation was performed every 10 min between 9AM and 4PM (Bernhardt, Dewey, Thrift, and Donnan, 2004).

During each 1-min observation, four categories were observed and recorded in an Excel spreadsheet: 1) location of the participant; 2) body position of the participant; 3) daily activity undertaken by the participant; and 4) persons in direct contact with the participant. Each category contained multiple predefined items (Table A1). The item that was observed for the longest period within the 1-min observation was recorded. If two or more items were observed for the same amount of time, the one with the highest intensity was recorded.

For this study, movement behavior was defined as the percentage of the total observed time that a participant spent in a specific body position. A distinction was made between lying in bed, sitting (i.e. bedside or chair), and moving (i.e. standing, transferring, walking, and cycling). The level of agreement with an accelerometer for identifying these three physical activity levels is strong (Valkenet, Bor, van Delft, and Veenhof, 2019). The proportion of time spent lying in bed was defined as the primary outcome.

The observations were performed by undergraduate physiotherapy students. The students received paper instructions and a face-to-face training by a physiotherapist-researcher about the assessment to be performed. During the first observation day of a student, a physiotherapist-researcher guided the student during the first observation round. Furthermore, a physiotherapist-researcher remained on standby for questions during the observation days.

Additional data collection

The following characteristics were collected per participant by the observers during the day of observation: gender, age, ward, medical specialty, date of admission, reason for admission, surgery (yes/no), intravenous catheter (yes/no), and urinary catheter (yes/no).

Physical function levels of the participants were assessed with the Activity Measure for Post-Acute Care (AM-PAC) "6-Clicks" inpatient Basic Mobility (Jette et al., 2014). This short form has six items that were scored by the observers on a 4-point ordinal scale based on patient report, direct observation, clinical judgment, or after consultation with the patient or nurse in charge (Hoyer et al., 2018). Total score ranges from 6 to 24 with higher scores indicating better function (Jette et al., 2014). The reliability and validity of this short form is excellent in acute hospitalized patients (Geelen, Valkenet, and Veenhof, 2019; Jette et al., 2014).

Furthermore, participants were asked by the observer which physical symptom (i.e. pain, fatigue, fear of falling, weakness, nausea, other, or none) they perceived to be the main barrier to undertake physical activity. The

level of encouragement participants perceived from nursing and medical staff to be physically active in the past two days was investigated with two statements. The statements were defined as follows: 'You have been encouraged by a nurse/physician to be physically active (i.e. getting out of bed as much as possible, sitting up or walking).' These statements could be answered on a 5-point scale (i.e. strongly disagree; disagree; undecided; agree; and strongly agree). The date of discharge was retrieved retrospectively from the electronic patient records.

Data analyses

All data were recorded directly in a Microsoft (Redmond, USA) Excel spreadsheet using a tablet computer. The spreadsheets per observer were merged, and imported into the Statistical Package for the Social Sciences (SPSS) version 25 (IBM, New York, USA) by a physiotherapist-researcher. Missing behavioral mapping observations were not included in the analyses. The proportion of time observed per behavioral map item, was calculated per participant. Following, the average proportion of time per item was calculated for the total population. The category 'body position' was further categorized into lying, sitting, and moving (Valkenet, Bor, van Delft, and Veenhof, 2019). The patterns of location, movement behavior, daily activity, and company of patients during the day were visualized by plotting the percentages of observed time per item against each 1-min observation over the total observation period.

Linear regression was used to examine factors associated with the proportion of time spent lying. Univariate linear regression was used to assess the association of 10 variables that were selected based on earlier studies (Brown et al., 2007; De Klein, Valkenet, and Veenhof, 2021; Koenders et al., 2021): 1) gender (male/female); 2) age > 65 years (yes/no); 3) level of dependence (i.e. needing assistance with walking) (yes/no); 4) presence of pain during physical activity (yes/no); 5) presence of one or more physical complaints during physical activity (yes/no); 6) presence of urinary catheter (yes/no); 7) presence of intravenous catheter (yes/no); 8) underwent surgery (yes/no); 9) received encouragement from a nurse to be physically active (yes/no); and 10) received encouragement from a physician to be physically active (yes/no). Variables with a p-value < 0.2 were entered in a multivariable linear model. Variables in the multivariable analyses with a $p < .05$ were considered statistically significant. The adjusted R^2 was used to estimate the variance in time spent lying by the variables in the multivariable model.

Results

The data of four observation periods, between September 2016 and June 2018, were included. In total 345 participants (period 1: n = 85; period 2: n = 83; period 3: n = 106; and period 4: n = 71) from 19 different non-ICU wards were included in the analyses. The gynecology ward was excluded in period 3 and 4 as this ward did not find direct observations appropriate for their population. Table A2 shows the number of participants, movement behavior, and physical functional levels per ward.

The mean age of the participants was 61 ± 16 years (SD) and 57% were male. In total, 65% of participants were independently mobile, while 70% reported a physical symptom as a barrier to perform physical activity (Table 1).

Across our sample participants spent on average 86% of the observed time in their room, and 55% of their time lying in bed, 35% sitting, and 10% moving (Table 2). Participants were alone 56% of the observed time, in direct contact with family or visitors for 13% of the time, with nursing staff 11% of the time, with physicians 3% of the time, and with a physiotherapist or occupational therapist 1% of the time. In total, 30% of the daytime was spent relaxing (doing nothing or reading) and 2% was spent on physical exercises.

In Figure 1 the patterns of movement behavior throughout the day are shown. It was observed that patients were in their room around lunchtime the most. A high proportion of patients returned to bed after lunchtime. Family/visitors were present more in the afternoon compared to the morning. The presence of

Table 1. Participant characteristics.

Demographic	Value	N
Age (years), mean (SD)	61 (16)	345
Male, N (%)	197 (57)	345
Surgery, N (%)	166 (48)	306
Elective admission, N (%)	127 (37)	300
Barriers for physical activity, N (%)	92 (30)	306
None	98 (32)	
Pain	53 (17)	
Fatigue	43 (14)	
Weakness	20 (7)	
Fear, nausea, other		
Assistance with walking, N (%)	206 (65)	317
Independent	93 (29)	
Walking aid	18 (6)	
Totally dependent		
Intravenous therapy, N (%)	116 (37)	317
Urinary catheter, N (%)	27 (8)	252[a]
AM-PAC Basic Mobility score, mean (SD)	21 (5)	257[b]
Length of stay (days), median (IQR)	10 (14)	301

SD: Standard Deviation, N: number of participants, AM-PAC: Activity Measure for Post-Acute Care, IQR: Interquartile Range; [a)] This variable was not included during the first observation round. [b)] In ±50% of the missing cases no AM-PAC data were available, in the other ±50% of the missing cases data were incompletely collected making the calculation of a (mean) total score not possible.

Table 2. Average percentage of the time observed per behavioral map item.

Location (n = 12,411 observations)*	% (SD)	Body position (n = 11,789 observations)*	% (SD)
Patient room	86 (15)	Lying in bed (HOB <30 degrees)	26 (27)
Outside the ward	7 (13)	Lying in bed (HOB >30 degrees)	29 (28)
Toilet/bathroom	3 (4)	Sitting edge of the bed	10 (12)
Corridor	3 (5)	Sitting in chair	25 (28)
Therapy room	0.1 (1)	Transfer bed-chair	1 (2)
Day care/living room	0.6 (3)	Standing	4 (6)
Medical examination room	0.5 (4)	Walking	5 (8)
		Ergometer cycling	0.1 (1)
Total	100%	Total	100%
Daily activity(n = 11,802 observations)*	% (SD)	In contact with(n = 11,785 observations)*	% (SD)
Reading/television/tablet	26 (21)	Nobody	56 (27)
Talking/phoning	23 (15)	Visit/family	13 (16)
Sleeping	13 (15)	Nurse	11 (10)
No activity	12 (12)	Other patient(s)	6 (10)
Eating/drinking	7 (6)	Physician	3 (7)
Medical examination	5 (9)	Therapist	1 (4)
Nursing/washing/clothing	5 (6)	Other staff	2 (4)
Physical exercise	2 (5)	Volunteer	0.3 (2)
Other	7 (11)	Other	8 (20)
Total	100%	Total	100%

* Observations took place every 10 minutes between 9 AM and 4 PM. Observers were allowed three 10 minute breaks leading to a possible maximum of 13,455 observations. HOB: head of bed; SD: Standard Deviation.

nursing staff peaked during three times (9.00–10.00 h, 11.30–12.00 h, 14.00–14.30 h). Physiotherapists or occupational therapists were infrequently observed throughout the day. The proportion of participants sleeping peaked directly after lunchtime, and the proportion of participants observed talking increased steadily during the afternoon. During most observations, the participants were observed relaxing (i.e. doing nothing or reading/using tablet or phone).

In Table 3 the results of the regression analyses are shown. All independent variables had a positive association with the time spent lying in the univariable analyses ($P < .2$). After entering these variables into a multivariable model the presence of an intravenous catheter, a urinary catheter, being female, and needing any help with walking were found to be positively associated with the time spent in lying in bed ($P < .05$). The adjusted R^2 of the multivariable model was 0.114.

Discussion

This study is the first to describe inpatient movement behavior across all clinical non-ICU wards of a hospital. Our results show that patients remain in their room for the majority of the day. Our results also show and patients are moving for only 10% of daytime hours. They only spend 2% of the daytime participating in supervised or self-directed exercise. Physiotherapists or occupational therapists were only in contact with patients during 1% of the observed time, while nursing staff and family members were present for 11% and 13% of the time, respectively.

It was observed that a higher proportion of patients were sitting and moving in the morning, and that patients returned to bed in the afternoon. This is consistent with the findings in a rehabilitation setting (McRae, Bew, Smith, and Mudge, 2020). Visitors were present more in the afternoon than the morning, coinciding with visiting hours in our hospital. This indicates that patients are less active when their family members or visitors are present.

Currently, patients and health-care professionals rely on physiotherapists or occupational therapists for patient mobility. Our results show that 65% of patients are independently mobile, which highlights the importance of the involvement of others in patient mobility. To integrate physical activity in daily care, it may be important to better involve family members and nursing staff. Recent research shows the potential of family participation in physiotherapy-related tasks (van Delft, Valkenet, Slooter, and Veenhof, 2021a). Understanding how to increase family participation in promoting physical activity may be an important next step (van Delft, Valkenet, Slooter, and Veenhof, 2021b). Additionally, understanding how to involve nursing staff in the promotion of inpatient physical activity, given their limited time, is important (Dermody and Kovach, 2017; Kneafsey, Clifford, and Greenfield, 2013).

Increasing patient awareness about the hazards of bedrest, and the importance of physical activity during hospitalization, is suggested as an important step to improve movement behavior (De Klein, Valkenet, and Veenhof, 2021; Koenders et al., 2020). However, our results show that participants who reported receiving

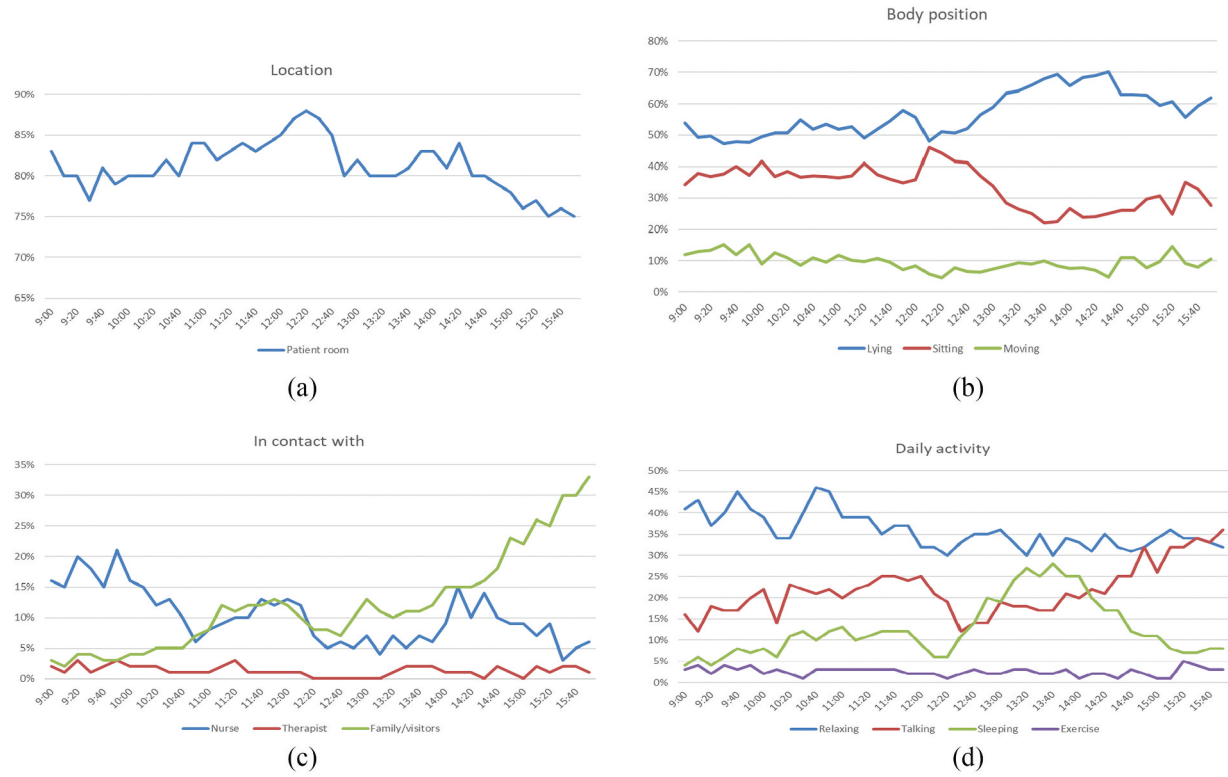

Figure 1. Patterns of key observed items throughout the day. 1a. Pattern throughout the day of the proportion of patients observed in their room. 1b. Patterns throughout the day of the proportion of patients spending their time lying, sitting or moving. 1c. Patterns throughout the day of the proportion of patients observed in direct contact with a nurse, therapist or family/visitors. 1d. Patterns throughout the day of the proportion of patients observed relaxing, talking, sleeping or performing exercise.

encouragement to be physically active by nursing or medical staff did not spend less time lying in bed. Although the causal relationship was not investigated, and the actual amount of encouragement participants received is unknown, encouragement to be physically active on its own may be inadequate to achieve higher levels of physical activity and may likely relate to other barriers.

We found the presence of an intravenous line, a urinary catheter, and being dependent on others for walking to be positively associated with the time spent lying in bed. This in line with earlier studies and confirms that these factors need to be addressed to promote physical activity (Brown et al., 2007; Koenders et al., 2021). Identifying the barriers and enablers to physical activity may help to design interventions. To achieve long-term changes previous literature highlights that unimodal interventions might not be sufficient (Craig et al., 2013; Moore et al., 2015). Programs like Hospital in Motion, Eat Walk Engage and the Johns Hopkins Activity and Mobility Promotion are good examples of multimodal interventions (Hoyer et al., 2016; Mudge,

Table 3. Associations between proportion of time spent lying in bed and factors of interest*.

	Univariable linear regression			Multivariable linear regression adjusted $R^2 = 0.114$		
	B	p-value	95% CI	B	p-value	95% CI
Age >65	−6.2	0.079	−13.1–0.7	−3.4	0.432	−12-5.2
Female gender	6.7	0.057	−0.2–13.6	9.4	**0.034**	0.7–18.2
Intravenous therapy	11.6	0.002	4.5–18.8	9.3	**0.039**	0.5–18.2
Urine catheter	25.4	<0.001	13.0–37.8	16.5	**0.031**	1.6–31.5
Any help with walking	16.5	<0.001	8.8–24.2	13.8	**0.016**	2.6–24.9
Surgery	10.3	0.005	3.2–17.5	0.1	0.977	−9.1–9.3
Encouraged by nurse	5.7	0.138	−1.9–13.3	−0.4	0.994	−10.1–10.0
Encouraged by physician	5.5	0.161	−2.2–13.2	6.7	0.167	−2.9–16.7
Any physical complaint during mobility	12.9	0.001	5.2–20.5	0.1	0.993	−10.2–10.3
Pain during mobility	9.2	0.017	1.7–16.8	1.7	0.772	−9.6–12.9

*The percentage lying in bed was used as dependent variable. R^2: R-squared; B: Beta; CI: Confidence Interval.

McRae, and Cruickshank, 2015; van Delft et al., 2020). These programs target multiple barriers (e.g. individual, inter-personal, and institutional) and use multi-disciplinary teams to improve physical activity and change culture (McLeroy, Bibeau, Steckler, and Glanz, 1988). In the Table A2 we report the amount of physical activity per ward. These numbers might serve as guide to specific wards for determining if additional actions are necessary.

Strengths and limitations

A limitation of this study is that, by using the behavioral mapping method, participants were only observed during the daytime, and only while they were present on the ward. Other limitations of this study are that the reasons for missing behavioral mapping data were not recorded, and that there are no data available of patients who were ineligible or unwilling to participate. While only patients with strict bed rest orders or receiving end-of-life care were excluded from the observations, patients feeling severely ill were likely approached less often, and declined participation more frequently, compared to patients feeling less ill. Therefore, selection bias cannot be ruled out. Furthermore, across our sample we found a median length of hospital stay of 10 days while the average of our hospital is 6 days (unpublished hospital data). We hypothesize that this is a result of the exclusion of patients who were due to be discharged on the observation day, resulting in more frequent exclusion of patients with shorter lengths of stay.

In conclusion, our findings confirm high levels of physical inactivity across the hospital. Our results show that family members and nursing staff spend more time with patients than physiotherapists or occupational therapists. Increasing the involvement of family members and nursing staff, making them key enablers of physical activity, might be an important next step in the promotion and support of physical activity. In this study, a higher proportion of participants were lying in bed during the afternoon which highlights the opportunity for additional physical activity in this part of the day. Addressing factors such as intravenous lines and the need for assistance remain important to facilitate physical activity.

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ORCID

Karin Valkenet PT, PhD http://orcid.org/0000-0002-4715-685X
Prue McRae PT, MSc http://orcid.org/0000-0002-1039-3632
Elja Reijneveld PT, MSc http://orcid.org/0000-0001-5005-6967
Petra Bor PT, MSc http://orcid.org/0000-0002-8494-349X
Lotte van Delft PT, PhD http://orcid.org/0000-0002-9397-8934
Daniel L. Young PT, DPT, PhD http://orcid.org/0000-0002-3575-6049
Cindy Veenhof PT, PhD http://orcid.org/0000-0003-0970-2896

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Table A1. Categories and items scored with the behavioral mapping method

Location	Body position	Daily Activity	In contact with
(1) Patient room	(1) Lying in bed (<30 degrees)	(1) Talking or phoning	(1) Nobody
(2) Toilet or bath room	(2) Sitting in bed (>30 degrees)	(2) Reading, television, tablet, or telephone	(2) Other patient(s)
(3) Corridor	(3) Moving (bed-chair)	(3) Eating or drinking	(3) Nurse
(4) Therapy room	(4) Sitting edge of the bed	(4) Sleeping	(4) Doctor
(5) Daycare or living room	(5) Sitting (toilet)chair	(5) Nursing, washing, or clothing	(5) Physio, occupational, or speech therapy
(6) Examination room	(6) Standing	(6) Physical exercise (self-therapy)	(6) Other staff
(7) Outside the ward	(7) Walking	(7) Medical examination	(7) Volunteer
	(8) Cycle ergometer	(8) No activity	(8) Visit or family
	(9) Other	(9) Other	(9) Other/unknown person(s)

Table A2. Movement behavior and physical functioning levels per specialism

	Lying % (SD)	*Sitting % (SD)*	*Moving % (SD)*	*Physical Functioning mean (SD)a*
Cardiology and pulmonology				
General cardiology (n = 28)	46 (30)	39 (26)	14 (17)	22 (3)
Cardiothoracic surgery (n = 25)	59 (35)	35 (20)	7 (8)	22 (4)
Pulmonary medicine (n = 19)	43 (48)	48 (31)	8 (10)	21 (4)
General medicine				
Internal medicine (n = 23)	47 (35)	45 (32)	8 (9)	18 (7)
Gerontology (n = 18)	42 (34)	49 (30)	9 (9)	22 (2)
Nephrology/ Gastroenterology (n = 15)	40 (39)	45 (33)	16 (21)	21 (3)
Rheumatology (n = 16)	63 (28)	24 (21)	13 (13)	21 (5)
Dermatology (n = 15)	42 (30)	47 (31)	11 (12)	22 (3)
Orthopedics				
Orthopedic surgery (n = 13)	68 (32)	24 (25)	8 (10)	17 (7)
Traumatology (n = 13)	77 (21)	18 (20)	5 (6)	17 (5)
Oncology				
GI oncological surgery (n = 27)	67 (29)	25 (24)	7 (8)	22 (4)
Medical oncology (n = 20)	52 (36)	38 (31)	10 (9)	23 (3)
Hematology (n = 20)	60 (30)	31 (29)	8 (9)	22 (6)
Neurology				
Neurology (n = 24)	52 (30)	40 (29)	8 (10)	22 (3)
Neurosurgery (n = 6)	68 (19)	26 (20)	6 (7)	19 (5)
Surgery				
Head neck surgery (n = 8)	33 (29)	45 (35)	22 (22)	24 (0)
Vascular surgery (n = 22)	64 (33)	31 (30)	5 (7)	18 (6)
Ear nose throat/Plastic surgery (n = 12)	73 (27)	8 (7)	19 (23)	24 (1)
Other				
Gynecology (n = 10)	76 (24)	19 (21)	6 (6)	21 (4)
Ward unknown (n = 11)	57 (37)	36 (35)	6 (5)	23 (3)

[a]Measured with the AM-PAC Basic Mobility short form (Activity Measure for Post-Acute Care: range from 6 to 24 with higher scores indicating better function) GI: gastrointestinal.