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Die Problematik sedentären Verhaltens hospitalisierter Demenzpatienten – Entwicklung eines lebensstil-integrierten Bewegungsansatzes zur Steigerung der körperlichen Aktivität

vorgelegt von
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In unendlicher Liebe und Dankbarkeit für meine Großmutter Ille, die mich stets gelehrt hat der Neugier in mir nachzugehen und für meine Eltern Konni und Tahar, die mir dies stets ermöglicht und mich dabei bedingungslos unterstützt haben.

Für meine Tochter.

Zusammenfassung

Thema der vorliegenden Arbeit ist die Beschreibung sedentären Verhaltens und iatrogener Immobilität hospitalisierter, geriatrischer Patienten mit beginnender bis mittelschwerer kognitiver Einschränkung. Die Einflüsse intramuraler Strukturen sowie immobilisierender Faktoren der geriatrischen Akutstation sollen dabei untersucht werden. Darüber hinaus steht die Entwicklung eines in den Klinikalltag integrierbaren Übungsansatzes und der damit zusammenhängenden Beibehaltung der relevanten motorischen Leistungen, wie Kraft, Ausdauer und Gleichgewicht, während eines Krankenhausaufenthaltes sowie einem Aufenthalt in der stationären Rehabilitation im Fokus der Untersuchung. Die Möglichkeit der intersektoralen Fortsetzung des Trainingsprogrammes nach Entlassung ist zukünftig eine zu berücksichtigende Komponente.

Manuskript 1 zeigt eine systematische Analyse der Wirksamkeit von lebensstilintegriertem funktionalem Training zur Verbesserung motorischer Funktionen bei älteren Erwachsenen und möglichen Vorteilen dieses Interventionstyps im Vergleich zu strukturierten Trainingsansätzen (Stand 2018). Während Programme, die beide Ansätze kombinieren bereits im institutionellen Umfeld mit positiven Effekten bewertet werden konnten, sind bei anderen Zielgruppen und Umfeldern kaum Erkenntnisse vorhanden. Der lebensstilintegrierte funktionelle Trainingsansatz stellt eine vielversprechende und ressourceneffiziente Alternative zu strukturiertem Training dar und kann darüber hinaus komplementär und vermutlich intersektoral nach Entlassung eingesetzt werden.

Manuskript 2 stellt die erste Untersuchung eines alltagsintegrierten funktionellen Trainingsansatzes mit kognitiv eingeschränkten, geriatrischen Rehabilitationspatienten dar. Funktionelle Übungen aus dem originalen LiFE (*Lifestyle-integrated functional exercise*)-Programm wurden hierbei in der Zielgruppe evaluiert. Die nachgewiesenen Bodeneffekte wiesen auf einen zu hohen Schwierigkeitsgrad der Übungen hin. Dies führte zu der Entscheidung die Übungen anzupassen ehe eine weitere Testung auf der geriatrischen Akutstation mit einer noch vulnerableren Patientengruppe stattfand.

Manuskript 3 ist eine systematische Analyse geriatrischer Assessments hinsichtlich ihrer Eignung zur Messung der Effekte unterschiedlicher frührehabilitativer Interventionen auf der geriatrischen Akutstation. Es zeigt, dass die Auswahl der Ergebnisparameter spezifisch mit den Interventionsinhalten in Zusammenhang gebracht werden muss, da sie einen Schlüssel-

faktor für das Auffinden von Interventionseffekten der Frührehabilitation bei geriatrischen Patienten auf der Akutstation darstellt. Eine unangemessene Auswahl von Outcome-Parametern und Tests kann sonst zu inkonsistenten Ergebnissen hinsichtlich der Wirksamkeit einer frührehabilitativen Intervention führen.

Manuskript 4 beinhaltet die Analyse der intramuralen Strukturen, Prozesse und häufiger iatrogener Faktoren, die eine Immobilisation der Patienten begünstigen. Mittels einer teilnehmenden Beobachtung sowie Interviews mit den auf der Station tätigen Berufsgruppen wurden Tagesroutinen und Abläufe erfasst und analysiert.

Abstract

The intention of this paper-based doctoral thesis is the description of sedentary behavior and iatrogenic immobility of hospitalized geriatric patients with a mild to moderate cognitive impairment. The influences of intramural structures of the geriatric acute care as well as immobilizing factors are therefore investigated over the course of this project. An additional focus lies on the development of a lifestyle-integrated exercise approach to increase physical activity and the associated maintenance of relevant motor performance, such as strength, endurance and balance, during a hospital stay as well as a stay in inpatient rehabilitation. The possibility of transitional continuation of the training program after discharge is a component to be considered.

Manuscript 1 presents a systematic analysis of the effectiveness of lifestyle-integrated functional training for improving motor function in older adults and possible advantages of this intervention type compared to structured training approaches (status 2018). While programs that combine both approaches have already been evaluated with positive effects in the institutional setting, little evidence exists in other target groups and settings. However, the lifestyle-integrated functional exercise approach represents a promising and resource-efficient alternative to structured exercise and can also be used in a complementary and presumably intersectoral way after discharge.

Manuscript 2 represents the first investigation of a lifestyle-integrated functional exercise approach with cognitively impaired, geriatric rehabilitation inpatients. Functional exercises from the original LiFE (Lifestyle-integrated-functional-exercise) program were evaluated in this target group. The proven ground effects indicated that the exercises were too difficult, which led to the decision to adapt the exercises before further testing on the geriatric acute care ward with an even more vulnerable population.

Manuscript 3 is a systematic analysis of geriatric assessments in terms of their suitability for measuring the effects of different early rehabilitation interventions on the acute geriatric ward. It shows that the selection of outcome parameters must be specifically related to the intervention contents, as they are a key factor in finding intervention effects of early rehabilitation in geriatric patients on the acute care ward. Otherwise, an inappropriate selection of outcome parameters and assessments can lead to inconsistent results regarding the effectiveness of an early rehabilitation intervention.

Manuscript 4 contains the analysis of intramural structures, processes and common iatrogenic factors that promote patient immobilization. Daily routines and processes were recorded and analyzed by means of participatory observation and interviews with the employees working on the ward.

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Verzeichnisse

Abkürzungsverzeichnis

ADL	= activities of daily living / Aktivitäten des täglichen Lebens
BADL	= basic activities of daily living / Basale Aktivitäten des täglichen Lebens
BPSD	= Behavioural and Psychological Symptoms in Dementia / Behaviorale und psychologische. Symptome der Demenz
DEMMI	= De Morton Mobility Index
DemTect	= Demenz-Detektions-Test
Dia-LiFE	= Demenz im Akutkrankenhaus-LiFE
IADL	= instrumented activities of daily living / Instrumentelle Aktivitäten des täglichen Lebens
LiFE	= Lifestyle-integrated Functional Exercise / Lebensstil-integriertes funktionelles Training
MmD	= Menschen mit Demenz
MMST	= Mini-Mental-State-Test
MoCA	= Montreal-Cognitive-Assessment-Test
NRS	= nicht-randomisiert-kontrollierte Studie
OPS	= Operationen- und Prozedurenschlüssel
RCT	= randomisiert-kontrollierte Studie
WHO	= World Health Organisation / Weltgesundheitsorganisation

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Vorbemerkung

Diese publikationsbasierte Dissertationsschrift ist in den Schnittstellenbereich der Sportwissenschaften und der Geriatrie (Altersmedizin) einzuordnen. Die Verfasserin dieser Arbeit war Empfängerin eines Promotionsstipendiums der Robert-Bosch-Stiftung (2016-2020) am Netzwerk Alternsforschung (NAR) der Universität Heidelberg. Unter der Projektleitung von Prof. Dr. med. Clemens Becker und Dr. Michael Schwenk war sie maßgeblich an der Konzeption, Durchführung und Evaluation des Projektes und federführend an der Durchführung der Studien beteiligt.

Hinweis für die Leserin/den Leser:

Zu Gunsten einer besseren Lesbarkeit finden in der vorliegenden Arbeit im Regelfall Ausdrucksformen im generischen Maskulin, wie Studienteilnehmer, Proband, Therapeut, Patient oder Betreuer, Anwendung. Es sei jedoch darauf hingewiesen, dass dabei stets, exemplarisch auf oben genannte Beispiele bezogen, weibliche und männliche Personen dieser Gruppe gemeint sind.

1. Einleitung

Geriatrische Patienten leiden neben diversen Erkrankungen, die zu einer Krankenhauseinweisung führen können, in einer Vielzahl von Fällen unter einer zusätzlichen kognitiven Einschränkung bis hin zu verschiedenen Demenzformen (Bickel, Hendlmeier, Heßler, Junge, Leonhardt-Achilles, Weber & Schäufele, 2018). Das unter anderem von kognitiven und motorischen Defiziten geprägte Krankheitsbild der Demenz hat einen erheblichen Einfluss auf die Selbstständigkeit, Autonomie und Lebensqualität der Erkrankten. Ein erhöhtes Sturzrisiko und voranschreitende motorische Einschränkungen führen zu einer stark limitierten Fähigkeit der Ausführung von Aktivitäten des täglichen Lebens (ADL) sowie einem erhöhten Pflegebedarf. Doch ein weiterer, häufig unterschätzter und unberücksichtigter Faktor, der zu einem immensen Funktionsverlust führt, ist das geringe Aktivitätsniveau von Patienten (Boyd, Landefeld, Counsell, Palmer, Fortinsky, Kresevic, Burant & Covinsky, 2008). Dieses sedentäre Verhalten wird speziell im Falle einer weiteren Erkrankung verstärkt und führt häufig zu irreparablen Einschränkungen und unwiederbringlichen motorischen Verlusten. Die vermehrten Folgen sind erhöhte Wahrscheinlichkeiten für wiederkehrende Krankenhauseinweisungen, Institutionalisierung und Tod. Die daraus resultierende Versorgungssituation gestaltet sich aufgrund eines zunehmenden Fachkräftemangels sowie steigender Patientenzahlen immer dramatischer hinsichtlich der Kosten und Fürsorge für diese Patientengruppe (Hessler, Schäufele, Hendlmeier, Junge, Leonhardt, Weber & Bickel, 2017).

Während die Wirksamkeit körperlichen Trainings bei Demenzpatienten mittlerweile in vielen qualitativ hochwertigen Studien im ambulanten Bereich nachgewiesen werden konnte (Schwenk, Zieschang, Oster & Hauer, 2010b; Hauer, Schwenk, Zieschang, Essig, Becker & Oster, 2012), wird darüber hinaus jedoch auch deutlich, dass ein Wiedergewinn an motorischen Funktionen eine immense Aufgabe für diese multimorbide und vulnerable Gruppe sowie einen enormen Aufwand für therapeutisches Personal darstellt. Hinsichtlich immer knapper werdender Ressourcen wächst der Bedarf nach präventiven anstatt rehabilitativen Maßnahmen zunehmend. Die vorliegende Arbeit soll sich aus diesem Grund mit einem speziell auf Demenzpatienten angepassten Bewegungsansatz beschäftigen, der einem Funktionsverlust während eines Krankenhausaufenthaltes präventiv vorbeugen soll, indem sedentäre Phasen reduziert werden und körperliche Aktivität gesteigert wird. Aufgrund der thematisierten Pati-

entengruppe sowie dem behandelten Krankenhaussetting erhält das Programm den Namen „dia“ (Demenz im Akutkrankenhaus)-LiFE (*lifestyle-integrated functional exercise*)“.

Die Steigerung körperlicher Aktivität während eines Krankenhausaufenthaltes soll mittels eines neuen Trainingsansatzes, in dem Übungen in den Alltag der Teilnehmer integriert werden, geschehen. Um die Effektivität und Machbarkeit dieses alltagsintegrierten Ansatzes in seiner Grundform jedoch zunächst beurteilen zu können, müssen bisherige Studien, die diesen Ansatz bereits in anderen Zielgruppen verwenden, systematisch überblickt und analysiert werden. Hierbei wird darüber hinaus dargestellt, dass die Patientenklientel der kognitiv eingeschränkten Älteren bisher unterrepräsentiert und somit eine Thematisierung notwendig ist. Um des Weiteren die Eignung der Bewegungsübungen in dieser Patientengruppe zu beurteilen, müssen deren Machbarkeit und Akzeptanz getestet werden. Erst im Anschluss können eventuell notwendige Anpassungen plausibel vorgenommen und die Übungen weiterentwickelt werden. Dazugehörige Anweisungen wie Übungen durchgeführt werden sollen, müssen ebenfalls überprüft und, wenn nötig, an geforderte Kommunikationscharakteristika für Demenzpatienten angepasst werden (Haberstroh & Pantel, 2011). Im Rahmen des dia-LiFE-Projektes sollen darüber hinaus die Patientenaktivität sowie patientenschädliche Abläufe des Krankenhausalltages analysiert und dargestellt werden, um evidenzbasierte Handlungsempfehlungen formulieren zu können. Ein weiterer Teil beschäftigt sich darüber hinaus mit der adäquaten Auswahl von Assessments. Viele bisherige Studien mussten sich der Kritik aussetzen qualitativ ungenügend zu sein (Schwenk, Lauenroth, Oster & Hauer, 2010a). Neben unzureichenden Stichprobengrößen, unvollständigen Beschreibungen der statistischen Methoden und Teilnehmern mit unterschiedlich starker kognitiver Einschränkung wurden darüber hinaus auch nicht standardisierte Assessmentmethoden kritisiert. Eine systematische Literaturübersicht soll sich daher im Rahmen dieses Projektes mit dem Thema der passenden Auswahl geeigneter Messinstrumente befassen.

Die folgende Gliederung soll die vorliegende Arbeit nachvollziehbar veranschaulichen. Das nachfolgende Kapitel macht sich den Wandel der Gesellschaft hinsichtlich der Altersverteilung sowie der daraus resultierenden Konsequenzen für das deutsche Gesundheitssystem zum Thema. In diesem Zuge sollen neben epidemiologischen und diagnostischen Aspekten der Demenz speziell die stationäre sowie intersektorale Versorgungssituation von Demenzpatienten geschildert werden. Darauffolgend werden die Zusammenhänge von motorischen und kognitiven Leistungen beschrieben und die Auswirkungen von sedentärem Verhalten speziell

für Demenzpatienten thematisiert. Es soll verdeutlicht werden, in welchem Ausmaß der krankheitsbedingte kognitive Leistungsverlust, gepaart mit inaktivem Verhalten, mit einem Funktionalitätsverlust in Zusammenhang steht und welche Auswirkungen dies impliziert. Darauffolgend werden die Fragestellungen dieser publikationsbasierten Dissertation formuliert und von den Zusammenfassungen der einzelnen Manuskripte (1-4) sowie der Darstellung bisher unveröffentlichter Daten komplementiert. Abschließend vervollständigen die Einordnung der gewonnenen Studienergebnisse in den internationalen Forschungszusammenhang sowie eine Zusammenfassung und ein Ausblick die behandelte Thematik.

2. Theoretischer Hintergrund

2.1. Demografischer Wandel

Der demografische Wandel beeinflusst speziell in Deutschland nicht nur die Altersverteilung in der Gesellschaft. Derzeitige Prognosen deuten aufgrund der stärkeren Zuwanderung auf wachsende Bevölkerungszahlen bis zum Jahr 2024 und bei gleichbleibenden Geburtenhäufigkeiten und Lebenserwartungen auf sinkende Zahlen ab dem Jahr 2040 hin. Aktuelle Berichte gehen derzeit von einem Anstieg der über 67-Jährigen von 16 Millionen im Jahr 2018 auf schätzungsweise 21 Millionen im Jahr 2038 aus. Im Jahr 2040 würde von prognostizierten 83 Millionen Einwohnern somit ein Viertel (25-27%) 67 Jahre und älter sein (Statistisches Bundesamt, 2019). Es wird darüber hinaus von steigenden Krankenhauseinweisungszahlen ausgegangen, da die Anzahl der Senioren hier zu Lande zunehmend ist. Weitere damit in Verbindung stehende Schätzungen einer potentiellen Pflegebedürftigkeit fallen dementsprechend aus. Diese werden von internationalen Experten wie folgt formuliert: während im Jahr 2000 in Deutschland von 100 Bewohnern, die 65 Jahre und älter waren, 24,3 und im Jahr 2020 bereits 34,2 pflegebedürftig sind, werden Prognosen zufolge im Jahr 2050 54,4 Personen von 100 Bewohnern pflegebedürftig sein (United Nations, Department of Economic and Social Affairs, Population Division, 2017). Insgesamt wird von einem Anstieg an Pflegebedürftigen in Deutschland von 2009 (2,3 Millionen) bis 2030 (3,4 Millionen) um 47,4% ausgegangen. Dies ist hauptsächlich durch die alternde Bevölkerung begründet (Bertelsmann Stiftung, 2012). Bereits im Jahr 2017 konnte das Statistische Bundesamt in Deutschland verdeutlichen, dass mit Blick auf die Verteilung der Personalkosten jene für Pflegepersonal (30%) im Krankenhaus lediglich durch die für ärztliches Personal minimal übertroffen werden (32%) (Statistisches Bundesamt, 2018a). Bei steigenden Patientenzahlen kann somit auch mit einem erhöhten Pflegeaufwand und damit verbundenen steigenden Pflegekosten gerechnet werden. Diese Daten sind unter dem Aspekt der geplanten bundesweiten Krankenhausschließungen jedoch mit äußerster Vorsicht zu interpretieren. Denn sollten Krankenhäuser geschlossen werden, hätte dies weitreichende Konsequenzen auf die Versorgungssituation, Personalzahlen und Kosten. Die angestrebte Ambulantisierung würde für eine Verschiebung der benötigten Personalkapazität sorgen; weg von großflächiger stationärer Versorgung zugunsten einer Spezialisierung und Konzentrierung von Angeboten und hin zu einem Fokus auf ambulant einzusetzendes Personal, um die ambulanten Versorgungsmöglichkeiten auszubauen. Diese Spezia-

lisierung soll im konzentrierten Sinne dann zwar zu einer Qualitätssteigerung in fachärztlicher und technischer Ausstattung führen, könnte dies jedoch wahrscheinlich nur auf Kosten einer eingeschränkten Erreichbarkeit erzielen, denn die Standortanzahl würde um circa 70% bis zum Jahr 2030 reduziert. Fallzahlen sollen auf diese Weise verringert und der Fokus auf betriebswirtschaftliche und nicht medizinisch-therapeutische Quantität gelegt werden. Ziel wäre somit eine Fallzahlreduzierung von etwa 22% bis zum Jahr 2030, bei der es sich aufgrund steigender Fallzahlen in der älteren Bevölkerungsgruppe (etwa 11%) schlussendlich um etwa verbleibende 11% im Vergleich zu 2017 handeln würde (Bertelsmann Stiftung, 2019). Derzeit beträgt die durchschnittliche Verweildauer geriatrischer Patienten im Krankenhaus 16 Tage (Statistisches Bundesamt, 2017a). Eine Verweildauer, die im europäischen Vergleich eher lang erscheint, jedoch auch unter dem Gesichtspunkt der Krankenhausschließungen kaum einer Reduzierung unterliegen wird aufgrund der dann vor allem zu behandelnden schweren Fälle (Bertelsmann Stiftung, 2019).

Mit einer Dauer von gut zwei Wochen sind geriatrische Patienten Langlieger der stationären Behandlung. Die Gruppe der 80- bis 85-Jährigen weist dabei den größten Anteil mit der längsten Verweildauer (16,3 Tage) in dieser Patientenklientel auf (Statistisches Bundesamt, 2017a). Während laut Schätzungen des „Status Quo“ Szenariums die Krankenhausfallzahlen der unter 40-Jährigen von 2008 und circa 28%, bis 2030 auf circa 21% sinken sollen, steigen hier die Zahlen der Fälle von über 60-Jährigen seit 2008 von circa 45%, auf 62% im Jahr 2030. Und auch im Szenario der „sinkenden Behandlungsquoten“ wird von einem Anstieg auf circa 61% gerechnet. Diese Prognosen für Behandlungsfälle in Krankenhäusern sowie für den Pflegebedarf stützen sich in zwei verschiedenen Szenarien entweder auf das sogenannte „Status Quo“ Szenario, welches auf Berechnungen beruht, die eine konstant bleibende Entwicklung der Krankheitsfälle entsprechend heutiger Daten in Betracht ziehen oder auf das Szenario „sinkende Behandlungsquoten“. Hierbei wird von einer längeren Lebenserwartung ausgegangen, die jedoch auch geprägt ist von einer längeren gesunden Lebensweise und somit späteren eventuellen Behandlungszeitpunkten. Beide Szenarien finden auch in den Prognosen des statistischen Bundesamtes hinsichtlich der Pflegebedürftigkeit ihre Anwendung und weisen dabei unterschiedliche Zahlen auf. In dem Szenario „Status Quo“ geht man derweil von einem Anstieg um 500.000 Behandlungsfälle pro Dekade aus, sodass im Jahr 2030 circa 3,4 Millionen Pflegebedürftige erwartet werden. In dem Szenario „sinkende Behandlungsquoten“ hingegen wird bis zum Jahr 2030 ein Anstieg auf circa 3 Millionen Pflegebedürftige erwartet.

Dieser Unterschied von 400.000 Pflegebedürftigen wäre jedoch nur realistisch, wenn die Betroffen länger gesund blieben und nicht unter Einschränkungen litten, die ihre Selbständigkeit im Alltag beeinflussen und einschränken würden (Statistisches Bundesamt, 2018b). Für dieses Ziel müssten jedoch Maßnahmen konkretisiert werden, die einen gesünderen Lebensstil als Ziel haben, um eine möglichst lange selbstständige Lebensweise zu ermöglichen. Prävention gewinnt in diesem Konzept daher zunehmend an Bedeutung, um Rehabilitationsangebote reduzieren zu können, ohne gleichzeitig eine Versorgungslücke zu schaffen.

Träger von stationären Vorsorge- und Rehabilitationseinrichtungen senken bereits seit längerem nach und nach die Anzahl der in Deutschland vorhandenen Einrichtungen. Der derzeitig jedoch weiterhin steigende Bedarf sorgt für eine zunehmende Auslastung. Die Nachfrage nach ärztlichem und pflegerischem Personal ist daher ebenfalls konstant steigend. Während die Verweildauer in Rehabilitationseinrichtungen über die letzten Jahre konstant zu sein scheint, nehmen die Pflegetage aufgrund steigender Fallzahlen zu (Statistisches Bundesamt, 2017b).

Stationäre und ambulante Pflegedienste steigern ihr Angebot konsequenterweise seit Jahren regelmäßig. Und dennoch zeigt deren Auslastung eine konstante Quote von über 90%. Berücksichtigt man hierbei die Tatsache, dass von derzeit circa 2,3 Millionen pflegebedürftigen geriatrischen Patienten circa 1,6 Millionen im Rahmen informeller Pflege in ihrem zu Hause versorgt werden, befindet sich lediglich ein Drittel zur Pflege in stationären Einrichtungen (Statistisches Bundesamt, 2018b).

Hinsichtlich dementieller Erkrankungen kann festgehalten werden, dass im Jahr 2016 bereits circa 1,7 Millionen Patienten in Deutschland an dieser Krankheit litten. Sollte keine geeignete Therapie entwickelt werden, wird für die nächsten drei Dekaden von einem jährlichen Zuwachs von rund 40.000 Patienten ausgegangen, was eine Anzahl von 2,2 Millionen Erkrankte im Jahr 2030 bedeuten würde (Bickel, Hendlmeier, Heßler et al., 2018). Neuere internationale Daten lassen jedoch Bedenken an diesen Zahlen aufkommen. Aktuelle Studien bei Patienten mit beginnender Demenz verdeutlichen positive Effekte eines verbesserten Bildungsansatzes sowie einer verbesserten Gesundheitsversorgung und einer Reduktion kardiovaskulärer Risikofaktoren, die speziell mit kognitiver Einschränkung assoziiert sind (Richardson, Stephan, Robinson, Brayne, Matthews & Cognitive Function and Ageing Study Collaboration, 2019). Hier war in den letzten zwei Dekaden speziell in Großbritannien eher ein Rückgang als eine Steigerung der Zahlen zu vermelden.

Geht man jedoch von einer kontinuierlichen Fortsetzung der bisherigen Entwicklung aus, die besagt, dass circa 40% der geriatrischen Akutpatienten als Nebendiagnose kognitive Einschränken und circa 20% eine Demenz vorweisen (Bickel, Hendlmeier, Heßler et al., 2018), muss von folgenden Zahlen ausgegangen werden: Im Jahr 2030 wird erwartet, dass circa 62% aller Krankenhauspatienten 65 Jahre und älter sind, von denen wiederum circa 40% eine kognitive Einschränkung vorweisen. Als Konsequenz wären somit 25% aller Krankenhauspatienten zusätzlich zu ihrem ursprünglichen Einweisungsgrund, kognitiv eingeschränkt. Der erhöhte Pflegebedarf, den damit verbundenen erhöhten Zeit- und Kostenaufwand der Betreuung dieser Patientengruppe sowie der notwendige Schulungsbedarf für Personal wird in den folgenden Kapiteln genauer behandelt.

2.2. Epidemiologie und diagnostische Kriterien der Demenz

Demografische Veränderungen in der Gesellschaft führen zu mehr dementiellen Neuerkrankungen bei gesunden Älteren als zu Sterbefällen in der Gruppe der bereits Erkrankten, was zu einem kontinuierlichen Wachstum der Patientenzahlen führt. Bei einer mittleren fortlaufenden, jährlichen Neuerkrankungsrate von 40.000 Patienten wird anhand deutscher Daten derzeit von einem Anstieg von circa 1,7 Millionen im Jahr 2016 auf circa 2,2 Millionen im Jahr 2030 ausgegangen (Bickel, Hendlmeier, Heßler et al., 2018).

Während weltweit in den letzten Dekaden ebenfalls von einem Anstieg der Fallzahlen auf 50 Millionen im Jahr 2018 und auf 152 Millionen im Jahr 2050 ausgegangen wurde (Alzheimer's Disease International, 2018), gestalten sich diese steigenden Trends in neueren Studien eher gegenteilig. Speziell Zahlen aus Großbritannien, den USA und Schweden verdeutlichen einen deutlich geringeren Anstieg der Patientenzahlen (Richardson, Stephan, Robinson et al., 2019; Stephan, Birdi, Tang, Cosco, Donini, Licher, Ikram, Siervo & Robinson, 2018). Die Wachstumsraten der Patientenzahlen für die kommenden Dekaden unterliegen derzeit aufgrund soziodemografischer, gesellschaftlicher und kultureller Aspekte scheinbar einem Wandel, der auch für Deutschland zu erwarten, jedoch aufgrund fehlender aktueller Daten noch nicht konkret zu benennen ist.

Derzeit sind die Prävalenzraten in Deutschland mit zunehmendem Alter jedoch noch von einer Steigerung gekennzeichnet. Während diese bei 65- bis 69-Jährigen noch bei 1,6% liegt, beträgt sie in der Gruppe der 75- bis 79-Jährigen bereits 7,3% und in der erneut zehn Jahre älteren Gruppe von 85- bis 89-Jährigen 26,1%. Die höchste Prävalenzrate mit 41,0% lässt sich dementsprechend in der Gruppe der über 90-Jährigen finden. Die Prävalenzraten der Frauen sind dabei ab dem 70. Lebensjahr durchgehend höher als die der Männer und übertreffen im Gesamtwert der über 65-Jährigen Frauen mit 11,0% sogar die Gesamtprävalenzrate der über 65-Jährigen in Deutschland mit 10,0%. Dies kann bedingt sein durch eine höhere Lebenserwartung von Frauen. Mit seinen knapp 1,7 Millionen Erkrankten im Jahr 2016 lag Deutschland zu diesem Zeitpunkt auf dem 5. Platz aller Nationen hinsichtlich der Zahlen an Demenz erkrankter Einwohner. Mehr Erkrankte gab es zu der Zeit lediglich in drei Ländern im asiatischen Raum (China, Indien und Japan) sowie den USA (Bickel, Hendlmeier, Heßler et al., 2018). Jene Länder weisen jedoch auch deutlich höhere Bevölkerungszahlen als Deutschland vor (China: 1.395,38 Millionen; Indien: 1.334,22 Millionen; USA: 327,35 Millionen; Japan:

126,49 Millionen; Deutschland: 82,89 Millionen) (Statista, 2018b). Japan stellt darüber hinaus weltweit den prozentual größten Anteil an Einwohnern über 64 Jahren (28%). In Deutschland sind vergleichsweise 21% der Bevölkerung 64 Jahre und älter (Statista, 2018a), ein Wert, der ebenfalls einer Steigerung bis schätzungsweise zur Mitte des Jahrhunderts unterliegen wird. Dies ist neben weiteren Faktoren ausschlaggebend für die verhältnismäßig hohe Prävalenzrate der Demenz hierzulande.

Inzidenzraten, die die jährliche Rate an Neuerkrankungen verdeutlichen, fallen ebenfalls in Abhängigkeit zum steigenden Alter höher aus. Während die Inzidenzrate bei 65- bis 69-Jährigen noch bei 0,5% liegt, ist die der 75- bis 79-Jährigen bereits mehr als dreifach gesteigert (1,7%). Die Rate der Höchstbetagten (über 90 Jahre) liegt bei 12,2%. Die durchschnittliche Inzidenzrate der über 65-Jährigen in Deutschland liegt bei 2,0% (Bickel, Hendlmeier, Heßler et al., 2018).

Als häufigste Ursache einer Demenz gilt in Industrieländern mit circa 66% die degenerative Alzheimer-Krankheit. Die vaskuläre Demenz, die durch Durchblutungsstörungen des Gehirns begünstigt ist, stellt die zweithäufigste Ursache mit circa 15 bis 20% dar. Die Mischformen des degenerativ-vaskulären Typs bilden die übrigen Fälle (Weyerer, 2005), wobei diese Zahl wahrscheinlich bisher unterschätzt wurde und heute höher eingeschätzt wird (Wharton, Brayne, Savva, Matthews, Forster, Simpson, Lace & Ince, 2011; Viswanathan, Rocca & Tzourio, 2009). Neben dem zunehmenden Alter stellen auch bereits vorliegende kognitive Defizite sowie eine geringe Schulbildung drei große Risikofaktoren dar. Vor allem eine bereits vorhandene kognitive Störung führt, im Vergleich zu nicht beeinträchtigten Gleichaltrigen, zu einer 20-fach erhöhten Wahrscheinlichkeit innerhalb der nächsten drei Jahre an einer Demenz zu erkranken (Bickel & Schäufele, 2000). Darüber hinaus gelten kardiovaskuläre Erkrankungen, Diabetes mellitus, Alkoholabusus, Adipositas, Rauchen sowie Fettstoffwechselstörungen als Risikofaktoren, die eine Demenz begünstigen (Mielke & Heiss, 2003). Die Lebenserwartung nach Beginn der Alzheimer-Demenzsymptomatik liegt im Durchschnitt zwischen vier und acht Jahren, bei einer vaskulären Demenz sogar bei einem Jahr weniger. Auf mögliche Gründe wie Stürze, Gebrechlichkeit und ein medizinisch verschlechterter Gesamtzustand, der von den Betroffenen nur ungenügend wahrgenommen und behandelt wird, weisen Schaub und Kollegen hin (Schaub, Hillen, Borchelt, Reischies & Steinhagen-Thiessen, 2002).

Nach der „Internationalen statistischen Klassifikation der Krankheiten und verwandter Gesundheitsprobleme (WHO, International Statistical Classification of Diseases and Related

Health Problems, ICD-10, Version 2019) gilt Demenz als ein chronisches oder fortschreitendes Syndrom aufgrund von Erkrankungen des Gehirns, die verschiedene kortikale Störungen verursachen. Dabei sind vor Allem Gedächtnis, Denken, Orientierung, Auffassung, Rechnen, Lernfähigkeit, Sprache und Urteilsvermögen beeinträchtigt. Die emotionale Kontrolle und das soziale Verhalten sowie die Motivation leiden ebenfalls häufig unter einer Beeinträchtigung. Motorische Einschränkungen gehören darüber hinaus zum Krankheitsbild und können die Erkrankten in ihren Aktivitäten des täglichen Lebens stark beeinträchtigen. Das Bewusstsein hingegen unterliegt keiner Beeinträchtigung.

Die ICD-10 definiert darüber hinaus auch eine leichte kognitive Störung (*Mild Cognitive Impairment*). Leichte kognitive Störungen können im Rahmen von zerebralen oder systemischen Infektionen oder anderen körperlichen Krankheiten auftreten und sind gekennzeichnet durch Gedächtnisstörungen, Lernschwierigkeiten und eine verminderte Konzentrationsfähigkeit. Das Lösen von Aufgaben kann hier häufig zu einer Ermüdung führen, jedoch sind keine dieser Symptome so schwerwiegend, dass sie zu einer Demenzdiagnose anhand etablierter Kriterien führen würden. International anerkannte Konsensuskriterien definieren eine leichte kognitive Störung darüber hinaus als einen kognitiven Abbau ohne Beeinträchtigung der Aktivitäten des täglichen Lebens. Es treten lediglich minimale Einschränkungen in komplexeren Aufgaben auf, die mittels Eigen- oder Fremdanamnese festgestellt werden (Winblad, Palmer, Kivipelto, Jelic, Fratiglioni, Wahlund, Nordberg, Bäckman, Albert, Almkvist, Arai, Basun, Blennow, de Leon, DeCarli, Erkinjuntti, Giacobini, Graff, Hardy, Jack, Jorm, Ritchie, van Duijn, Visser & Petersen, 2004). Eine leichte kognitive Störung kann als Vorstufe einer Demenz angesehen werden. Jedoch entwickeln sich jährlich lediglich circa 10% der Fälle zu einer Demenz (Mitchell & Shiri-Feshki, 2009).

Nach ICD-10 Kriterien muss neben dem Gedächtnis mindestens eine weitere kognitive Funktion beeinträchtigt sein (z.B. Urteilsfähigkeit, Denkvermögen, Orientierung), um eine Demenzdiagnose stellen zu können. Um die Symptome von einer vorübergehenden Leistungsstörung wie eines Delirs abzugrenzen, ist für die Demenzdiagnose eine Mindestdauer der Symptome von einem halben Jahr vorausgesetzt, die darüber hinaus eine Beeinträchtigung in der Bewältigung des Alltags bewirken.

2.2.1. Screening und Assessment

Vor einer ausführlichen Diagnostik stehen Screeningmaßnahmen zur Verfügung, die einen ersten Überblick über den kognitiven Status eines Patienten liefern. Diverse Kurztests haben sich hierbei über die vergangenen Dekaden etabliert. Hinsichtlich ihrer Einsetzbarkeit haben sich jedoch Unterschiede herauskristallisiert. Während sich beispielsweise der Mini-Mental-State-Test (MMST) (Folstein, Folstein & McHugh, 1975) sowie der Montreal-Cognitive-Assessment-Test (MoCA) (Nasreddine, Phillips, Bédirian, Charbonneau, Whitehead, Collin, Cummings & Chertkow, 2005) für eine eher mittelschwere kognitive Einschränkung eignen, hat der Demenz-Detektions-Test (DemTect) (Kalbe, Kessler, Calabrese, Smith, Passmore, Brand & Bullock, 2004) eine hohe Spezifizität sowie Sensitivität bei einer beginnenden kognitiven Einschränkung sowie bei leichter bis mittlerer Demenz vorgewiesen. In diesem, im Jahr 2000 in Deutschland entwickelten Test kann ein Maximalwert von 18 Punkten erreicht werden. Dabei getestet werden neben den Funktionen des verbalen Gedächtnisses auch die Wortflüssigkeit, die intellektuelle Flexibilität sowie die Aufmerksamkeit. Während Ergebnisse mit einer Punktzahl von über 12 auf eine kognitiv intakte Leistung hinweisen, bedeuten Punktwerte von 9 bis 12 eine leichte kognitive Beeinträchtigung und Punktzahlen unter 9 den Verdacht einer beginnenden Demenz. Je niedriger der Wert dabei sinkt, desto stärker ist der jeweilige Grad der kognitiven Einschränkung ausgeprägt. In den Studien der vorliegenden Arbeit wurde der DemTect aufgrund dieser genannten Eigenschaften als Screeningmethode verwendet. Der DemTect dient dabei nicht als diagnostisches Instrument, sondern als Screeningmethode für Eingangsuntersuchungen, die im klinischen Alltag aufgrund der kurzen Dauer in der Durchführung (8 Minuten) zur Erstbeurteilung eingesetzt werden kann. Gemäß der S3-Leitlinie Demenz bedarf es bei einem Demenzverdacht nach einer ersten Anamnese anschließend weiterer diagnostischer Abklärung mittels beispielsweise neuropsychologischer Tests, der Erfassung demenzassoziierter psychischer und weiterer Verhaltenssymptome sowie Beeinträchtigungen der Alltagsbewältigung, bildgebender Verfahren, Blutuntersuchungen und gegebenenfalls Liquordiagnostik (Deuschl, Maier, Jessen & Spottke, 2016). Zur Differenzierung des Demenztyps sind darüber hinaus weitere Maßnahmen möglich, die in dieser Arbeit nicht weiter thematisiert werden.

2.3. Die Versorgungssituation von Demenzpatienten

Für Menschen mit Demenz ist die Aufnahme in ein Krankenhaus mit weitaus mehr Komplikationen und Herausforderungen verbunden als für kognitiv gesunde Ältere. Demenzpatienten weisen aufgrund ihrer kognitiven Einschränkung speziell während eines stationären Aufenthaltes ein hohes Bedürfnis an Vertrautheit, angepasster Kommunikation und Orientierung auf (Bundesministerium für Gesundheit, 2007). Doch genau auf diese Bedürfnisse kann in Krankenhäusern aufgrund meist standardisierter Versorgungsabläufe, die für Patienten mit somatischen Erkrankungen ohne kognitive Defizite konzipiert sind, kaum eingegangen werden (Pinkert & Holle, 2012). Darüber hinaus sorgt das „Durchschleusen" von Patienten (*Patientenflow*) zwischen verschiedenen Fachbereichen für zusätzlichen Stress und eine ungewohnte Umgebung (Müller, Dutzi, Hestermann, Oster, Specht-Leible & Zieschang, 2008). Neue Daten konnten verdeutlichen, dass das Auftreten eines Delirs, das häufig begünstigt wird durch eine psychisch herausfordernde Krankenhausumgebung, die Entwicklung einer Demenz begünstigt (Garcez, Apolinario, Campora, Curiati, Jacob-Filho & Avelino-Silva, 2019).

Kognitive Einschränkungen beeinflussen den Gesundheitszustand eines Patienten maßgeblich und führen speziell im Falle einer Begleitdiagnose Demenz während eines Krankenhausaufenthaltes zu rapiden funktionellen und kognitiven Einbußen (Rose, Wahl, Crusius & Löwe, 2011). Während Demenzpatienten allgemeine Gesundheitsleistungen wie Arztbesuche seltener in Anspruch nehmen als kognitiv gesunde Ältere, werden sie jedoch häufiger in ein Krankenhaus eingewiesen. So kann die Schätzung geäußert werden, dass etwa ein Drittel aller an Demenz erkrankten Patienten mindestens einmal jährlich einen Krankenhausaufenthalt vorzuweisen hat. Gründe für die Einweisung variieren hierbei von Stürzen, über Verhaltensauffälligkeiten sowie Störungen des Ernährungszustandes bis hin zu Herz-, Atemwegs- oder gastrointestinalen Erkrankungen sowie Infektionen (Pinkert & Holle, 2012). Aus diesen Fällen ergeben sich derzeit circa 50.000 Patienten mit unterschiedlichem Grad kognitiver Einschränkung täglich, die in deutschen Krankenhäusern versorgt werden müssen (Bickel, Schäufele, Hendlmeier & Heßler-Kaufmann, 2019). Zu berücksichtigen gilt es jedoch auch die niedrige Quote an verlässlichen Demenz-Diagnosen, die lediglich zwischen 40% und 50% liegt (Prince, Comas-Herrera, Knapp, Guerchet & Karagiannidou, 2016). Darüber hinaus ist bei einer Vielzahl von Demenzpatienten (63,3%) kein Verweis auf die kognitive Einschränkung in der Patientenakte vorzufinden, was eine angemessene, proaktive Behandlung von

Beginn an erschwert (Bickel, Hendlmeier, Heßler et al., 2018; Kirchen-Peters & Krupp, 2019).

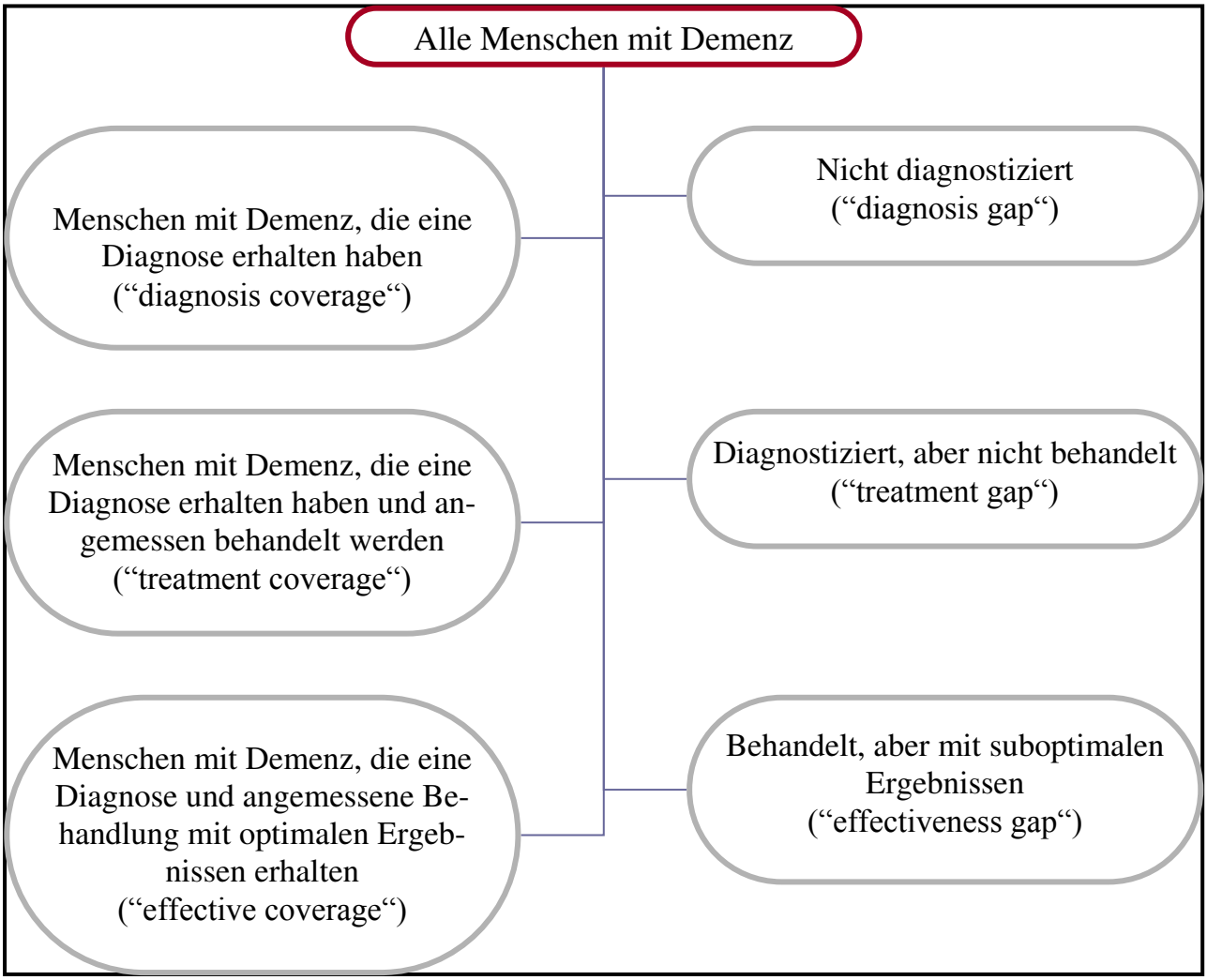

Abbildung 1 Möglicher Ablauf von Diagnose und Behandlung (nach Prince, Comas-Herrera, Knapp, Guerchet & Karagiannidou, 2016)

Wie die vorangehende Grafik verdeutlichen soll, können Negativkonsequenzen durch verschiedene Probleme in den Abläufen von Diagnose und Behandlung, wie unzureichende Diagnosen (*diagnosis gap*), mangelnde Behandlungen (*treatment gap*) sowie eine ausbleibende Effektivität im Falle einer Behandlung (*effectiveness gap*) verursacht werden (Prince, Comas-Herrera, Knapp et al., 2016).

Als Risikofaktoren für eine Krankenhauseinweisung gelten laut Rudolph und Kollegen Komorbidität (Deyo-Charlson-Index >1), eine bereits vorangegangene Krankenhausbehand-

lung im jeweiligen Jahr, ein hohes Alter, das männliche Geschlecht sowie eine kurze Dauer der Symptome (Rudolph, Zanin, Jones, Marcantonio, Fong, Yang, Yap & Inouye, 2010).

2.3.1. Stationäre Versorgung

In der stationären Versorgung deutscher Akutgeriatrien ergeben sich im Rahmen des fallpauschalisierten Entgeltsystems Unterschiede in der Kategorisierung und anschließenden therapeutischen Behandlungsart des Patienten. Dies geschieht anhand vordefinierter Kategorien, die über die Einordnung des jeweiligen Patienten sowie folgende therapeutische und rehabilitative Maßnahmen entscheiden. Hierbei muss im großen Maße auf ein optimiertes Behandlungsmanagement sowie eine dafür benötigte Kooperation zwischen allen beteiligten Ärzten, Therapeuten und Pflegenden vertraut werden.

Mittels diverser Assessments, die nach der Verlegung von einer Notaufnahme, aber auch bei Direkteinweisung auf eine geriatrische Akutstation routinemäßig durchgeführt werden, wird zwischen drei Patientengruppen unterschieden. Zunächst finden sich hierbei die (1) Patientengruppe mit „akutgeriatrisch-frührehabilitativem Behandlungsbedarf“, die aufgrund ihres medizinischem Bedarfs begleitende therapeutisch-rehabilitative Maßnahmen bereits während ihres Aufenthaltes auf der Akutstation erhält sowie die Patientengruppe mit „hohem frührehabilitativem Behandlungsbedarf“, die darüber hinaus einen therapeutischen Ansatz, der die Überweisung in geriatrisch-rehabilitative Strukturen beinhaltet, erhält. Die (2) Patientengruppe mit „primär-rehabilitativem Behandlungsbedarf“ wird hingegen schnellstmöglich aus dem Akutaufenthalt entlassen und in ambulante Rehabilitationsstrukturen überwiesen. Die letzte Gruppe der (3) Patienten mit „primärem Versorgungsbedarf ohne weitergehenden akutmedizinischen oder rehabilitativen Behandlungsbedarf“ wird in die Betreuung von Sozialdiensten oder der Kurzzeitpflege überwiesen (Lübke, 2001). Die therapeutischen Einheiten, die sich während des Akutaufenthaltes daraus ergeben, tragen maßgeblich zur Rehabilitation der Patienten bei und unterscheiden sich hierbei in ihrer Anzahl der Einheiten während des Krankenhausaufenthaltes.

Die Prognose des Statistischen Bundesamtes aus dem Jahr 2010, die auf der Datenbasis von ICD-Diagnose-Codierungen beruht, unterschätzt vermutlich aufgrund einer noch immer präsenten Untercodierung von Demenz die steigenden Zahlen von Demenzpatienten in Krankenhäusern bis 2030 und weist lediglich auf den steigenden Pflegeaufwand durch diese Patientengruppe im ambulanten Bereich hin (Statistische Ämter des Bundes und der Länder, 2010).

Während Krankenkassendaten aufgrund von Codierungen in nur circa 6% der Fälle von dem primären Einweisungsgrund Demenz ausgehen, schätzt das Pflegepersonal laut Befragung das Vorkommen dieses Krankheitsbildes auf geriatrischen Akutstation auf bis zu 20% (Schütz, 2012). Zu berücksichtigen gilt darüber hinaus, dass Demenzpatienten ein um das dreifach erhöhte Risiko einer akuten Krankenhauseinweisung vorweisen als kognitiv gesunde Ältere (Thies & Bleiler, 2012). Neuere Daten gehen von einer 40%igen Erscheinungsrate kognitiver Einschränkung bei geriatrischen Akutpatienten aus, wovon circa 18,4% unter einer Demenz leiden (Bickel, Hendlmeier, Heßler et al., 2018). Demenzpatienten weisen jedoch in den meisten Fällen nicht nur eine Akuterkrankung auf, sondern leiden unter Multi- beziehungsweise Polymorbidität, die einer komplikationslosen Behandlung häufig im Wege steht. Patienten mit der Nebendiagnose Demenz weisen darüber hinaus größere Komplikationen während ihres Krankenhausaufenthaltes auf als kognitiv gesunde Patienten, welche den Pflegeaufwand intensivieren und Versorgungskosten steigern. Frührehabilitative Maßnahmen sind hierbei meist zwingend erforderlich, häufig aber schwer umsetzbar. Die aufgabenzentrierte Orientierung der Krankenhäuser steht einer notwendigen personenzentrierten Orientierung gegenüber, die für Demenzpatienten unumgänglich ist (Prince, Comas-Herrera, Knapp et al., 2016). Neben einer größeren Einschränkung in den Aktivitäten des täglichen Lebens (ADL), einem erhöhten Sturz- und Dekubitusrisiko sind auch mit Ernährungsproblemen assoziierte Beschwerden (Appetitlosigkeit, Erbrechen oder Schluckbeschwerden) deutlich häufiger. Darüber hinaus sind die Mortalitätsrate ebenso wie die Rate der Entlassungen in Langzeitpflegeeinrichtungen höher und die Anwendung freiheitsentziehender Maßnahmen häufiger (Motzek, Junge & Marquardt, 2017). Motzek und Kollegen konnten darüber hinaus für deutsche Krankenhäuser zeigen, dass aufgrund einer um 1,5 Tagen längeren Verweildauer sowie der häufigeren Inanspruchnahme von Sozialdienst- und physiotherapeutischen Leistungen pro Demenzpatient im Schnitt 19% (510€) höhere Kosten in Form von DRG-Entgelten pro Krankenhausaufenthalt im Vergleich zu Nicht-Demenzpatienten entstehen. Dies kann durch das Komorbiditätsmaß (+ 214€), die Zahl der Operationen (+ 543€) sowie nichtoperative Maßnahmen (+ 977€) weiter steigen (Motzek, Junge & Marquardt, 2017). Auch das Risiko postoperativer Komplikationen wie akutes Nierenversagen, Pneumonie, Septikämie, Schlaganfall oder Harnwegsinfekt ist bei Menschen mit Demenz (MmD) höher im Vergleich zu Nicht-Demenzpatienten (Hu, Liao, Chang, Wu & Chen, 2012). Trotz jahrelanger Behandlung des Themas finden sich noch immer gravierende Probleme in der stationären Versorgung von

Demenzpatienten. Eine lückenhafte Evidenzlage qualitativ-hochwertiger Studien trägt zu einer unübersichtlichen Literaturlandschaft bei, die klare Handlungsempfehlungen erschwert. Kirchen-Peters und Kollegen (2019) verdeutlichen die Problematiken der Weiterentwicklung von Krankenhausstrukturen hin zu einem demenzsensiblen Ansatz wie folgt und verdeutlichen, dass sich diese über diverse Ebenen erstrecken:

Tabelle 1 Erschwernisse für die Etablierung von Demenzsensibilität in Krankenhäusern (nach Kirchen-Peters & Krupp, 2019, S. 292-294)

Individuelle Ebene	*Institutionelle arbeitsorganisatorische Ebene*	*Übergeordnete und betriebswirtschaftliche Ebene*
Kurative Orientierung: ➔ Frage des beruflichen Selbstverständnisses hinsichtlich Orientierung auf Heilung und Spitzenmedizin, MmD als uninteressante Patientengruppe, mangelndes Interesse sich mit diagnostischer Abklärung von Demenzsyndromen und präventiven, therapeutischen Strategien zu befassen	**Eingefahrene Strukturen**: ➔ eingefahrene Organisationsentwicklung, Kommunikationsmuster schwer umsetzbar ➔ traditionelle Hierarchien, berufliche Orientierungen sorgen für mangelnde Bereitschaft zur Beteiligung an Maßnahmen zur Steigerung der Demenzsensibilität	**Zunehmender Wirtschaftlichkeits- und Effizienzdruck:** ➔ Krankenhäuser stehen wirtschaftlich unter Markt- und Überlebensdruck ➔ wenig Spielräume für finanziell riskante Entscheidungen (z.B. der Rückzug der Länder aus der Übernahme von Investitionskosten der Krankenhäuser)
Verdrängung: ➔ Mangelnde Beschäftigung mit Ängsten vor dem eigenen Alter oder dem Altern der Eltern in Bezug auf geistigen Abbau und daraus resultierender Abhängigkeit von Dritten	**Kein Modellwissen:** ➔ mangelnde Kenntnisse über demenzsensible Konzepte und Good practice ➔ erschwerte Neustrukturierung von Prozessen, verschwendete Ressourcen durch Umwege	**Arbeitsverdichtung:** ➔ Krankenhauspersonal arbeitet am Rande der Belastungsgrenze ➔ hektische und gestresste Gesamtatmosphäre entsteht
Verkennen der Relevanz: ➔ Häufigkeit der Behandlung von MmD in Akutkrankenhäusern unterschätzt ➔ Kommunikationsbarrieren verhindern Verdeutlichen von Schwierigkeiten im Umgang mit diesen sowie empfundener Hilflosigkeit in eskalierenden Situationen	**Ablauforientierung:** ➔ bei kurzer Verweildauer liegt Fokus auf reibungslosen Abläufen der geplanten Prozeduren, auch aufgrund finanzieller Anreizsysteme ➔ unsichtbare, präventive Arbeit mit MmD zur Verhinderung unerwünschter Vorkommnisse kaum wertgeschätzt	**Betriebswirtschaftliche Faktoren:** ➔ MmD erzeugen Mehrkosten durch erhöhten Personalaufwand, Zusatzentgelte für Konsile und längere Liegezeiten ➔ Krankenhäuser befürchten durch offensive Ausrichtung auf das Krankheitsbild mehr MmD
Schwierige Patienteninteraktion: ➔ MmD als aufwendige Patientengruppe, zusätzliche Aufgabe/Last, herausforderndes Verhalten als besondere Belastung ➔ mangelnde Erfahrung im Umgang lassen Entlastungspotenziale durch personenorientierten Umgang nicht erkennen	**Professioneller Tunnelblick:** ➔ zunehmende Spezialisierung und Funktionalisierung der Kliniken fördert einseitigen Blick auf Ziele der Fachbereiche, versperrt ganzheitlichen Blick auf komplexe medizinische, pflegerische, soziale Bedürfnislage der MmD ➔ mangelnde Bereitschaft und Strukturen für interdisziplinäre Arbeitsweise	
	Begrenzte Ressourcen: ➔ mangelnde Schulung des Personals → kein Fortschritt in der Demenzsensibilität	

2.3.2. Ambulante Versorgung

Die ambulante Versorgung von Demenzpatienten wird mit dem Grundsatz „ambulant vor stationär“, der im Pflegeversicherungsgesetz (SGB XI) sowie im Krankenversicherungsgesetz (SGB V) vorzufinden ist, gefordert und findet zu einem hohen Maß in den Familien statt. Dies bedeutet für die Pflegenden eine enorme finanzielle und psychische Belastung, die über das Abfinden mit der Erkrankung eines geliebten Menschen hinausgeht. Zu Beginn des Jahrzehnts lebten circa 800.000 Demenzpatienten in Privathaushalten und wurden dort versorgt und gepflegt, weitere 500.000 lebten in Pflegeheimen (Schäufele, Köhler, Hendlmeier, Hoell & Weyerer, 2013; Schäufele, Köhler, Lode & Weyerer, 2009). Diese Zahlen könnten inzwischen ebenfalls gestiegen sein. Die Ziele der Weltgesundheitsorganisation (WHO) von 2013, wie die Teilhabe von kognitiv eingeschränkten Menschen auszusehen hat, scheinen klar (WHO, 2013). So gilt ein gewisser Grad an Selbstständigkeit, um die eigenen Verpflichtungen zu erfüllen sowie am sozialen Leben teilzunehmen, als zentrale Kompetenz sozialer Gesundheit (Huber, Knottnerus, Green, van der Horst, Jadad, Kromhout, Leonard, Lorig, Loureiro, van der Meer, Schnabel, Smith, van Weel & Smid, 2011). Es sollte dementsprechend auch dementiell erkrankten Menschen ein gewisser Lebensstandard ermöglicht sein, der in der heimischen Umgebung aufgrund von kognitiven und funktionellen Einbußen jedoch meist nur noch mit Unterstützung möglich ist. 40% der leicht bis mittelschwer Betroffenen weisen starke Probleme mit dem Kurzzeitgedächtnis, 30% mit dem prozeduralen Gedächtnis und 20% mit dem situativen Gedächtnis, das für die Orientierung sowie das Wiedererkennen von Personen verantwortlich ist, auf. Das Organisieren von Finanzen oder Medikamenten beispielweise ist lediglich für weniger als 10% der Betroffenen eigenständig zu bewerkstelligen. Der Grad der absoluten Abhängigkeit in diesen Domänen liegt teilweise sogar bei knapp 70% (Garms-Homolová, Notthoff, Declercq, van der Roest, Onder, Jónsson & van Hout, 2017). Der häufigste Grund für die Einweisung in ein Pflegeheim stellt jedoch das herausfordernde Verhalten dar, dass viele Angehörige überfordert (Afram, Stephan, Verbeek, Bleijlevens, Suhonen, Sutcliffe, Raamat, Cabrera, Soto, Hallberg, Meyer, Hamers, 2014). In Deutschland sind circa 34% der pflegenden Angehörigen leicht dementiell Erkrankter nebenbei auch noch berufstätig. Verschlechtert sich der gesundheitliche Zustand des Erkrankten jedoch, können nur noch wenige Angehörige ihr Arbeitsverhältnis aufrechterhalten (22%). Darüber hinaus sinkt mit zunehmender Pflegedauer die Wahrscheinlich einer Erwerbsbeteiligung. Zwischen

46% und 85% der Demenzpatienten weisen die Pflegestufe 2 oder 3 auf und benötigen somit eine 24-Stunden-Betreuung. Problematisch ist dabei jedoch, dass die kostenintensive Pflege dementiell Erkrankter immer noch zu einem großen Teil (75% bis 80% der Krankheitskosten) von den Privatpersonen getragen wird (Leicht & König, 2012). Speziell bei der Alzheimer-Krankheit treten bei mittelschwerem Krankheitsverlauf Kosten von bis zu knapp 29.000€ jährlich pro Patient auf. Dabei verteilen sich die Kosten auf direkte medizinische Kosten des Patienten (7.144€), direkte Pflegekosten des Patienten (3.194€), direkte medizinische Kosten des Pflegenden (2.655€) sowie informelle Pflegekosten (15.949€) (Boess, Lieb, Schneider, Zimmermann, Dodel & Belger, 2016). Frauen, die sich um einen Angehörigen kümmern und gleichzeitig erwerbstätig sind, weisen darüber hinaus in rund 33% der Fälle eine depressive Symptomatik auf (Schäufele, Köhler & Hendlmeier, 2016).

Das 2012 verabschiedete Familienpflegezeitgesetz sollte die nötigen Strukturen für eine verbesserte Versorgung schaffen, blieb jedoch hinter den Erwartungen zurück und wurde daher 2015 durch eine gemeinsame Reform des Pflegezeitgesetzes und des Familienpflegezeitgesetzes ergänzt. Doch auch diese Reform lässt einen Erfolg in der Verbesserung der Situation derzeit anzweifeln, da die vorgeschriebene Mindestarbeitszeit von 15 Stunden wöchentlich während einer 24-Stunden-Betreuung ebenfalls nicht umsetzbar ist. Das Gesetz zur Reduktion der Arbeitszeit, das für zwei Jahre möglich ist, lässt sich darüber hinaus nicht mit der Lebenserwartung der Betroffenen (3-6 Jahre) vereinbaren (Schäufele, Köhler & Hendlmeier, 2016). Nicht umsonst ist der Hauptgrund einer vorzeitigen Auflösung der häuslichen Pflege die Überlastung der Angehörigen (Luppa, Luck, Weyerer, König, Brähler & Riedel-Heller, 2010).

2.4. Auswirkungen von Demenz auf Krankenhausaufenthalt und Pflege

In deutschen Krankenhäusern geben 80% der Pflegekräfte an immer häufiger mit Demenzpatienten zu arbeiten. Lediglich 30% von ihnen fühlen sich hierfür jedoch ausreichend vorbereitet (Nock, Hielscher & Kirchen-Peters, 2013). Pflegekräfte berichten von erhöhtem Zeitaufwand in der Pflege kognitiv eingeschränkter Patienten aufgrund von häufigeren Komplikationen, Verweigerung von Unterstützung bei der Nahrungsaufnahme, Kommunikationsproblemen, Schlafstörungen oder Verweigerung von pflegerischen und medizinischen Handlungen (Hendlmeier, Bickel, Heßler-Kaufmann & Schäufele, 2019).

Ungeeignete Räumlichkeiten mit fehlenden Orientierungshilfen, mangelnde Beschäftigungsmöglichkeiten und Tagesstrukturen sowie starre Zeitvorgaben, die zu einem von Stress gekennzeichneten Aufenthalt führen, steigern Angst, Unsicherheit und fehlende Orientierung bei den Patienten und erhöhen somit das Risiko von Umherirren und herausforderndem Verhalten. Der Aufwand des Pflegepersonals wird somit ebenfalls erhöht, was häufig in einer starken psychischen Belastung für das Personal resultiert (Kirchen-Peters & Krupp, 2019). Die Betreuung der Patienten gestaltet sich häufig hochgradig herausfordernd, da circa 67% bis 88% der kognitiv eingeschränkten Patienten, je nach Schweregrad der Einschränkung, neben dieser Störung weitere nicht-kognitive Symptome wie nächtliche Unruhe, Umherirren und Aggressivität aufweisen.

Es verwundert daher nicht, dass Pflegekräfte die nervliche Belastung in der Betreuung von Demenzpatienten als doppelt so hoch einstufen wie in der Betreuung von Nicht-Demenzpatienten (Hessler, Schäufele, Hendlmeier et al., 2017).

2.5. Alltagsintegriertes, funktionelles Training

Die größten Barrieren älterer Menschen zur Aufnahme und Aufrechterhaltung eines Trainingsprogrammes liegen laut Studien im Zugang sowie benötigten Transportmöglichkeiten zu den zugehörigen Einrichtungen, die darüber hinaus die Motivation zunehmend negativ beeinflussen (Schutzer & Graves, 2004), mangelnder Bereitschaft im Gruppenformat zu trainieren (Burton, Khan & Brown, 2012), als auch in einem zu großen Zeitaufwand für strukturierte Programme (Cohen-Mansfield, Marx, & Guralnik, 2003). Aus dieser Problematik heraus gewinnen sogenannte alltagsintegrierte Trainingsformate in den letzten Jahren zunehmend an Bedeutung (Bauman, Merom, Bull, Buchner & Fiatarone Singh, 2016) und konnten darüber hinaus mit unterschiedlichen Zielsetzungen gute Ergebnisse erreichen. Eine spezifizierte Form dieses Trainings ist das funktionelle Training, das in den Alltag seiner Teilnehmer integriert wird und somit das Ziel der Nachhaltigkeit stärker in den Fokus rückt (Clemson, Singh, Bundy, Cumming, Weissel, Munro, Manollaras & Black, 2010; Clemson, Fiatarone Singh, Bundy, Cumming, Manollaras, O'Loughlin & Black, 2012). Funktionelles Training erhöht seine Effektivität mit steigender spezifischer Anpassung auf individuelle Bedürfnisse und Ziele der Teilnehmer. Das Ziel dieses funktionellen, alltagsintegrierten Trainings ist dabei in erster Linie die Steigerung der körperlichen Aktivität (Liu, Shiroy, Jones & Clark, 2014). Im Mittelpunkt dieser Trainingsprogramme liegen derzeit als zentrale Komponenten der Funktionalität und ihrer Aufrechterhaltung Kraft- und Gleichgewichtsübungen, die unverzichtbar sind für Selbständigkeit im Alter (Sherrington, Michaleff, Fairhall, Paul, Tiedemann, Whitney, Cumming, Herbert, Close & Lord, 2016), welche jedoch nur von einem Bruchteil der älteren Bevölkerung momentan trainiert werden (Kraft: 12% & Balance: 6% der über 65-Jährigen) (Merom, Pye, Macniven, van der Ploeg, Milat, Sherrington, Lord & Bauman, 2012).

Die Forschungsgruppe um Lindy Clemson befasst sich bereits seit Längerem mit diesem Trainingsformat und entwickelte im Verlauf ihrer Arbeit das *„Lifestyle-integrated functional Exercise“* (LiFE)-Programm (2010, 2012). Dieses Programm beinhaltet spezifische Kraft- sowie Gleichgewichtsübungen, die gezielt in den Alltag der Trainierenden integriert werden, um somit Routinen als regelmäßige und widerkehrende Trainingsgelegenheiten zu nutzen. Durch den Bezug zu Alltagsroutinen werden weder zusätzliche Trainingszeiten noch besondere Trainingsorte benötigt. So findet die Durchführung der jeweiligen Übung beispielsweise

während der Badezimmerroutine (Tandemstand während des Zähneputzens) oder der Küchenarbeit (Kniebeuge während des Ausräumens des Geschirrspülers) statt.

Mittels eines Verhaltensänderungskonzeptes soll die Nachhaltigkeit des Programmes ermöglicht werden, da sich in alltägliche Routinen integrierte Übungen zu einem Automatismus entwickeln sollen, der regelmäßig und dauerhaft angewandt wird und somit eine Verhaltensänderung nach sich zieht (Clemson, Munro, & Singh, 2014). Dieses Programm konnte nicht nur in der ursprünglichen Zielgruppe der eingeschränkten und bereits gebrechlichen über 75-Jährigen positive Ergebnisse hinsichtlich Kraft-, Gleichgewichtsfähigkeit und einer reduzierten Sturzrate vorweisen (Clemson, Singh, Bundy et al., 2010; Clemson, Fiatarone Singh, Bundy et al., 2012; Burton, Lewin, & Clemson, 2014; Burton, Lewin, Clemson, & Boldy, 2013; Burton, Lewin, Clemson, & Boldy, 2014), sondern auch in der Zielgruppe der 60- bis 70-Jährigen positive Ergebnisse hinsichtlich der Prävention und Beibehaltung eines gesunden Lebensstils erzielen (Schwenk, Bergquist, Boulton, Van Ancum, Nerz, Weber, Barz, Jonkman, Taraldsen, Helbostad, Vereijken, Pijnappels, Maier, Zhang, Becker, Todd, Clemson & Hawley-Hague, 2019).

Bewegungsansätze sollten speziell für Demenzpatienten konzipiert sein, um als erfolgversprechend zu gelten. Nicht nur eine adäquate Kommunikation, sondern auch die Möglichkeit der individuellen Anpassung der Übungsintensität sowie eine Supervision sollte bei einem Training mit dieser Zielgruppe berücksichtigt werden. Die Übungen sollten in regelmäßigen Wiederholungen zum Einsatz kommen und im optimalen Fall sowie im Sinne der Nachhaltigkeit auch Angehörige und Laien involvieren (Dutzi, Werner, Hauer, 2014). So kann das Programm auch in seiner Fortsetzung über rehabilitative Angebote hinaus gesichert werden. Das alltagsintegrierte Training bietet die Möglichkeit dieser Charakteristika eines Übungsprogrammes und kann sowohl bereits in der Prävention als auch in der Rehabilitation eingesetzt werden. Darüber hinaus ist es allein als auch komplementär zu strukturierten Programmen in stationären Einrichtungen vermittelbar. Trainern kommt hierbei hinsichtlich des motivationalen als auch des unterstützenden Aspekts eine besondere Rolle zu (Boulton, Weber, Hawley-Hague, Bergquist, Van Ancum, Jonkman, Taraldsen, Helbostad, Maier, Becker, Todd, Clemson & Schwenk, 2019). Durch seine Niedrigschwelligkeit könnte es nach einer Schulung jedoch auch durch Laien unterstützt werden. Darüber hinaus bedarf es keines materiellen oder zeitlichen Zusatzaufwandes. Es wäre ebenso als Präventionsmaßnahme gegen den Verlust der Mobilität sowie zur Steigerung der körperlichen Aktivität in diversen Umgebungen und Ziel-

gruppen denkbar. In der Zielgruppe der 60- bis 70-Jährigen konnte bereits beobachtet werden, wie sedentäres Verhalten durch das Programm reduziert wurde (Schwenk, Bergquist, Boulton et al., 2019).

Durch Unterstützung in Form von Angehörigen in Besuchssituationen sowie Pflege- oder medizinisches Personal bei täglichen Routinemaßnahmen könnte dieser Ansatz seine Anwendung finden und sedentäres Verhalten während eines Krankenhausaufenthaltes reduzieren. Bilateral sollte der Ansatz der Verhaltensänderung nicht ausschließlich auf den Patienten, sondern auch auf die im Kontakt stehenden Personen abzielen. Übungen könnten dementsprechend über Auslöser für alle Beteiligten getriggert werden, um auf diese Weise zu einer Bewegungsausführung zu motivieren.

Es wurde jedoch noch kein Versuch unternommen diesen Trainingsansatz im klinischen Alltag, speziell bei kognitiv eingeschränkten Patienten, als Ansatz der Steigerung der körperlichen Aktivität während des Krankenhausaufenthaltes mit dem Ziel der bestmöglichen Beibehaltung körperlicher Kapazität zu testen.

2.6. Demenz und Motorik

Eine intakte Basismotorik stellt eine zentrale Komponente in der Bewältigung des Alltages hinsichtlich der Selbstständigkeit älterer Personen dar (Werner, Dutzi & Hauer, 2014). Diese ist jedoch, ebenso wie funktionelle Alltagsleistungen, von einem Verlust geprägt und ist bei Demenzpatienten neben motorischen Fehlleistungen ein typisches Krankheitsmerkmal (Schwenk, Oster & Hauer, 2008). Denn der Abbau funktionell-motorischer Leistungen ist neben kognitiven Einschränkungen ein weiteres Merkmal der dementiellen Erkrankung (Sheridan, Solomont, Kowall & Hausdorff, 2003). Speziell Gangapraxie, Bradykinesie, Steifheit, Tremor und diverse Gangstörungen sind bekannt (Camicioli, Howieson, Oken, Sexton & Kaye, 1998; Scarmeas, Albert, Brandt, Blacker, Hadjigeorgiou, Papadimitriou, Dubois, Sarazin, Wegesin, Marder, Bell, Honig & Stern, 2005). Nicht umsonst führen diese Einschränkungen am häufigsten zu Pflegebedürftigkeit und sind ein stärkerer Einflussfaktor in der Einschränkung der Aktivitäten des täglichen Lebens als die kognitive Komponente (Njegovan, Hing, Mitchell & Molnar, 2001).

Bei Demenzpatienten ist darüber hinaus das Sturzrisiko aufgrund von Gang- und Balancestörungen (Allan, Ballard, Burn & Kenny, 2005) um ein Vielfaches höher als bei Nicht-Demenzpatienten (Lord, Sherrington & Menz, 2001) und gilt als einer der häufigsten Einweisungsgründe in ein Krankenhaus (Pinkert & Holle, 2012). Aufgrund von Veränderungen im Bewegungsverhalten, wie eine verkürzte Schrittlänge oder eine verlängerte *support time* des Fußes (Zeit, wenn beide Füße beim Gehen gleichzeitig den Boden berühren), kommt es häufig zu einem verlangsamten Gang (Van Iersel, Hoefsloot, Munneke, Bloem & Olde Rikkert, 2004). Gangveränderungen gelten daher schon länger als ein Frühindikator einer Demenzerkrankung (Jamour, Becker, Synofzik & Maetzler, 2012). Räumlich-zeitliche Störungen der Bewegungskontrolle werden darüber hinaus auch in Transfersituationen deutlich. Mangelnde Muskelkraft und fehlerhafte Bewegungsabläufe resultieren auch bei dieser Bewegung in einem erhöhten Sturzrisiko (Tinetti, Speechley & Ginter, 1988). So ergeben sich durch unterschiedliche Problematiken in der Motorik starke Einschränkungen in der mobilitätsabhängigen Lebensqualität, die mit einem hohen Verletzungsrisiko einhergehen.

2.6.1. Zusammenhang von kognitiven und motorischen Leistungen

Kognitive Einschränkungen im Verarbeitungsprozess sowie krankheitsbedingte Veränderungen der Hirnstrukturen haben einen enormen Effekt auf die motorischen Leistungen von Menschen. Speziell bei Demenzpatienten führt dies zu fatalen Konsequenzen. Um den Gang sicher durchführen zu können, sind neben motorischen Fähigkeiten auch Aufmerksamkeits- und Exekutivfunktionen nötig. Kommt es in diesen Prozessen zu einer Fehlverarbeitung, beispielsweise aufgrund einer Überforderung durch *dual-task* Aufgaben (kognitive und motorische Aufgabe zur selben Zeit), ist die Fähigkeit, angemessen zu agieren beziehungsweise zu reagieren, eingeschränkt und die motorische Leistung lässt nach, im schlimmsten Falle bis hin zu einem Sturz (Hauer, Marburger & Oster, 2002; Sheridan, Solomont, Kowall & Hausdorff, 2003, Beauchet & Berrut, 2006; Verghese, Buschke, Viola, Katz, Hall, Kuslansky & Lipton, 2002). Studien konnten zeigen, dass *dual-task* Aufgaben geeignet sind, um Dysfunktionen des Frontal- oder Temporallappens zu erkennen und somit als frühzeitiges klinisches Mittel in der Demenzdiagnostik eingesetzt werden können (Jamour, Becker, Synofzik & Maetzler, 2012). Darüber hinaus ist mittlerweile bekannt, dass diese gleichzeitige Verarbeitung von kognitiven und motorischen Aufgaben bei Demenzpatienten zu einem gewissen Maß trainierbar ist (Schwenk, Zieschang, Oster & Hauer, 2010b).

Das Gehen findet durch subkortikale und spinale Kontrolle statt und weist einen automatischen beziehungsweise impliziten und rhythmischen Charakter auf, der bei gesunden Erwachsenen nur begrenzte Aufmerksamkeit des motorischen prozeduralen Gedächtnisses erfordert (Dubost, Annweiler, Aminian, Najafi, Herrmann & Beauchet, 2008; Nutt, Marsden & Thompson, 1993). Bei Demenzpatienten ist die Aufmerksamkeitskontrolle der Exekutivfunktionen jedoch beeinträchtigt (Baddeley, Baddeley, Bucks & Wilcock, 2001). Dysfunktion in den Bereichen des Temporal- oder Frontallappens verursachen motorische Beeinträchtigungen wie sie bei Demenzpatienten häufig in Erscheinung treten. Gangstörungen, die besonders bei dual-task Aufgaben auffallen, hängen bei Demenzpatienten also häufig mit einer Störung im Fronttallappen zusammen. Die stärkste Form der Gangstörung ist die Gangapraxie, welche auf eine gestörte Gang- und Haltungskontrolle zurückzuführen ist. Eine temporale Atrophie sowie eine Beeinträchtigungen der Basalganglien und Großhirnrinde, des Hippocampus sowie des Thalamus und der subkortikalen weißen Substanz können bei Demenzpatienten somit für

kognitive als auch motorische Defizite sorgen (Nutt, Marsden & Thompson, 1993; Scherder, Eggermont, Swaab, van Heuvelen, Kamsma, de Greef, van Wijck & Mulder, 2007).

2.6.2. Demenz und körperliche Aktivität

Caspersen und Kollegen definieren körperliche Aktivität als jede von der Skelettmuskulatur erzeugte Körperbewegung, die zu einem Energieaufwand führt. Im täglichen Leben kann diese in ganz verschiedenen Bereichen wie beispielsweise im Beruf, Sport oder auch Haushalt stattfinden. Als Übung ist dabei eine Teilmenge der körperlichen Aktivität, die geplant, strukturiert und wiederholt stattfindet, zu verstehen und die als lang- oder auch kurzfristiges Ziel die Verbesserung oder Erhaltung der körperlichen Fitness hat (Caspersen, Powell & Christenson, 1985). Bei Demenzpatienten sind bereits die Aktivitäten des täglichen Lebens eingeschränkt. Wie Brown und Kollegen zeigen konnten, weisen beispielsweise über 97% der Alzheimer-Patienten bereits im Anfangsstadium Einschränkungen in einer oder mehr Aktivitäten des Alltags auf. Dabei sind bis zu 66,3% der Patienten auf Hilfe einer weiteren Person angewiesen. Zurückzuführen sind diese Einschränkungen den Autoren zufolge auf ein reduziertes hippocampales sowie entorhinales Kortexvolumen, eine verminderte Verarbeitungsgeschwindigkeit sowie eine verschlechterte Gedächtnisleistung. Mit zunehmender Einschränkung in den alltäglichen Aktivitäten ist zudem eine zunehmende Verschlechterung der Gedächtnis- und Verarbeitungsgeschwindigkeit sowie eine zunehmende mediale temporale Atrophie zu beobachten (Brown, Devanand, Liu & Caccappolo, 2011).

Demenzpatienten sind selten in Bewegungsprogramme involviert und so sind die Aktivitäten des täglichen Lebens häufig die einzig stattfindende Bewegungsmaßnahme. Treten hierbei Einschränkungen auf, verfallen die Patienten in inaktives und sedentäres Verhalten. Ergänzt wird dies durch eine ständige Abhängigkeit von weiteren Personen. Ein Blick auf die Hierarchie des Verlusts der Fähigkeiten der alltäglichen Aufgaben verdeutlicht, dass im Bereich der Grundaktivitäten des täglichen Lebens moderat kognitiv eingeschränkter Patienten (*basic activities of daily living* = BADL) zunächst die der persönlichen Hygiene verloren geht, gefolgt von dem eigenständigen An- und Auskleiden sowie dem Toilettengang. Anschließend verlieren die Patienten die Fähigkeit des selbständigen Transfers sowie der Bettmobilität. Schließlich werden die allgemeine Fortbewegung und das Essen impraktikabel (Carpenter, Hastie, Morris, Fries & Ankri, 2006). Und auch im Hinblick auf die instrumentalisierten Aktivitäten des täglichen Lebens (*instrumented activities of daily living* = IADL) ist eine Hierarchie er-

kennbar. Nach dem Verlust der Kochfähigkeit, verlieren sich die eigenständige Fähigkeit, Finanzen, den Haushalt oder den Einkauf zu organisieren und durchzuführen. Gefolgt sind diese Einbußen von dem Verlust die Medikamenteneinnahme selbstständig handzuhaben. Die stärksten negativen Auswirkungen sind bei Patienten mit einem Mini Mental State Test (MMST) Ergebnis von 16 Punkten zu finden (Feldman, Van Baelen, Kavanagh & Torfs, 2005). Der Verlust der Funktionalität bedeutet somit auch den Verlust der Selbständigkeit und Autonomie.

Werden Demenzpatienten in ein Krankenhaus eingeliefert, verändert sich darüber hinaus ihr gesamter Tagesablauf und täglich notwendige Routinen sind nicht länger vorhanden. Dies hat erneute Konsequenzen in dem körperlichen Verhalten der Erkrankten. Zu beobachten sind dann häufig unangemessene Verhaltensweisen, Umherwandern und Agitiertheit, aber auch Apathie sowie zirkadiane Rhythmusstörungen (Lyketsos, Carrillo, Ryan, Khachaturian, Trzepacz, Amatniek, Cedarbaum, Brashear & Miller, 2011). Die Schrittanzahl von Demenzpatienten auf einer deutschen Akutstation variiert in einer enorm großen Spanne (794 – 13.885 Schritte) und weist im Durchschnitt circa 6.000 Schritte auf. Darüber hinaus sind Agitiertheit und Aggression die am häufigsten auftretenden neuropsychiatrischen Symptome (*Behavioural and Psychological Symptoms of Dementia* = BPSD). Doch auch Apathie ist ein häufig auftretendes Problem. Die Inaktivität der Patienten, in der sie lediglich liegen oder inaktiv sitzen oder stehen, erstreckt sich über fast 22 Stunden beziehungsweise 91% täglich (Fleiner, Gersie, Ghosh, Mellone, Zijlstra & Haussermann, 2019). Die Negativkonsequenzen eines solch inaktiven Verhaltens werden nachfolgend thematisiert.

2.6.3. Sedentäres Verhalten und seine Negativkonsequenzen

Körperlich inaktives Verhalten bewirkt enorme Negativkonsequenzen für den Gesundheitszustand eines Menschen bis hin zu einem deutlich erhöhten Mortalitätsrisiko (Ekelund, Tarp, Steene-Johannessen, Hansen, Jefferis, Fagerland, Whincup, Diaz, Hooker, Chernofsky, Larson, Spartano, Vasan, Dohrn, Hagströmer, Edwardson, Yates, Shiroma, Anderssen & Lee, 2019). Speziell während eines Krankenhausaufenthaltes hat sedentäres Verhalten in Form eines hohen Anteils an Bettlägerigkeit, die zum Teil verursacht wird durch Medikamentisierung und Iatrogenität, fatale Auswirkungen für ältere Menschen. Kortebein und Kollegen konnten zeigen, dass bereits 10 inaktive Tage, die von bettlägerigem Verhalten gekennzeichnet sind, bei gesunden Älteren über 65 Jahre eine signifikante Verschlechterung der Kraftwer-

te in den unteren Extremitäten, die unter anderem zum Treppensteigen benötigt werden, verursachen. Auch die aerobe Kapazität reduzierte sich signifikant und die Motivation zur freiwilligen körperlichen Aktivität nahm ebenfalls ab, während die inaktiv verbrachte Zeit anstieg (Kortebein, Symons, Ferrando, Paddon-Jones, Ronsen, Protas, Conger, Lombeida, Wolfe & Evans, 2008). Eine weitere Studie mit gesunden über 60-Jährigen konnte bereits nach 5 Tagen Bettlägerigkeit einen signifikanten Verlust in der fettfreien Masse der Beine sowie der Streckkraft der Knie nachweisen (Moreira, Wohlwend, Åmellem & Jannig, 2016). Die Auswirkungen auf die unteren Extremitäten sowie das Ausdauersystem sind demnach gravierend. Es verwundert daher nicht, dass 40% der älteren Patienten nach einer Akutstationierung von einer Verschlechterung in den Fähigkeiten der Aktivitäten des täglichen Lebens berichten, von denen sie sich auch ein Jahr nach Entlassung aus dem Krankenhaus nicht erholt haben und die langfristige Folgen in Form von Mobilitätseinschränkungen verursachen (Boyd, Landefeld, Counsell et al., 2008; Gill, Gahbauer, Murphy, Han & Allore, 2012).

Ebenso steigt die Wahrscheinlichkeit einer Einweisung in eine Langzeitpflegeeinrichtung (Brown, Friedkin & Inouye, 2004). Die Problematik des sedentären und inaktiven Verhaltens scheint dabei nicht einmal an die Gehfähigkeit der Patienten geknüpft zu sein, denn trotz Vorhandensein dieser, verdeutlichen Untersuchungen die Inaktivität älterer Patienten während eines Krankenhausaufenthaltes, die bei längeren Aufenthalten sogar noch größer ausfällt als bei kürzeren Aufenthalten (Fisher, Goodwin, Protas, Kuo, Graham, Ottenbacher & Ostir, 2011). Ein weiterer Aspekt, der einen Funktionalitätsverlust begünstigt, ist eine unzureichende Nahrungsaufnahme während einer Akuthospitalisierung (Sullivan, Sun & Walls, 1999). Wie zuvor beschrieben ist diese eigenständige Nahrungsaufnahme bei Demenzpatienten jedoch häufig bereits stark eingeschränkt und so setzen sich während eines Krankenhausaufenthaltes diverse Faktoren wie Inaktivität, sedentäres Verhalten, mangelnde Nahrungszufuhr, fehlende Motivation, ein belastendes Umfeld in Form einer ungewohnten Umgebung und eine begrenzte Funktionalität zu einem weiteren Verlust von Mobilität und damit einhergehender Lebensqualität zusammen. Dies endet bei Demenzpatienten daher deutlich häufiger in der Institutionalisierung in einer Langzeitpflegeeinrichtung, vermehrten Krankenkausaufenthalten oder dem Tod (Motzek, Junge & Marquardt, 2017).

Diverse Untersuchungen konnten jedoch die Trainierbarkeit und das Rehabilitationspotenzial dieser Patientengruppe aufzeigen (Hauer, Schwenk, Zieschang et al., 2012; Schwenk, Zieschang, Englert, Grewal, Najafi & Hauer K, 2014). Es ist darüber hinaus bekannt, dass

Demenzpatienten mit einer gesteigerten körperlichen Aktivität während ihres Krankenhausaufenthaltes bessere Mobilitätswerte bei Entlassung aufweisen als inaktive Patienten (Brown, Foley, Lowman Jr, MacLennan, Razjouyan, Najafi, Locher & Allman, 2016; Karlsen, Loeb, Andersen, Joergensen, Scheel, Turtumoeygard, Perez, Kjaer & Beyer, 2017). Aufgrund von speziellen Anforderungen eines Bewegungsprogrammes für Demenzpatienten stellen sich diese Interventionen jedoch häufig als ressourcenintensiv heraus und wurden bisher trotz ihrer erzielten positiven Effekte aufgrund der Kosten- und Personalintensität nicht flächendeckend implementiert.

3. Fragestellungen

Um für den Projektverlauf eine bisher in Studien zu alltagsintegriertem Training unterrepräsentierte Zielgruppe zu definieren, wurde zunächst eine systematische Literaturrecherche durchgeführt. Darauf aufbauend wurde die Zielgruppe geriatrischer, dementiell erkrankter Akutpatienten gewählt und eine Pilotstudie zur Überprüfung von Machbarkeit und Akzeptanz geplant.
Um die gewählte, vulnerable und multimorbide Patientengruppe jedoch nicht zu überfordern, wurde entschieden diese erste Testung zunächst mit physisch stabilen Demenzpatienten der geriatrischen Rehabilitation durchzuführen. Im Anschluss daran wurden mittels der erlangten Ergebnisse Anpassungen der Übungen vorgenommen, ehe diese mit Demenzpatienten der Akutgeriatrie getestet wurden.
Da es sich darüber hinaus um einen integrierten Trainingsansatz handelt, mussten Tagesstrukturen und Routinen der Akutstation analysiert und Gründe sowie Auslöser für körperliche Inaktivität der benannten Zielgruppe erfasst und dargestellt werden.

<u>Im Rahmen des diaLiFE-Projektes wurden folgende Fragestellungen bearbeitet:</u>

- Inwieweit sind alltagsintegrierte Trainingsprogramme umsetzbar und effektiv? (Manuskript 1)
- Welche Zielgruppe ist mit Hinblick auf alltagsintegrierte Trainingsprogramme unterrepräsentiert? (Manuskript 1)
- Sind die Übungen des LiFE-Programmes mit kognitiv eingeschränkten Rehabilitationspatienten sicher durchführbar und werden diese von den Patienten verstanden und akzeptiert? (Manuskript 2)
- Wie sollten Messinstrumente ausgewählt werden, um Ergebnisse einer frührehabilitativen Intervention bei geriatrischen Akutpatienten möglichst reliabel und valide abzubilden? (Manuskript 3)
- Welche Faktoren beeinflussen die körperliche Aktivität geriatrischer, kognitiv eingeschränkter Akutpatienten während ihres Krankenhausaufenthalts? (Manuskript 4)
- Sind die neu adjustierten diaLiFE-Übungen mit kognitiv eingeschränkten Patienten in der Akutstation durchführbar? (unveröffentlicht)

- Wie gestaltet sich die körperliche Aktivität dementiell erkrankter Patienten auf einer geriatrischen Akutstation? (unveröffentlicht)

Nachfolgend stellen die zusammengefassten Manuskripte die Ergebnisse der durchgeführten Studien dar. Im Anhang dieser Dissertationsschrift finden sich die thematisierten und publizierten Originalmanuskripte.

4. Liste der eingereichten wissenschaftlichen Veröffentlichungen

Manuskript 1:

*Weber, M., **Belala, N**., Clemson, L., Boulton, E., Hawley-Hague, H., Becker, C. & Schwenk, M. (2018). Feasibility and Effectiveness of Intervention Programmes Integrating Functional Exercise into Daily Life of Older Adults: A Systematic Review. Gerontology. 64(2):172-187.*

Manuskript 2:

***Belala, N.**, Schwenk, M., Kroog, A. & Becker, C. (2019). Feasibility of the lifestyle integrated functional exercise concept in cognitively impaired geriatric rehabilitation patients. Z Gerontol Geriatr. Feb;52(1):61-67.* (Projektnummer: 335/2017BO1)

Manuskript 3:

*Heldmann, P., Werner, C., **Belala, N.**, Bauer, J.M. & Hauer, K. (2019). Early inpatient rehabilitation for acutely hospitalized older patients: a systematic review of outcome measures. BMC Geriatr. Jul 9;19(1):189.*

Manuskript 4:

***Belala, N.**, Maier, C., Heldmann, P., Schwenk, M. & Becker, C. (2019). A pilot observational study to analyze (in)activity and reasons for sedentary behavior of cognitively impaired geriatric acute inpatients. Z Gerontol Geriatr. Nov;52 (Suppl 4):273-281.* (Projektnummer: 881/2018BO2)

4.1. Systematische Analyse der Machbarkeit und Effektivität von alltagsintegriertem Training

Manuskript 1: *Weber, M., **Belala, N**., Clemson, L., Boulton, E., Hawley-Hague, H., Becker, C. & Schwenk, M. (2018). Feasibility and Effectiveness of Intervention Programmes Integrating Functional Exercise into Daily Life of Older Adults: A Systematic Review. Gerontology. 64(2):172-187.*

Hintergrund und Zielsetzung

Herkömmlicherweise finden Trainingsprogramme zur Sturzprävention und Verbesserung der körperlichen Fähigkeiten in strukturierten Einheiten statt. Ein alternativer Ansatz der Integration von funktionalen Trainingsübungen in alltägliche Routinen gewinnt jedoch seit ein paar Jahren zunehmend an Bedeutung. Das Ziel dieser systematischen Übersichtsarbeit ist es, die Evidenz bezüglich Machbarkeit und Effektivität solcher lebensstilintegrierter Interventionsprogramme zusammenfassend darzustellen.

Methodik

Eine systematische Literaturrecherche mit folgenden Einschlusskriterien der gefunden Artikel wurde durchgeführt: (1) Teilnehmer ≥60 Jahre; (2) Interventionsstudien mit und ohne randomisiert-kontrolliertem Studiendesign (RCT & NRS); (3) Verwendung eines lebensstilintegrierten Ansatzes; (4) Verwendung funktioneller Übungen zur Verbesserung von Kraft, Gleichgewicht oder körperlicher Funktionalität; und (5) mit berichteten Ergebnissen hinsichtlich Machbarkeit und/oder Effektivität. Die methodische Qualität der RCTs wurde mittels der PEDro Skala evaluiert.

Ergebnisse

In sechs Datenbanken konnten 4.415 Artikel gefunden werden. Davon erfüllten 14 Studien, darunter 6 RCTs, die Einschlusskriterien. Die Qualität der RCT Studien variierte dabei von mittelmäßig bis gut. Die Interventionskonzepte beinhalteten (1) das „*Lifestyle-integrated Functional Exercise*“ (LiFE) Programm, das Übungen in alltägliche Aktivitäten integriert, sowie (2) kombinierte Programme, die den integrierten als auch strukturierten Trainingsansatz verwenden. Drei RCTs untersuchten das LiFE Programm mit Teilnehmern aus der Kommune

und berichteten von signifikanten Verbesserungen in Kraft, Gleichgewicht und körperlicher Performance im Vergleich zu Kontrollgruppen, die entweder keinerlei Intervention oder Übungen mit niedriger Intensität oder strukturiertem Training erhielten. Zwei dieser randomisiert-kontrollierten Studien berichteten darüber hinaus von einer signifikanten Reduzierung der Sturzrate verglichen mit den Kontrollgruppen ohne jegliche Intervention, beziehungsweise mit Übungen von niedriger Intensität. Drei RCTs verglichen kombinierte Programme aus strukturiertem und integriertem Training mit der Regelversorgung in institutionalisierter Umgebung und berichteten von Verbesserungen für einige (Gleichgewicht, Funktionalität), jedoch nicht alle (Kraft, Sturzrate) Outcome-Parameter. Nicht-randomisiert-kontrollierte Studien konnten eine Verhaltensänderung in Bezug auf das LiFE-Programm sowie eine erhöhte Machbarkeit in eingeschränkteren Zielgruppen zeigen. Eine NRS verglich ein kombiniertes Programm für zu Hause mit einem strukturierten Programm in einer Sporthalle und berichtete von einer besseren Nachhaltigkeit des kombinierten Programmes für zu Hause.

Diskussion

Diese Übersichtsarbeit bietet Evidenz hinsichtlich der Effektivität von integrierten Trainingsprogrammen zur Verbesserung der körperlichen Funktionalität von älteren Menschen. Dabei weisen einzelne Studien einen Vorteil integrierten Trainings im Vergleich zu strukturiertem Training auf. Kombinierte Programme wurden darüber hinaus in institutionalisierter Umgebung positiv erprobt, während nur wenig Evidenz in anderen Zielgruppen vorhanden ist. Zusammenfassend kann also festgehalten werden, dass der Ansatz des alltagsintegrierten funktionellen Trainings eine erfolgsversprechende Alternative beziehungsweise Ergänzung zu strukturierten Trainingsprogrammen darstellt. Dennoch sind weitere RCTs nötig, um dieses Konzept sowie eine angestrebte dauerhafte Verhaltensänderung auch in weiteren Zielgruppen zu evaluieren.

4.2. Testung der Machbarkeit und Akzeptanz von alltagsintegriertem Training mit kognitiv eingeschränkten Patienten der geriatrischen Rehabilitation

Manuskript 2: ***Belala, N.**, Schwenk, M., Kroog, A. & Becker, C. (2019). Feasibility of the lifestyle integrated functional exercise concept in cognitively impaired geriatric rehabilitation patients. Z Gerontol Geriatr. Feb;52(1):61-67.* (Projektnummer: 335/2017BO1)

Hintergrund und Zielsetzung

Die Zahl geriatrischer Patienten, die für eine stationäre Behandlung in Krankenhäuser eingewiesen werden, steigt aufgrund der alternden Gesellschaft zunehmend an. Bis zu 40% der Patienten weisen zusätzlich zu ihrem hauptsächlichen Einweisungsgrund eine kognitive Einschränkung auf. Aufgrund der Problematik der Immobilität während eines Krankenhausaufenthalts, die zu rapiden Verschlechterungen des physischen und kognitiven Zustandes speziell in dieser Zielgruppe führt, ist der Bedarf geeigneter Ansätze zur Prävention des Verlusts körperlicher Fähigkeiten dringend notwendig. Der Verlust körperlicher Fähigkeiten geht meist mit einem abhängigen Lebensstil einher und steigert somit die Pflegebedürftigkeit der Patienten sowie das Risiko einer Einweisung in eine Langzeitpflegeeinrichtung, das bei Patienten mit kognitiver Einschränkung um das Dreifache erhöht ist. Für kognitiv eingeschränkte Patienten gestalten sich die Anforderungen an ein Trainingsprogramm jedoch etwas anders als bei kognitiv gesunden Patienten. Strukturierte Trainingsprogramme weisen dabei sehr häufig einen enorm hohen Ressourcenaufwand auf und sind somit nicht nur personal-, sondern auch kostenintensiv. Alle Patienten trotz der steigenden Zahlen angemessen versorgen zu können, wird daher eine zunehmend größere Herausforderung. Das „*Lifestyle-integrated Functional Exercise*“ (LiFE) Programm, entwickelt von australischen Ergotherapeuten, integriert Übungen zum Training von Kraft und Gleichgewicht in Aktivitäten des täglichen Lebens und konnte bereits vielversprechende Ergebnisse bei über 70-Jährigen zu Hause lebenden Teilnehmern mit Sturzneigung erzielen. Dieser neue Ansatz bietet somit eine vielversprechende Alternative zu strukturierten Trainingsprogrammen. Im Rahmen dieser Pilotstudie sollten daher zunächst die Machbarkeit, Akzeptanz und empfundene Sicherheit der Übungen des

LiFE-Programmes auf der geriatrischen Rehabilitation, speziell mit kognitiv eingeschränkten Patienten, getestet werden.

Methodik

Eine Stichprobe von 20 kognitiv mittelschwer eingeschränkten Rehabilitationspatienten (Durchschnittsalter: 84,5 Jahre, durchschnittlicher DemTect-Wert: 8,3 Punkte) testete die Machbarkeit und Akzeptanz der LiFE-Übungen. Hierbei berücksichtigt wurden die Dauer der Übungen, das Empfinden der Übungen als angenehm beziehungsweise unangenehm sowie die Durchführbarkeit der einzelnen Übungen. Die Teilnehmer wurden darüber hinaus hinsichtlich empfundener Schwierigkeit und Sicherheit während der Übungen sowie einem möglichen Nutzen der Kraft- und Gleichgewichtsübungen befragt. Um die Ergebnisse mit der Mobilitätskapazität der Probanden in Verbindung setzen zu können, wurde darüber hinaus die Short Physical Performance Battery (SPPB) erhoben.

Ergebnisse

Die Testung wies für jede der einzelnen Übungen Bodeneffekte auf. Zwei der getesteten Übungen (über Gegenstände steigen, Fersengang) waren für über die Hälfte der Teilnehmer zu schwierig und auch mit Unterstützung durch einen Therapeuten nicht durchführbar. Die Rate der Bodeneffekte der übrigen Übungen variierte zwischen 20% und 40%. Lediglich eine Übung (aus dem Sitz in den Stand) wies eine niedrige Bodeneffektrate auf und war für 95% der Teilnehmer umsetzbar. Diese Ergebnisse waren stimmig mit den Ergebnissen der SPPB-Messung, die mit einem unterdurchschnittlichen Wert für diese Zielgruppe auf Gleichgewichts- und Kraftdefizite der Probanden hinwies. Hinsichtlich Zufriedenheit, Sicherheit und empfundenem Nutzen der LiFE-Übungen lagen die Werte durchgängig über 3,5 (5-Punkte Likert-Skala) und wiesen somit positive Ergebnisse auf. Lediglich die Frage der empfundenen Schwierigkeit wurde mit durchschnittlich 2,9 Punkten (5-Punkte Likert-Skala) bewertet und untermauert die gefundenen Bodeneffekte der Übungen, die sich als zu schwierig herausstellten.

Diskussion

Körperliches Training, speziell Kraft- und Gleichgewichtstraining sind für ältere Menschen

unerlässlich, wenn das Ziel der Erhalt einer bestmöglich selbstständigen Lebensweise ist. Für diese Gruppe von kognitiv mittelschwer eingeschränkten Rehabilitationspatienten waren alle Übungen zu schwierig und benötigten Supervision oder sogar körperliche Unterstützung durch einen Therapeuten und konnten dennoch nicht durchgängig durchgeführt werden. Eine Anpassung der LiFE-Übungen ist daher zunächst zwingend notwendig ehe über ihren Einsatz oder eine weitere Testung in dieser Umgebung und in dieser Zielgruppe oder noch vulnerableren Zielgruppen wie Akutpatienten nachgedacht werden kann. Die Akzeptanz und empfundene Sicherheit der Übungen lag jedoch im positiven Bereich und spricht für die Eignung dieses Ansatzes, der auch als transsektorales Modell eines Bewegungsprogrammes möglich ist und somit ebenfalls auch auf Nachhaltigkeit ausgelegt wäre. Die Bekanntheit der Übungen könnte in angemessenem Schwierigkeitsgrad zu einer gesteigerten Adhärenz führen und die Motivation der Patienten sich in diesem Programm zu engagieren steigern. Darüber hinaus ist der Bedarf an Bewegungsprogrammen mit einem frühestmöglichen Beginn für alle stationären Patienten, unabhängig von ihrem OPS (Operationen- und Prozedurenschlüssel)-Status (Komplex- vs. Nicht-Komplexbehandlung), enorm. Ein in die alltägliche Routine integriertes Programm wie das LiFE-Programm könnte den genannten Ansprüchen nachkommen.

4.3. Systematische Analyse von Messverfahren während der Frührehabilitation auf der geriatrischen Akutstation

Manuskript 3: *Heldmann, P., Werner, C., **Belala, N.**, Bauer, J.M. & Hauer, K. (2019). Early inpatient rehabilitation for acutely hospitalized older patients: a systematic review of outcome measures. BMC Geriatr. Jul 9;19(1):189.*

Hintergrund und Zielsetzung

Geeignete Messinstrumente für Interventionen mit vulnerablen, multimorbiden, älteren Patienten mit akuten und chronischen Beschwerden auszuwählen, stellt eine große Herausforderung dar. Diese Schwierigkeit könnte bei vergangenen, frührehabilitativen Interventionen mit akuthospitalisierten geriatrischen Patienten zu inkonsistenten Ergebnissen geführt haben. Das Ziel dieser Übersichtsarbeit ist es, Messinstrumente für Primäroutcomes zu beschreiben, die in randomisiert-kontrollierten Studien in der Frührehabilitation von akuthospitalisierten älteren Patienten verwendet wurden. Darüber hinaus soll ihre jeweilige Eignung analysiert sowie die Effekte der Passung zwischen Messinstrument und Hauptergebnissen der RCTs evaluiert werden.

Methodik

Eine systematische Literaturrecherche wurde in den Datenbanken PubMed, Cochrane CENTRAL, CINAHL und PEDro durchgeführt. Zusätzlich wurden Studien über Quellen- und Zitatrecherche gesucht. Einschlusskriterien für gefundene Artikel lauteten: (1) randomisiert-kontrollierte Studie (RCT); (2) Patienten ≥65 Jahre; (3) Einweisung auf eine medizinische Akutstation (jedoch ohne Intensivstation); (4) körperliche Trainingsintervention (ebenfalls als Teil eines multidisziplinären Interventionsprogrammes); und (5) Messung des Primäroutcomes während des Krankenhausaufenthaltes. Zwei unabhängige Reviewer extrahierten die Daten, prüften die methodische Qualität der Studien und analysierten die Passung des verwendeten Messinstruments des Primäroutcomes für die Intervention, der jeweiligen Stichprobe und Umgebung. Die Hauptergebnisse der Studie wurden anschließend in Beziehung zu den Ergebnissen dieser Passungsprüfung gesetzt.

Ergebnisse

In den Datenbanken konnten 11.657 Artikel gefunden werden. Achtundzwanzig Artikel, die von 24 Studien berichten, wurden eingeschlossen. Unterschieden wurde dabei in zwei Interventionsansätze. Zum einen die übliche Pflegeversorgung (*usual care*) mit zusätzlichem Bewegungsprogramm, und zum anderen multidisziplinäre Programme, die verschiedene Berufsgruppen wie Geriater, Pflegekräfte, Physio- und Ergotherapeuten, Ernährungsberater und Sozialarbeiter involvierten und somit mehrere Betreuungskomponenten umfassten, die über das Bewegungsprogramm hinausgingen. Insgesamt 33 verschiedene Messinstrumente für Primäroutcomes wurden gefunden und in sechs Gruppen kategorisiert: (1) Funktionaler Status, (2) Mobilitätsstaus, (3) Krankenhausoutcomes, (4) Nebenwirkungen, (5) Psychologischer Status, und (6) Kognitive Funktion. Die Qualität der Studien variierte von mittelmäßig bis gut und ergab eine durchschnittliche qualitative Bewertung von 6 Punkten und somit eine gute methodische Qualität. Die Messinstrumente variierten stark innerhalb der jeweiligen Kategorien und zeigten eine große Heterogenität in ihrer Passung in Bezug auf die Intervention, die Stichprobe und die Umgebung. Jene Messinstrumente, die speziell auf die Interventionsinhalte angepasst waren, konnten auch mit einer größeren Wahrscheinlichkeit interventionsgetriggerte Effekte darstellen. Mobilitätsinstrumente schienen dabei am sensitivsten auf diesen Nutzen zu reagieren. Die Wahrscheinlichkeit, einen signifikanten Effekt einer Intervention zu finden, stieg mit der Passung von Messinstrument und Interventionsinhalt.

Diskussion

Diese Übersichtsarbeit verdeutlicht, dass die Auswahl der Messinstrumente hochgradig spezifisch auf den Interventionsinhalt angepasst sein sollte. Als Schlüsselfaktor kann nur so der eventuelle und jeweilige Nutzen der frührehabilitativen Intervention bei älteren, akuthospitalisierten Patienten ermittelt und gemessen werden und eventuelle signifikante Ergebnisse evaluiert werden. Ungeeignete Messinstrumente könnten somit einen Hauptgrund für bisherige inkonsistente Ergebnisse hinsichtlich der Effektivität von frührehabilitativen Interventionen darstellen. Für zukünftige Studien kann daher empfohlen werden, die Auswahl der zu erzielenden und messenden Ergebnisparameter spezifischer auf die Interventionsinhalte anzupassen.

4.4. Tagesstrukturen, Routinen und Gründe für sedentäres Verhalten kognitiv eingeschränkter Patienten während des Aufenthaltes auf der geriatrischen Akutstation

Manuskript 4: ***Belala, N.**, Maier, C., Heldmann, P., Schwenk, M. & Becker, C. (2019). A pilot observational study to analyze (in)activity and reasons for sedentary behavior of cognitively impaired geriatric acute inpatients. Z Gerontol Geriatr. Nov;52 (Suppl 4):273-281.* (Projektnummer: 881/2018BO2)

Hintergrund und Zielsetzung

Ein körperlicher Funktionalitätsverlust sowie eine Verschlechterung des kognitiven Status aufgrund von sedentärem Verhalten während eines Krankenhausaufenthaltes sind nur zu häufig die Folge einer akuten Krankenhausbehandlung bei geriatrischen Patienten. Diese Komplikation tritt vor allem bei den Patienten auf, die bereits vor der Krankenhauseinweisung ein kognitives Defizit vorzuweisen hatten. Während sensorbasierte Studien bereits Informationen über die körperliche Aktivität von geriatrischen Patienten liefern konnten, wenn auch in eingeschränktem Maße bei kognitiv eingeschränkten Patienten, fehlen Kontextinformationen, die Gründe und Auslöser für körperliche Inaktivität darstellen, bis heute gänzlich. Diese Information ist jedoch unerlässlich, wenn Übungsprogramme zum Ziel haben, die körperliche Aktivität der Patienten zu steigern, um damit Inaktivität zu reduzieren. Die vorliegende Studie analysiert die Alltagsroutinen der geriatrischen Akutstation, um damit die Gründe und Auslöser für sedentäres Verhalten kognitiv eingeschränkter Patienten herauszuarbeiten.

Methodik

Eine Stichprobe von 20 kognitiv mittelschwer beeinträchtigen geriatrischen Patienten (Durchschnittsalter: 84 Jahre, durchschnittlicher DemTect-Wert: 7,4) wurde auf einer Akutstation rekrutiert. Mittels einer teilnehmenden Beobachtung wurden Informationen zu Personen, die mit Patienten verkehren, Aufenthaltsort des Patienten, Kontext, Typ und Schwierigkeit der beobachteten Patientenaktivität und Tageszeit gesammelt. Im Rahmen des *behavioral mapping*-Ansatzes wurden so 35 Zeitpunkte in 15-minütigen Abständen für jeweils eine Minute beobachtet und notiert. Diese 35 Messzeitpunkte wurden dann zu einer Summe von 525 Mi-

nuten extrapoliert, um den Tagesablauf von 9 Uhr morgens bis 19 Uhr abends zu analysieren. Die Tagesroutinen auf der Akutstation wurden mittels halbstrukturierten Interviews mit fünf Vertretern des verschiedenen Gesundheitspersonals (Ärzte, Ergotherapeuten, Physiotherapeuten, Pflegepersonal, Servicepersonal) ebenfalls in 15-minütigen Zeitblöcken über denselben Zeitraum (9-19 Uhr) erfasst.

Ergebnisse

Die beobachteten Patienten verbrachten im Durchschnitt 16,9 Tage auf der Akutstation. Sechzehn von ihnen wurden aus ihrem zu Hause ins Krankenhaus eingeliefert. Nur 8 konnten dorthin auch wieder zurückkehren. Die Einweisungsgründe variierten von Harnwegsinfekten, über Stürze und Infektionen, bis hin zum Schlaganfall. Relevante Zusammenhänge zwischen kategorialen und ordinalen Variablen während des stationären Aufenthaltes, wie Patientenaktivität, Personen, die die Patienten aufsuchten, Tageszeit, Aufenthaltsort, Schwierigkeitsgrad der Aktivität und Kontextfaktoren, wurden gefunden. Die extrapolierten Daten zeigen, dass Patienten im Durchschnitt 396,7 Minuten (75% der beobachteten Zeit) in ihrem Zimmer, 342,0 Minuten (65%) allein und 236,2 Minuten (45%) im Bett liegend verbrachten. Lediglich 13,9% der beobachteten Zeit verbrachten die Patienten aktiv. Diese Aktivitäten waren an Tageszeit, Aufenthaltsort und involvierte Personen geknüpft. So stellten sich speziell der Stationsflur sowie das Badezimmer als Orte heraus, die aktives Verhalten förderten. Speziell der Vormittag war von Aktivität gekennzeichnet, was ebenfalls mit der vermehrten Präsenz von Therapeuten und Pflegekräften in Verbindung stand und Krankenhausroutinen sowie Aktivitäten des täglichen Lebens beinhaltete. Speziell der Nachmittag, der häufig allein oder in Anwesenheit von Freunden oder Verwandten und darüber hinaus im Bett liegend oder sitzend verbracht wurde, war hingegen von sedentärem und inaktivem Verhalten geprägt. Interviewdaten zeigen des Weiteren, dass die Zeit, die die Patienten allein verbrachten, von den Angestellten unterschätzt wurde.

Diskussion

Die Zeit ohne Gesellschaft und sinnvolle Aktivitäten, geprägt von kontinuierlicher Bettlägerigkeit aufgrund fehlender Anreize das Zimmer zu verlassen, könnten zu mehr Zeit geführt haben, die seitens der Patienten allein und inaktiv verbracht wurde. Diese Auslöser scheinen

starke Prädiktoren für sedentäres Verhalten zu sein. Routinen der Akutstation sollten daher überdacht und neu organisiert werden, um die körperliche Aktivität dieser vulnerablen Patientengruppe mittels geeigneter Anreize zu steigern und somit sedentäres Verhalten zu reduzieren. Auch die ungenaue Wahrnehmung der allein verbrachten Zeit der Patienten durch das Personal ist problematisch und könnte zu einer verminderten Aktivierung und Mobilisierung der Patienten führen. Eine Maßnahme zur Steigerung der Aktivität könnte die regelmäßige Durchführung von ADL sein wie beispielsweise das begleitete Aufsuchen der Toilette statt dem Verwenden von Windeln, das morgendliche und abendliche Wechseln der Kleidung sowie das Speisen in Gemeinschaftsräumen oder zumindest an Tischen statt im Bett. Während Untersuchungen und pflegerischen Routinen sollten die Patienten darüber hinaus motiviert werden aus dem Bett aufzustehen und ein paar Schritte zu gehen. Diese kurzen Bewegungseinheiten unterbrechen die toxischen sedentären Phasen und könnten als Routinen ressourcenschonend einen positiven Effekt erzielen. Auch die verstärkte Einbindung von Freunden und Verwandten, um Patienten zu mehr Aktivität zu stimulieren, könnte hier wirken. Letztendlich wäre aber auch eine Neustrukturierung von Therapieeinheiten wünschenswert, die anstatt in einer langen Einheit bevorzugt in zwei kurzen und über den Tag verteilten Einheiten vermittelt werden sollten. Regelmäßige Unterbrechungen sedentären Verhaltens tragen speziell bei Krankenhauspatienten zu einer gesteigerten Lebensqualität bei und sind daher erstrebenswert.

5. Unveröffentlichte Studienergebnisse

5.1. Sensorbasierte Messung der körperlichen Aktivität akuthospitalisierter Demenzpatienten

Objektive, sensorbasierte Messungen sind gegenüber subjektiven, eigenen Berichten über das Aktivitätsverhalten kaum fehleranfällig und liefern präzise und zuverlässige Daten. Vor allem hinsichtlich des Aktivitätsverhaltens verschiedener Zielgruppen ist diese Messmethode in den vergangenen Jahren in den Fokus der Forschung gerückt und konnte an Bedeutung gewinnen. Studien konnten derweilen den Zusammenhang zwischen einem täglichen sedentären Verhalten von mehr als 9,5 Stunden (exklusive der Schlafdauer) und einem erhöhten Mortalitätsrisiko aufzeigen. Darüber hinaus bestehen inzwischen evidenzbasierte Erkenntnisse über den positiven Effekt von leichter Aktivität wie Gehen auf die individuelle Gesundheit (Ekelund, Tarp, Steene-Johannessen et al., 2019).

Das Aktivitätsverhalten geriatrischer Patienten in verschiedenen Settings wurde in diversen Studien bereits durch den Einsatz von Sensoren untersucht. In der Gruppe der Demenzpatienten während eines Aufenthaltes auf der geriatrischen Akutstation hingegen ist der Einsatz von Sensoren bisher nicht weit verbreitet. Unter Berücksichtigung der Kenntnis, dass circa 20% aller stationären geriatrischen Patienten von einer Demenz betroffen sind, sollte diese Gruppe dringend in den Fokus sensorbasierter Aktivitätsmessung rücken.

Aufgrund dieser Tatsache sowie der bekannten Negativkonsequenzen sedentären und inaktiven Verhaltens hinsichtlich des Gesundheitszustandes, wurde im Rahmen der zuvor beschriebenen Beobachtungsstudie (Kapitel 4.4) des Weiteren eine sensorbasierte Messung der körperlichen Aktivität der Studienteilnehmer vorgenommen. Die Stichprobe von 20 Demenzpatienten einer geriatrischen Akutstation (im Durchschnitt 84 Jahre, durchschnittlicher DemTect-Wert: 7,4) wurde mit jeweils einem Aktivitätssensor (activPAL-Accelerometer) am Oberschenkel sowie einem weiteren am unteren Rücken (Lendenwirbel 5) ausgestattet, um über einen Zeitraum von 24 Stunden objektiv Daten über das Bewegungsverhalten zu sammeln.

Dabei weisen die Ergebnisse des am Oberschenkel befestigten Sensors (*Tabelle 2*) auf große Unterschiede in dem Aktivitätsverhalten der Probanden hin. Die Anzahl der gemessenen Schritte variierte in den aufgezeichneten 24 Stunden stark (64 – 7.216 Schritte) (Median: 535 Schritte) und wies einen Durchschnitt von 1.295 Schritten auf. Auch die Anzahl der Sitz-

zum-Stand-Transfers wies große Unterschiede (5 – 64 Transfers) mit einem Durchschnitt von 29 Transfers in dem gemessenen Zeitraum auf. Die Patienten befanden sich im Durchschnitt 130 Minuten in aufrechter Haltung (stehend oder gehend), während sie durchschnittlich 1.310 Minuten sitzend oder liegend verbrachten. Während der aufrecht verbrachten Zeit liefen die Probanden im Durchschnitt 18,4 Minuten täglich. Die Unterschiede waren auch hierbei enorm. Ebenso verhielt es sich hinsichtlich der Dauer dieser Einheiten des Gehens (durchschnittlich 13,8 Sekunden). Dabei kam es äußerst selten zu Intervallen, die über 60 Sekunden, umso häufiger aber zu jenen, die zwischen einer und zehn Sekunden dauerten.

Tabelle 2 Ergebnisse der sensorbasierten Messung körperlicher Aktivität

	Ø daily walking duration [min]	*Ø daily walking interval length [s]*	*daily walking bouts ≥1s [n]*	*daily walking bouts ≥10s [n]*	*daily walking bouts ≥60s [n]*	*Ø daily steps [n]*	*Median cadence [steps/min]*	*Ø daily upright time [min]*	*Ø daily STS [n]*
MD	7,83	13,42	42,0	14,5	0,5	535,0	57,84	90,13	26,0
1.QT	3,45	8,32	22,0	5,5	0,0	206,0	50,39	34,72	16,25
3.QT	19,37	16,64	90,75	33,75	3,0	1545,0	70,36	180,83	39,75
Min	1,47	3,78	3,0	1,0	0,0	64,0	42,22	10,02	5,0
Max	105,18	40,93	349,0	164,0	24,0	7216,0	82,62	698,86	64,0

min: Minuten*; s:* Sekunden*; n:* Anzahl*; STS:* Sit-to-Stand (Sitz-zum-Stand)*; MD:* Median*; QT:* Quartil*; Min:* Minimum*, Max:* Maximum

Demenzpatienten scheinen über den Tag verteilt eher kürzere Aktivitätsmuster von bis zu 10 Sekunden vorzuweisen. Längere Bewegungsintervalle von über einer Minute treten hingegen eher selten auf. Dies spricht für die typischen Verhaltensweisen der Agitiertheit und des Umherwanderns, die häufig bei Demenzpatienten vorzufinden sind (Lyketsos, Carrillo, Ryan et al., 2011). Sie werden durch Stehenbleiben, Hinsetzen oder Hinlegen unterbrochen, um zeitnah wieder in Erscheinung zu treten.

Die Ergebnisse der 24-Stundenmessung deuten auf ein inaktives und sedentäres Verhalten hin. Dabei verdeutlicht die Schrittfrequenz von durchschnittlich 60 Schritten pro Minute erneut die durch die Komorbidität verursachte Vulnerabilität der hier getesteten Population akuthospitalisierter Demenzpatienten. Ebenfalls kognitiv eingeschränkte Studienteilnehmer anderer Untersuchungen, wie beispielsweise Demenzpatienten der geriatrischen Rehabilitation (durchschnittlich 137 Schritten pro Minute) (Schwenk, Zieschang, Englert et al., 2014) und Alzheimer-Patienten eines Memory-Zentrums (durchschnittlich 97 Schritte pro Minute) (König, Klaming, Pijl, Demeurraux, David & Robert, 2017) weisen hier bessere Ergebnisse vor. Dieser Zustand ist hinsichtlich eines Bewegungsprogrammes durchaus von Bedeutung. Entscheidend ist, dass auch die Schrittfrequenz von Demenzpatienten durch Steigerung der körperlichen Aktivität und Training verbessert werden kann (Schwenk, Zieschang, Englert et al., 2014; Zeng, Deng, Shuai, Zhang, Wang & Song, 2016).

Die Ergebnisse der Schrittmessung in dieser besonders vulnerablen Patientenklientel sind jedoch mit Vorsicht zu interpretieren, da die Software des activPAL-Accelerometers eine Gehgeschwindigkeit des Probanden von 0,4m/sec voraussetzt, um technisch valide einen durchgeführten Schritt messen zu können. Da diese Gehgeschwindigkeit in der behandelten Zielgruppe aufgrund einer nicht durchgeführten Analyse der individuellen Gehgeschwindigkeit jedoch nicht garantiert werden kann, ist die Aussagekraft und Zuverlässigkeit der Daten dieses Parameters limitiert. Die Schrittzahl galt in dieser Studie jedoch nicht als Primäroutcome, sondern die vom Oberschenkelsensor gemessene aufrecht beziehungsweise sitzend oder liegend verbrachte Zeit. Diese Ergebnisse liefern mehr Aufschluss über das Aktivitätsverhalten der Probanden und deuten auf starke Inaktivität hin. Darüber hinaus weisen die Daten eine starke Heterogenität in der körperlichen Aktivität der eingeschlossenen Probanden auf. Beispielhaft verdeutlicht Abbildung 2 diese Heterogenität zweier eingeschlossener Probanden.

Beide Probanden wiesen bei Einschluss den gleichen DemTect-Wert von 6 auf und unterschieden sich in der Anzahl ihrer Diagnosen (5 versus 7) sowie in ihrem Alter (87 versus 86 Jahre) nur minimal. Während Proband 1 knapp 160 Minuten aktiv war sowie 32 Transfers aufweisen konnte, war Proband 2 lediglich 10 Minuten aktiv und führte nur 5 Transfers durch. Proband 1 wies einen Krankenhausaufenthalt von lediglich sechs Tagen auf, während Proband 2 fünf Wochen auf der Station (36 Tage) war. Die Testung der körperlichen Funktion in Form des De Morton Mobility Index (DEMMI) (De Morton, Davidson & Keating, 2008) am

Tag der Entlassung zeigte abschließend große Unterschiede (62 versus 24) in den körperlichen Fähigkeiten.

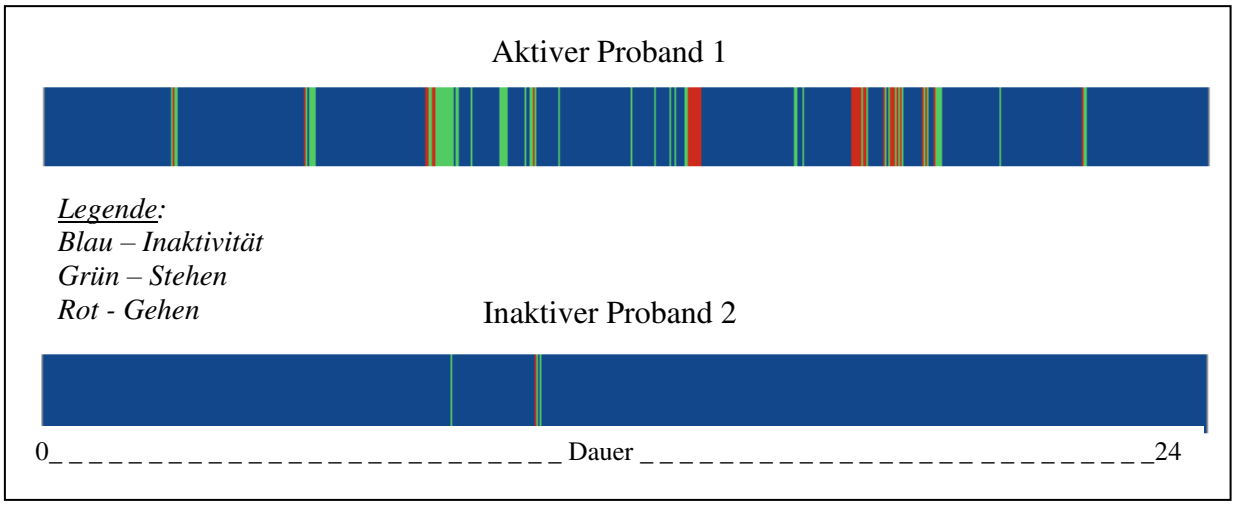

Abbildung 2 Exemplarische Darstellung körperlicher Aktivität akuthospitalisierter Demenzpatienten

Eine daraus resultierende Konsequenz war die Entlassung von Proband 1 in das eigene zu Hause, während Proband 2 in ein Pflegeheim eingewiesen wurde. Beide Probanden lebten vor der Krankenhauseinweisung daheim und waren gehfähig.

6. Einordnung der Studienergebnisse in den Forschungszusammenhang

Die systematische Literaturrecherche hinsichtlich der Effekte von strukturierten und lebensstilintegrierten Trainingsformaten verdeutlicht, dass der lebensstilintegrierte Ansatz des LiFE-Programmes in diversen Zielgruppen einsetzbar ist und eine durchaus erfolgreiche Alternative, sowohl einzeln vermittelt als auch als Ergänzung zu strukturiertem Training, darstellen kann (Manuskript 1; Kapitel 4.1). Die Recherche zeigt darüber hinaus, dass es bisher keine evaluierten Krankenhausprogramme dieses Formats gibt. Eine derzeit laufende Studie in Australien beschäftigt sich mit dem LiFE-Ansatz in der Zielgruppe der Schlaganfallpatienten (Falls After Stroke Trial – FAST). Ergebnisse der zugehörigen randomisiert-kontrollierten Studie werden für 2023 erwartet (Details unter ACTRN12619001114134, ANZCTR.org.au). Eine andere Forschungsgruppe (an der School of Optometry and Vison Science an der University of New South Wales) beschäftigt sich des Weiteren mit dem LiFE-Ansatz bei älteren, visuell eingeschränkten Patienten (v-LiFE) und konnte mittels erster Versuche bereits die Machbarkeit des Programmes bestätigen (*bisher unveröffentlicht*). Die Gruppe der kognitiv eingeschränkten Älteren wurde bis zu diesem Dissertationsprojekt jedoch noch nicht berücksichtigt.

Nach einer bereits mehrfach evaluierten Vorgehensweise der schrittweisen Anpassung der Übungen (Schwenk, Bergquist, Boulton et al., 2019), die auch für das vorliegende Projekt gewählt wurde, konnten die Ergebnisse der durchgeführten Studien verdeutlichen, dass der Ansatz und die Übungen des LiFE-Programmes von Demenzpatienten nicht nur akzeptiert, sondern auch als sinnvoll und positiv wahrgenommen und darüber hinaus als vertraut bewertet werden (Manuskript 2; Kapitel 4.2). Jedoch stellten sich die Übungen teilweise in ihrer Originalversion als zu herausfordernd heraus und mussten demnach angepasst werden. In der angepassten Version (diaLiFE) waren für geriatrische Akutpatienten mit dementieller Erkrankung von den zehn getesteten Übungen, fünf in Teilen der Stichprobe immer noch durch Bodeneffekte gekennzeichnet (Tandemgang: 55%; Vor- & Rücklehnen: 65%; über Gegenstände steigen: 40%; Fersengang: 40%; Zehengang: 30%)[1]. Es wird demnach deutlich, dass dieser Übungsansatz geeignet, jedoch in seiner Schwierigkeit noch immer nicht angemessen ist. Der

[1] Die Ergebnisse zur Testung der diaLiFE Übungen auf der geriatrischen Akutstation sind bislang noch unveröffentlicht.

getestete Schwierigkeitsgrad der Übungen könnte dabei als längerfristiges Trainingsziel des Heimtrainings im Sinne der Nachhaltigkeit angesehen werden.

Als Limitierung sei erwähnt, dass in den durchgeführten Studien keine Unterscheidung der Demenzformen vorgenommen wurde. Dies könnte möglicherweise hinsichtlich der Intervenierbarkeit dieser Patienten mittels des LiFE-Programmes von Bedeutung sein. Denn während Patienten mit nichtdegenerativen Demenzen, wie der vaskulären Demenz, bereits im früheren Stadium eine klinisch relevante Verschlechterung ihrer Mobilität aufweisen, wie zum Beispiel ein verändertes Gangbild, das geprägt ist durch kleine schlurfende Schritte sowie eine statische und dynamische Instabilität (Allan, Ballard, Burn & Kenny, 2005), tritt dies bei Alzheimer-Patienten erst in einem späteren Stadium auf (O'Keeffe, Kazeem, Philpott, Playfer, Gosney & Lye, 1996). Aktivitäten des täglichen Lebens, die in dem hier behandelten Bewegungsprogramm von großer Relevanz sind, sind jedoch bei Alzheimer-Patienten bereits im frühen Stadium stark eingeschränkt (Brown, Devanand, Liu & Caccappolo, 2011).

Wie des Weiteren gezeigt werden konnte, ist die Auswahl geeigneter Assessments, die der Intervention entsprechen und die behandelten Parameter valide abbilden, von großer Bedeutung. Die systematische Literaturrecherche verdeutlicht dabei, dass dies speziell im Bereich der geriatrischen Frührehabilitation in vorangegangen Studien nicht immer zuverlässig erfolgte und so zum Teil widersprüchliche Aussagen und inkonsistente Ergebnisse erklärt werden könnten (Manuskript 3; Kapitel 4.3). Um zukünftig also aussagekräftige und vergleichbare Studienergebnisse zu produzieren, sollte in jedem Studiendesign eine wohl überlegte Auswahl der Messinstrumente erfolgen, die die zu untersuchenden Parameter valide abbilden.

Hinsichtlich des LiFE-Ansatzes ist eine Anpassung an den Lebensalltag seiner Teilnehmer erforderlich, um die einzelnen Übungen erfolgreich zu Routinen zu entwickeln. Diese Charakteristik wirkt sich positiv auf die Adhärenz aus und bietet einen Ansatz mit nachhaltigem Charakter (Clemson, Fiatarone Singh, Bundy et al., 2012). Aus diesem Grund wurden die Alltagsroutinen und -strukturen der geriatrischen Akutstation sowie das Ausmaß und mögliche Gründe und Auslöser für sedentäres Verhalten kognitiv eingeschränkter Patienten mittels einer teilnehmenden Beobachtung analysiert (Manuskript 4; Kapitel 4.4). Übereinstimmend mit anderen Studien bezüglich des inaktiven Verhaltens dieser Patientengruppe auf einer gerontopsychiatrischen Station (Fleiner, Gersie, Ghosh et al., 2019) konnte festgestellt werden, dass der Alltag der Patienten zu einem hohen Maß von Inaktivität und sedentärem Verhalten geprägt ist (Manuskript 4; Kapitel 4.4). Diverse Auslöser scheinen hierbei eine Rolle zu spielen,

die Anpassungen und Umstrukturierungen des Alltags auf den Stationen erforderlich machen, um die Aktivität der Patienten zu steigern. Während die in den meisten Studien bisherig angewandte sensorbasierte Messung von körperlichem Aktivitätsverhalten akuthospitalisierter Patienten lediglich die Quantität von (In)Aktivität und geleisteten Schritten verdeutlicht, lieferte sie keinerlei Kontextinformationen zu diesem Verhalten. Die hier durchgeführte Analyse von Gründen und Auslösern sedentären Verhaltens der Demenzpatienten einer deutschen Akutgeriatrie in Form einer teilnehmenden Beobachtung ergab jedoch, dass in erster Linie ungeeignete Therapiekonzepte, unpassende Tagesstrukturen mit mangelnden Beschäftigungen für die Patienten und darüber hinaus Handlungseinschränkungen oder Zeitmangel des Personals als triviale und zentrale Problemstellungen erscheinen, die sedentäres Verhalten begünstigen (Manuskript 4; Kapitel 4.4).

Die Auswirkungen von Inaktivität geriatrischer, vor allem kognitiv eingeschränkter Patienten während eines Krankenhausaufenthaltes sind aufgrund des demografischen Wandels gesellschaftlich hochrelevant. Steigende Zahlen älterer Menschen, die zunehmend pflegebedürftig werden, erhöhen den Bedarf an präventiven Maßnahmen, um das Gesundheitssystem zu entlasten. Der LiFE-Ansatz gilt hierbei als interessante und erfolgversprechende Möglichkeit, um, unter Anderem sedentäres Verhalten auf ressourcenschonende Weise zu reduzieren (Schwenk, Bergquist, Boulton et al., 2019).

7. Schlussfolgerung und Ausblick

Studien konnten bereits die positiven Effekte aktivitätssteigernder Maßnahmen in Krankenhäusern darstellen, die nicht in Form von strukturierten Interventionen vermittelt, sondern durch Maßnahmen der Umstrukturierung von Alltagsroutinen erreicht wurden und als vielversprechend zu verstehen sind (Brown, Foley, Lowman Jr. et al., 2016). Der hohe Bedarf an Ressourcen organisierter Bewegungsformen für dementiell erkrankte Patienten in Krankenhäusern, der sich in einem hohen Personalaufwand sowie damit verbundenen Kosten äußert, stellt in seiner möglichen Implementierung in den Krankenhausalltag eine Hürde dar, die für Entscheider im Gesundheitssystem eine abschreckende Wirkung inne hat. Als besser geeignete Alternative könnte hierbei ein Bewegungsprogramm gelten, das nicht zu festen Uhrzeiten in dafür bereitgestellten Räumen und mit einem großen Bedarf an Personal und Materialien stattfindet, sondern dessen Übungen in den Alltag des Krankenhauses und die Routinen des Personals und der Patienten integriert sind. Auf diese Weise kann die körperliche Aktivität der Patienten gesteigert und sedentäres Verhalten reduziert werden. Damit verbundene Maßnahmen der Umstrukturierung dürften im ersten Schritt zwar schwierig erscheinen, könnten langfristig jedoch auf ressourcenschonende Weise einen positiven Effekt auf die körperliche Verfassung der Patienten sowie deren Gesundheitszustand und Ziel bei Entlassung haben. Speziell für die Zielgruppe der Demenzpatienten geeignete Formate, die großflächig umsetzbar, möglichst ressourcenschonend und nachhaltig sind, gewinnen somit an Bedeutung. Die Umsetzbarkeit sollte aus gesellschaftlichen und gesundheitskostenbezogenen Gründen nicht ausschließlich an professionelle Therapeuten und Pfleger gebunden werden, sondern auch mit Hilfe von Angehörigen und beispielsweise ehrenamtlichen Personen leistbar sein.

Aufgrund der vielversprechenden Ergebnisse des LiFE-Programmes in verschiedenen Zielgruppen (Clemson, Fiatarone Singh, Bundy et al., 2012; Schwenk, Bergquist, Boulton et al., 2019) sowie der guten Akzeptanz in der Gruppe dementiell erkrankter Rehabilitationspatienten (Manuskript 2), gilt dieser Ansatz als überaus geeignet, den diversen Anforderungen an ein zweckmäßiges Bewegungsprogramm entsprechen zu können. Um die Umsetzbarkeit des diaLiFE-Programmes in einer Pilotstudie als hierfür zutreffenden Ansatz evaluieren zu können, bedarf es als nächsten Schritt zunächst weiterer Anpassungen der körperlichen Übungen für die Patienten, Material zur Anwendung und Umsetzung des Programmes für Krankenhauspersonal, Familien, Freunde und Ehrenamtliche sowie ein konkretes Testkonzept der

Umstrukturierung der Alltagsroutinen und Abläufe einer Akutstation anhand der analysierten Daten. Dann könnte dieses Programm als ein geeigneter und vor allem praktikabler und möglichst flächendeckend zu implementierender Ansatz eines Bewegungsprogrammes mit einem hohen gesellschaftlichen Nutzen gelten. Die besonderen Anforderungen kognitiv eingeschränkter Patienten erfordern ein flexibles Modell, um Inaktivität und sedentäres Verhalten während eines Krankenhausaufenthaltes, aber auch im Sinne der Nachhaltigkeit darüber hinaus, auf geeignete Weise behandeln, reduzieren und Mobilität fördern zu können. Aufgrund der hohen Anzahl informeller Pflegepersonen muss dieser Ansatz niedrigschwellig und praktikabel umsetzbar sein. Dabei kann dieser Ansatz der Bewegungsförderung auf präventive als auch rehabilitative Bedarfe abzielen.

Im Rahmen einer geeigneten Evaluierung körperlicher Aktivität bei dieser Patientengruppe ist darüber hinaus ein valider Ansatz der Aktivitätsmessung nötig. Bisherige Messungen sind in der behandelten Zielgruppe mit Vorsicht zu interpretieren, da die Messung eines activPAL-Accelerometers, der am Oberschenkel befestigt wird, um so Schritte und Gangphasen zu messen, eine Mindestgehgeschwindigkeit von 0,4m/sec voraussetzt. Aufgrund der zum Teil stark ausgeprägten Mobilitätseinschränkungen oder dementiell bedingter veränderter Gangmuster dieser Patienten ist die Messung in dieser Kohorte häufig nur in begrenztem Ausmaß valide. Um aussagekräftige und reliable Daten zu erhalten, scheint daher ein *sensor-fusion*-Ansatz sinnvoller, der die Datensätze zweier an unterschiedlichen Körperstellen (Oberschenkel & unterer Rücken/Bereich Lendenwirbel 5) befestigter Sensoren kombiniert. Dieser Ansatz wird derzeit als weiterer Projektteil validiert. Zuverlässige Daten zu der Gruppe der Demenzpatienten sind vor dem Hintergrund der in dieser Arbeit dargestellten, fatalen Auswirkungen körperlicher Inaktivität von höchster Relevanz.

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Eigene Beiträge an den publizierten Arbeiten

Ein Teil der Dateninterpretation sowie das Verfassen von Teilen des Manuskripts 1 (gemeinsam mit der Kollegin Michela Weber) waren Aufgaben im ersten Schritt meines Dissertationsprojekts.

1. Weber M., Belala N., Clemson L., Boulton E., Hawley-Hague H., Becker C. & Schwenk M. (2017) Feasibility and Effectiveness of Intervention Programmes Integrating Functional Exercise into Daily Life of Older Adults: A Systematic Review. Gerontology. 2018;64(2):172-187.

Die in Manuskript 2 veröffentlichte Studie wurde vollständig von mir (unter der Aufsicht meines Betreuers Prof. Dr. Becker) geplant, durchgeführt, evaluiert und ausgewertet. Das zugehörige Manuskript wurde von mir verfasst und von meinen Betreuern und den Ko-Autoren geprüft.

2. Belala N., Schwenk M., Kroog A. & Becker C. (2018) Feasibility of the lifestyle integrated functional exercise concept in cognitively impaired geriatric rehabilitation patients. Z Gerontol Geriatr. 2019 Feb;52(1):61-67.

Für die systematische Literaturanalyse des dritten Manuskripts wurde die Datengewinnung sowie Datenanalyse und die Qualitätsbewertung der Studien (gemeinsam mit dem Kollegen Patrick Heldmann) von mir durchgeführt.

3. Heldmann P., Werner C., Belala N., Bauer J.M. & Hauer K. (2019) Early inpatient rehabilitation for acutely hospitalized older patients: a systematic review of outcome measures. BMC Geriatr. Jul 9;19(1):189. doi: 10.1186/s12877-019-1201-4.

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4. Belala N., Maier C., Heldmann P., Schwenk M. & Becker C. (2019) A pilot observational study to analyze (in)activity and reasons for sedentary behavior of cognitively impaired geriatric acute inpatients. Z Gerontol Geriatr. Nov;52 (Suppl 4):273-281. doi: 10.1007/s00391-019-01644-x.

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Belala N., Weber M., Schwenk M. & Becker C. (2017) Den Alltag als Trainingsgelegenheit nutzen: ein verborgenes Potential? Kongress zum 10-jährigen Jubiläum des Netzwerks AlternsfoRschung (NAR) der Universität Heidelberg, Heidelberg, Deutschland, 19. Mai 2017 (Vortrag)

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Manuskripte zur publikationsbasierten Dissertation

Manuskript 1

Weber, M., Belala, N., Clemson, L., Boulton, E., Hawley-Hague, H., Becker, C. & Schwenk, M. (2018). Feasibility and Effectiveness of Intervention Programmes Integrating Functional Exercise into Daily Life of Older Adults: A Systematic Review. Gerontology. 64(2):172-187.

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Feasibility and Effectiveness of Intervention Programmes Integrating Functional Exercise into Daily Life of Older Adults: A Systematic Review

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Keywords

Aging · Balance · Daily life · Exercise training · Lifestyle · Physical performance · Feasibility · Functional exercise · Individual activity plan · Habit formation

Abstract

Background: Traditionally, exercise programmes for improving functional performance and reducing falls are organised as structured sessions. An alternative approach of integrating functional exercises into everyday tasks has emerged in recent years. ***Objectives:*** Summarising the current evidence for the feasibility and effectiveness of interventions integrating functional exercise into daily life. ***Methods:*** A systematic literature search was conducted including articles based on the following criteria: (1) individuals ≥60 years; (2) intervention studies of randomised controlled trials (RCTs) and non-randomised studies (NRS); (3) using a lifestyle-integrated approach; (4) using functional exercises to improve strength, balance, or physical functioning; and (5) reporting outcomes on feasibility and/or effectiveness. Methodological quality of RCTs was evaluated using the PEDro scale. ***Results:*** Of 4,415 articles identified from 6 databases, 14 (6 RCTs) met the inclusion criteria. RCT quality was moderate to good. Intervention concepts included (1) the Lifestyle-integrated Functional Exercise (LiFE) programme integrating exercises into everyday activities and (2) combined programmes using integrated and structured training. Three RCTs evaluated LiFE in community dwellers and reported significantly improved balance, strength, and functional performance compared with controls receiving either no intervention, or low-intensity exercise, or structured exercise. Two of these RCTs reported a significant reduction in fall rate compared with controls receiving either no intervention or low-intensity exercise. Three RCTs compared combined programmes with usual care in institutionalised settings and reported improvements for some (balance, functional performance), but not all (strength, falls) outcomes. NRS showed behavioural change related to LiFE and feasibility in more impaired populations. One NRS comparing a combined home-based programme to a gym-based programme reported greater sustainability of effects in the combined programme. ***Conclusions:*** This review provides evidence for the effectiveness of integrated training for improving motor performances in older adults. Single studies suggest advantages of integrated compared with structured training. Combined programmes are positively evaluated in institutionalised settings, while little evidence exists in other populations. In summary, the approach of integrating functional exercise into daily life represents a promising alterna-

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tive or complement to structured exercise programmes. However, more RCTs are needed to evaluate this concept in different target populations and the potential for inducing behavioural change.

Introduction

Exercise programmes specifically developed for improving functional performance play an important role in maintaining functional independence and reducing falls in older adults [1–3]. Several programmes have been positively evaluated in different target populations [4–6]. While the exercise content differs among these programmes, all of them are delivered in a structured format either in groups [7–10] or individually at home [4, 11–13]. Common characteristics are standardised repetitive exercises, performed several times a week. While structured programmes are an essential element of intervention strategies [14], authors have repeatedly discussed the lack of long-term adherence to them [15, 16]. Survey data suggest that the proportion of persons aged 65 years or older participating in specific strength and balance training programmes is less than 13% [17].

For many older adults, engagement in structured exercise or sport is not appealing [18, 19]. This is often related to a lack of transportation, limited access to facilities [20], time commitments [21–23], unwillingness to join a group [22], or aversion to exercise, as some do not regard themselves as "sporty" [18]. Recent studies highlight older adults' preference for lifestyle activities, such as cleaning or gardening, rather than performing specific exercises [24]. Structured programmes typically do not include a behavioural change concept for fostering long-term adherence and habitualisation of exercise. The development of alternative approaches for those who are not interested in structured exercise and which implement behavioural change concepts has been repeatedly requested [7, 21, 25].

Integrating exercises into daily life has been discussed as one promising alternative to structured programmes [25, 26]. Integrated programmes aim to turn daily routines into opportunities for exercising rather than performing separate exercises. Some studies have focused solely on increasing daily walking time, for instance by walking to the store rather than taking the bus [27, 28]. This approach has been expanded to integrate various functional exercises designed for improving balance and strength [29]. Functional exercises are performed with the purpose of enhancing basic everyday motor performances, e.g. stair climbing, obstacle crossing, or rising from a chair, and are based on the principle of specificity of training [29]. Studies suggest that functional exercise training is effective because the training content is linked to the specific outcome (i.e., being closely aligned with daily tasks) [29, 30]. Examples of integrated training tasks are squatting when reaching to a low shelf or drawer, or intentionally stepping over objects in the daily environment for practising a specific motor skill, which is relevant for safe ambulation.

One advantage of integrated training is that it can be performed without reserving extra time for training. It has been proposed that integrated training may become habitual after a period of regular practice [25, 26, 31].

Integrated training seems to be a promising concept. The aim of this systematic review is to summarise the available evidence for the feasibility and effectiveness of lifestyle-integrated functional exercise training in older adults.

Methods

A systematic literature search was performed in May 2016 according to the PRISMA statement [32]. Searches were conducted in PubMed, Web of Science, Cochrane Library, PsycInfo, CINAHL, and GeroLit without any language or publication date restrictions. Initial search terms were compiled and iteratively refined by content experts in the fields of geriatrics, gerontology, exercise, and library science. The PubMed search strategy (online suppl. Table S1; for all online suppl. material, see www.karger.com/doi/10.1159/479965) was modified for the other databases.

Inclusion criteria were: (1) individuals aged ≥60 years; (2) intervention studies including randomised controlled trials (RCTs) and non-randomised studies (NRS) (e.g., controlled before-after studies); (3) use of a lifestyle-integrated approach; (4) use of functional exercises focusing on strength, balance, or physical functioning; and (5) reporting outcomes about feasibility and/or effectiveness (i.e., balance, strength, physical functioning, mobility, falls, and psychosocial aspects). Reference lists of relevant articles were subsequently hand-searched to identify additional appropriate articles.

Study selection was performed by 2 independent reviewers (M.W., T.G.). In case of disagreements, the articles were discussed with the other authors. Titles and abstracts of retrieved references were screened for inclusion, and full texts of potential articles were analysed further to determine inclusion. Data extraction included information about study design and aims, setting, sample characteristics, outcome parameters, adherence, adverse events, and results. Authors were contacted for additional information that was not available from the articles. We aimed to include all intervention studies that evaluated aspects of feasibility and/or effectiveness of integrated training, regardless of study design. We report study results separately for RCTs and NRS. Methodological qual-

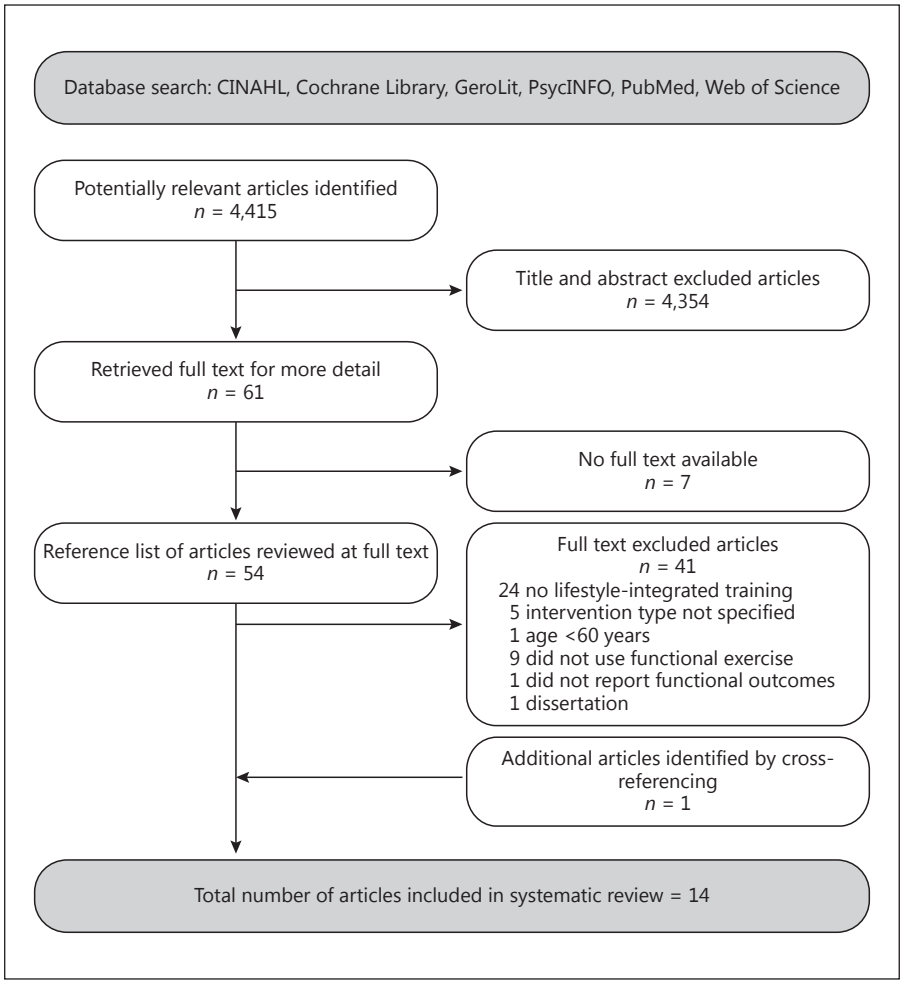

Fig. 1. Flowchart showing the literature search and the extraction of studies meeting the inclusion criteria.

ity of RCTs was rated using the PEDro scale ranging from 0 to 11 points [33]. Risk of bias was assessed using the Cochrane Collaboration's Risk of Bias Tool [34].

Results

Study Selection

Out of 4,415 articles screened, 14 met the inclusion criteria (Fig. 1). Among these, 7 [25, 26, 35–39] reported RCTs. One RCT was published in 2 articles on short- [35] and long-term effects [36]. In total, 6 RCTs were included. Seven articles [40–46] reported NRS. Among these, 3 articles [40–42] reported before-after studies focusing on feasibility [40–42], acceptance [41, 42], motor performances [40–42], and behavioural change [41]. Four articles [43–46] reported 1 controlled trial including effects on fitness and cardiorespiratory risk factors [46], and short- [43] and long-term effects on physical activity (PA) [44, 45].

Methodological Quality

Quality rating of RCTs is shown in Table 1. The average PEDro Score was 7.8 points (range 7–9). Methodological weaknesses were lack of concealed allocation [37–39], lack of participant blinding (all RCTs), and dropout rates >15% [26, 37, 38].

Risk of bias rating was performed for all articles included (online suppl. Table S2). No article had risk of bias related to incomplete outcomes and selective reporting, 6 NRS articles had risk of selection bias [40–46], and 5 articles (2 RCTs [37, 39], 3 NRS [40–42]) had a risk of performance bias.

Studies Using an RCT Design

An overview of RCTs is provided in Table 2. In summary, RCTs compared the interventions with passive controls [25], controls receiving ordinary care [37–39], or structured exercise [26, 35, 36]. Included were community dwellers with a history of falls [25, 26] or receiving

Table 1. Results of quality scoring of RCTs using the PEDro Scale

	Burton et al. [35, 36]	Clemson et al. [25]	Clemson et al. [26]	Grönstedt et al. [37]	Kerse et al. [38]	Peri et al. [39]
Eligibility criteria specified	×	×	×	×	×	×
Random allocation	×	×	×	×	×	×
Concealed allocation	×	×	×	–	–	–
Groups similar at baseline	×	×	×	×	×	×
Participant blinding	–	–	–	–	–	–
Therapist blinding	–	–	–	–	–	–
Assessor blinding	–	×	×	×	×	×
<15% dropouts	×	×	–	–	–	×
Intention-to-treat analysis	×	×	×	×	×	×
Between-group statistical comparison	×	×	×	×	×	×
Point measures and variability data	×	×	×	×	×	×
Sum score	8	9	8	7	7	8

PEDro, Physiotherapy Evidence Database, studies are classified as excellent (9–11 points), good (6–8 points), fair (4–5), and poor (<4); ×, criterion is evidenced in the article; –: criterion is not evidenced, not applicable, not coded, or could not be determined in the article.

restorative home care [35, 36], and institutionalised older adults [37–39]. Sample sizes ranged from 34 to 473 participants, mean age from 80.2 to 85.0 years, and percentage of women from 50 to 85%.

Interventions

The intervention period ranged from 8 weeks [35, 36, 40] to 12 months [38]. The programmes were delivered by physio- and occupational therapists [25, 26, 35, 36], home-help service staff [37], or usual caregivers [38, 39]. All RCTs consistently recommended that integrated exercises should be performed daily, as often as possible throughout the day.

The most frequently evaluated intervention was the Lifestyle-integrated Functional Exercise (LiFE) programme [25, 26, 35, 36]. LiFE focuses on embedding functional exercises into daily life, thereby enhancing the overall level of PA. The programme is taught by professional trainers during 5–7 home visits and 2 follow-up phone calls over a 6-month period [47].

A participants' manual illustrates the LiFE "principles" for improving balance, lower-limb strength, and increasing PA [48]. Balance principles include postures and walking with gradual reduction in the base of support (e.g., upgrading tandem stand to one-leg stand over time), and dynamic movements that perturb the centre of gravity (e.g., leaning in different directions, stepping over obstacles) [26]. Strength principles include functional activities focusing on improving lower extremity muscles around the hip and knee (e.g., squatting, chair rise, sideward walking) and ankle (e.g., toe stand, toe and heel walking) with gradual increase of intensity through performing more challenging activities [26]. Important elements of LiFE are strategies for behavioural change, based on habit re-framing theory [49]. LiFE activities are linked to daily tasks by using situational and environmental cues (e.g., tooth brushing) as prompts to action. The idea of LiFE is to perform the activities intentionally and consciously until they become a habit.

Two RCTs evaluated the LiFE programme in older fallers [25, 26]. One of these RCTs [25] used a control group not receiving any intervention. The other [26] compared LiFE with a structured exercise programme which included balance and strength exercises (with ankle cuff weights) performed 3 times a week at home. As with LiFE, the structured training was taught by professional trainers during 5–7 sessions and 2 follow-up phone calls over a 6-month period [47]. Participants in a third group (controls) performed low intensity and flexibility exercises taught during 2 sessions, 1 booster session, and 6 follow-up phone calls.

One RCT [35, 36] evaluated a modified version of LiFE in a restorative home care setting. The teaching period was shorter (8 weeks). Care managers (health professionals, nurses) taught the programme during regular visits every 10–14 days (3 times on average). LiFE was compared with structured training including balance and

Table 2. Description of the 10 trials with regard to study purpose, subjects, settings, and interventions

First author [Ref.]	Study design	Study purpose	Subjects and setting	Intervention	Behaviour change approach T, F, D		Delivery of the intervention	Follow-up	Adherence
Randomised controlled trials									
Burton [35, 36]	Pragmatic RCT	Compare the effectiveness of LiFE vs. structured exercise on greater functional gains	*n* = 80 Mean age: IG: 80.2 years, CG: 79.6 years Female: IG: 75%, CG: 90% Dropout: IG: 2.5%, CG: 7.5%	IG: LiFE CG: structured balance and strength exercises	Habit formation framework aiming to make LiFE activities habitual	IG: T: individualized F: daily D: 8 weeks CG: T: 15–20 min F: 3× weekly D: 8 weeks	IG: PTs, OTs, nurses, 5 home visits CG: restorative home care team	8 weeks and 6 months	IG: 4.05 times/week (4.91 times/week during the 8 weeks, 3.62 times/week at follow-up) CG: 3.66 times/week (4.42 times/week during the 8 weeks, 3.28 times/week at follow-up)
Clemson [25]	Pilot RCT	Determine the adherence and effectiveness of LiFE on fall prevention	*n* = 34 Mean age: IG: 81.0 years, CG: 82.0 years Female: IG: 50%, CG: 44%, Dropout: 11.1%	IG: LiFE CG: none	Habit formation framework aiming to make LiFE activities habitual	T: individualized F: daily D: 3 months	PTs, OTs, 5 home visits, 2 booster phone calls, 2 follow-up phone calls	3 months and 6 months	N/A
Clemson [26]	Randomized parallel trial	Determine the effectiveness of LiFE on fall prevention	*n* = 317 Mean age: 83.4 years Female: 54.9% Dropout: IG: 26.2%, IG: 7.5%, IG2: 8.6%, CG: 13.3%	IG1: LiFE IG2: structured balance and strength exercises CG: gentle and flexibility exercises	Habit formation framework aiming to make LiFE activities habitual	IG1: T: individualized F: daily D: 6 months IG2: T: N/A F: II: 3× weekly D: II: 6 months CG: T: N/A F: N/A D: 6 months	IG1 and IG2: PTs, OTs, 5 home visits, 2 booster phone calls, 2 follow-up phone calls CG: PTs, OTs, 2 home visits, 2 booster phone calls, 6 follow-up phone calls	6 months and 12 months	IG1: 33% (over 6 months), poor adherence (<25%): 7% IG2: 29% (over 6 months), poor adherence (<25%): 19% CG: 34% (over 6 months), poor adherence (<25%): 11%
Grönstedt [37]	Randomized clinical trial	Determine the effectiveness of an individually tailored intervention program on function	*n* = 332 Mean age: 85.0 years Female: 73.5% Dropout: IG: 15.9%, CG: 17.8%	IG: individually tailored physical and daily activities in different combination CG: ordinary care and treatment	Individual goal setting strategies related to physical and daily activities	T: individualized F: daily D: 3 months	OTs, PTs, staff members at the unit, daily visits	3 months	N/A
Kerse [38]	Cluster RCT	Determine the effectiveness of an individualized functional activity program on quality of life	*n* = 473 Mean age: 84.3 years Dropout: IG: 32%, CG: 29%	IG: individualized program of physical activities based on repetitions of activities of daily living CG: usual care	Behavioural strategies focusing on goal setting for improving physical function	T: individualized F: daily D: 12 months	Healthcare assistants, number of visits depend on resident's needs	3 months, 6 months and 12 months	N/A
Peri [39]	Cluster RCT	Determine the effectiveness of an individualized functional activity programme on function, mobility and quality of life	*n* = 149 Mean age: 84.7 years Female: IG: 85%, CG: 83% Dropout: IG: 13.7%, CG: 19.7%	IG: individualized program of physical activities based on repetitions of activities of daily living CG: usual care	Behavioural strategies, focusing on goal setting for improving physical function	T: individualized F: daily D: 6 months	Healthcare assistants, number of visits depend on resident's needs	3 months and 6 months	N/A

Table 2 (continued)

First author [Ref.]	Study design	Study purpose	Subjects and setting	Intervention	Behaviour change approach	T, F, D	Delivery of the intervention	Follow-up	Adherence
Non-randomised studies									
Opdenacker [43–45] Van Roie [46]	Controlled trial	Determine the effectiveness of a lifestyle intervention vs. structured exercise on physical activity and on self-esteem	*n* = 186 Mean age: IG1: 63.3 years, IG2: 67.0 years, CG: 67.9 years Female: IG1 and IG2: 50%, CG: 54.5% Dropout: IG1: 23.3%, IG2: 18.3%, CG: 30.3%	IG1: Home-based lifestyle intervention, including endurance, strength, flexibility and balance IG2: structured exercise program, including endurance, strength, flexibility and balance CG: assessments	Behavioural strategies, derived from self-determination theory, transtheoretical model and social-cognitive theory, targeting self-supportive behaviour (enhancing autonomy, reducing support)	IG: T: individualized F: daily D: 11 months IG2: T: 60–90 min F: 3× weekly D: 11 months	IG1: exercise psychologist, 1 home visit, 5 monthly collective sessions, 16 booster phone calls IG2: instructors at a fitness centre	6 months, 11 months and 23 months	IG1: 85.5% (11 post-test), 87.0% (follow-up) IG2: 82.8% (post-test), 83.7% (23 follow-up) C: N/A
Burton [40]	Before-after study	Test the feasibility of LiFE in terms of suitability in restorative home care	*n* = 9 Mean age: 80.8 years Female: 75% Dropout: 11.1%	IG: LiFE, including 7 balance and 6 strength principles CG: none	Habit formation framework aiming to make LiFE activities habitual	T: individualized F: daily D: 8 weeks	PTs, OTs, nurses, 5 home visits	8 weeks	N/A
Fleig [41]	Before-after study	Test the feasibility of a group-based EASY-LiFE intervention in terms of habit formation	*n* = 13 Mean age: 66.2 years Female: 100% Dropout: 23.1%	IG: group-based LiFE CG: none	Phase-specified behavioural change techniques making everyday actions habitual	T: individualized F: daily D: 4 months	Exercise physiologists, personal trainer, health psychologists, 7 group sessions	6 months	N/A
Keay [42]	Before-after study	Determine the feasibility of LiFE in older adults with visual impairment	*n* = 16 Mean age: 70.0 years Female: 92.9% Dropout: 6.2%	IG: LiFE CG: none	Habit formation framework aiming to make LiFE activities habitual	T: individualized F: daily D: 3 months	Trained orientation and mobility instructors, 7 home visits	5 months	N/A

RCT, randomized controlled trial; LiFE, lifestyle-integrated functional exercise; LAT, LiFE assessment tool; PT, physiotherapists; OT, occupational therapists; PA, physical activity; SB, sedentary behaviour; N/A, not available; IG, intervention group; CG, control group; T, time bout; F, frequency; D, duration.

strength exercises performed 3 times a day. The structured training was also taught by care managers with similar frequency and duration.

Three RCTs evaluated combined programmes including structured training and lifestyle-integrated basic functional exercises [37–39]. One of these RCTs [37] aimed at preventing functional decline in nursing home residents. Structured training including practise of transfers, walking, functional balance, and strength exercises, was taught by physio- and occupational therapists within individual supervised sessions (frequency and duration were not specified). Additionally, residents were taught on self-administered training and incorporating the functional exercises into daily routines. Exercises were selected based on individual treatment goals and taught by physio- and occupational therapists (frequency and duration not specified).The intervention was compared with usual care within a 3-month trial.

The 2 other RCTs on combined training [38, 39] aimed at improving mobility and quality of life of older adults living in long-term residential care using the Promoting Independence in Residential Care (PIRC) training. PIRC focuses on basic functional exercise training (e.g., chair rising and walking during daily routines). Exercises are designed to increase strength, balance, and endurance. They are performed either fully integrated into daily routines or supervised at least twice a day. Exercise intensity depends on participant's capabilities and is upgraded during the course of the intervention (e.g., increasing repetitions). In the 2 RCTs [38, 39], exercise frequency and duration were not specified. Gerontology nurses and healthcare assistants implemented PIRC based on individuals' treatment goals and functional performance level. An activity programme displayed in the participant's room was used to encourage residents' engagement. Both RCTs compared PIRC to controls receiving usual care over a period of 6 [39] and 12 months [38].

Dropouts from Study

For LiFE, the number of dropouts was lower (5 [35, 36] to 18% [26]) compared with structured training (7.5 [35] to 21% [26]) and passive controls (25%) [25], and identical to an active control group (18% [26]) (Table 2).

For combined programmes, 1 RCT reported higher dropouts in the intervention (32%) compared with controls (29%) [38], while 2 reported lower dropouts for the intervention (13.7% [39], 15.9% [37]) compared with controls (19.1% [37], 19.7% [39]). Main factors for dropouts were unrelated to the programme, including death

[37–39], illness [25, 26], health problems [25, 26], or moving [25, 26, 37], while some were related to the intervention, such as pain or lack of training partners [26].

Adherence

For LiFE, adherence was measured through an activity planner, in which participants documented their daily LiFE activities. One study compared adherence in LiFE with adherence in structured training. Completing predefined LiFE activities for ≥3 days/week or structured home exercises 3 times a week was rated as 100% adherence [50]. Results showed significantly higher adherence to LiFE (64% of participants) compared with structured training (53%) [26]. Poor adherence (<25%) was apparent in 7% of LiFE and 19% of structured training participants [26]. In 2 other RCTs, adherence was reported as the number of days of LiFE practice or structured training per week, respectively [35, 36]. During the intervention period, adherence for LiFE was higher (4.91 days/week) compared to structured training (4.42) [35, 36]. Four months after the intervention, adherence to both programmes was similar (3.62 vs. 3.66) [36]. During follow-up, 1 study reported significantly higher adherence to the LiFE programme (64% of participants), in comparison with structured exercising (53%). Three studies did not report adherence [25]. For combined programmes, adherence was not reported [37–39].

Adverse Events

In an RCT with 317 participants, 1 participant in the LiFE group was diagnosed with a pelvic stress fracture and attributed this to increased walking and stair climbing, but continued with the programme [26]. In the structured comparison group, 1 participant had a surgery for an inguinal hernia and withdrew from the programme, but it was unclear whether this was related to the intervention.

An RCT on PIRC reported fatigue in 31% of the intervention group and 43% of controls [39]. No adverse events were reported in other RCTs [25, 35–38].

Effectiveness on Motor Performances

Table 3 summarises the effects on outcome measures.

Balance. LiFE was more effective for improving some, but not all, balance outcomes during short-term (8 weeks) and long-term assessments (6 and 12 months) compared with structured training [26, 35, 36], passive controls [25]), or control exercise [26]. Inconsistent results were found for combined programmes, with 1 study reporting significant improvement in the intervention group compared with usual care [37], while others did not [38, 39].

Lower-Limb Strength. Effects for lower-limb strength varied. One RCT reported greater improvements for some (i.e., ankle), but not all (i.e., knee and hip) strength measures for LiFE compared with structured training during short- and long-term assessment [26]. No additional effects for LiFE, compared with structured training, were found in 2 studies [35, 36]. Compared with inactive controls, LiFE significantly increased knee [25], but not hip strength. For combined programmes, effects were either insignificant [38, 39] or not measured [37].

Functional Performance. LiFE was more effective for improving functional performance, measured by performance-based tests or self-report measures shown in Table 3, compared with structured training. For combined programmes, 1 RCT reported significantly improved functional leg muscle strength, measured by timed chair rises, in the intervention while controls deteriorated [37]. Within PIRC, effects on self-reported function were only present in the subsample of cognitively intact participants [38, 39].

Effectiveness for Increasing PA

One RCT showed greater effects of LiFE on PA and energy expenditure compared with structured training [26]. Another RCT did not report increased PA after LiFE compared to passive controls [25].

An RCT evaluating a combined programme reported significant improvements in PA, energy expenditure, and life space (i.e., distance travelled between and within home) in the intervention compared with usual care [37].

Effectiveness for Reducing Falls

For LiFE, a significant reduction in fall rate (31%) in comparison with controls (gentle and flexibility exercises) was reported [26]. Descriptive data showed a non-significant lower rate of falls in LiFE (172 falls) as compared with structured exercise (193) at 12-month follow-up [26]. Another RCT showed a significantly reduced relative risk for falls in LiFE (RR = 0.21) in comparison with controls [25]. For combined programmes, effects were either insignificant [38, 39] or not measured [37].

Studies Using an NRS Design

NRS studies are shown in Table 2. Three before-after studies evaluated the feasibility of LiFE in different settings (i.e., restorative home care [40]), different target populations (i.e., visually impaired [42]), or different administration mode (i.e., group-based [41]). One of them

Table 3. A summary of results reported in the 10 trials with regard to main physical outcome dimensions and measurements

First author [Ref.]	Outcome dimension	Outcome measurements	Outcomes: post-intervention	Outcomes: long-term follow-up		
Randomised controlled trials						
Burton [35, 36]			IG vs. CG:	IG vs. CG:		
	Balance	Functional reach Tandem walk Tandem walk errors	Functional reach: ns Tandem walk: IG↑ Tandem walk errors: IG↑	Functional reach: ns Tandem walk: IG↑ Tandem walk errors: IG↑		
	Muscle strength	Chair rise	Chair rise: ns	Chair rise: ns		
	Functional mobility	TUG	TUG: ns	TUG: ns		
	Self-efficacy	FES ABC Scale	FES: ns ABC Scale: IG↑	FES: ns ABC Scale: IG↑		
	Health-related outcomes	Vitality Plus Scale	Vitality Plus Scale: IG↑	Vitality Plus Scale: IG↑		
	Function	LLFDI	LLFDI: IG↑ for limitation, function total, basic and advanced lower extremity	LLFDI: IG↑ for basic and advanced lower extremity		
Clemson [25]			IG vs. CG:	IG vs. CG:		
	Balance	Static balance (tandem stand, one-leg stand) Dynamic balance (tandem walk)	Static balance: ns Dynamic balance: IG↑	Static balance: ns Dynamic balance: ns		
	Strength	Static hip strength Static knee strength Static ankle strength	Static hip strength: ns Static knee strength: IG↑ for left knee Static ankle strength: ns	Static hip strength: ns Static knee strength: ns Static ankle strength: ns		
	Falls	Number of falls	Number of falls: IG↑	Number of falls: IG↑		
	Self-efficacy	FES (modified) ABC Scale	MFES: IG↑ ABC Scale: ns	MFES: ns ABC Scale: IG↑		
	Health-related outcomes	Markus Exercise Self-Efficacy Scale SF-36	Markus Exercise Self-Efficacy Scale: ns SF-36: ns	Markus Exercise Self-Efficacy Scale: ns SF-36: ns		
	Physical activity	Life Space Index	Life Space Index: ns	Life Space Index: ns		
Clemson [26]					IG1 vs. CG	IG2 vs. CG
	Balance	Five level balance scale (SPPB) Eight level balance scale Tandem walk	–/–	5-level balance scale: *d*, sig 8-level balance scale: *d*, sig Tandem walk: *d*, sig	0.55↑ 0.63↑ 0.42↑	0.33 ns 0.29 ns 0.49↑
	Strength	Maximal isometric lower hip strength Maximal isometric knee strength Maximal isometric ankle strength		Static hip strength: *d*, sig Static knee strength: *d*, sig Static ankle strength: *d*, sig	N/A, ns N/A, ns 0.40↑	N/A, ns N/A, ns 0.17 ns
	Falls	Number of falls		Number of falls: IRR, sig	0.69↑	0.81 ns
	Self-efficacy	ABC scale		ABC Scale: *d*	0.38↑	0.37↑
	Function	Late Life Disability Index (LLDI) Late Life Function Index (LLFI) NHANES independence measure for ADL		LLDI: *d*, sig LLFI: *d*, sig NHANES: *d*, sig	0.73↑ 0.49↑ 0.54↑	0.41 ns 0.17↑ 0.26 ns
	Health-related outcomes	EQ-VAS EQ-5D PASE		EQ-VAS: *d*, sig EQ-5D; *d*, sig PASE: *d*, sig	0.34↑ N/A, ns 0.25↑	0.06 ns N/A, ns 0.05 ns
	Physical activity	Paffenberger physical activity index Life Space Index		Paffenberger index: *d*, sig Life Space Index: *d*, sig	0.62↑ N/A, ns	0.36↑ N/A, ns
Grönstedt [37]			IG vs. CG			
	Activities of daily living	Functional Independence measure (FIM) BBS	FIM: ns BBS: IG↑			
	Balance	Nursing Home Life Space Diameter (NHLSD)	NHLSD: IG↑			

Table 3 (continued)

First author [Ref.]	Outcome dimension	Outcome measurements	Outcomes: post-intervention	Outcomes: long-term follow-up		
	Physical activity	10 m indoors walking or wheelchair propulsion	Walking or wheelchair propulsion: ns			
	Mobility	Physiotherapy Clinical Outcome Variables (COVS)	COVS: IG↑			
	Strength	Dynamometer Chair rise	Dynamometer: ns Chair rise: ns			
	Falls Self-Efficacy	FES, Swedish version	FES-S: ns			
Kerse [38]			IG vs. CG:	IG vs. CG:		
	Function	LLFDI TUG EMS FICSIT-4-balance test	LLFDI: IG↑ (cognitively normal group) TUG: ns EMS: ns FICSIT-4-balance test: ns	LLFDI: ns TUG: ns EMS: FICSIT-4-balance test: ns		
	Quality of life	EuroQol instrument Life Satisfaction Index (LSI)	EuroQol instrument: ns LSI: ns	EuroQol instrument: ns LSI: ns		
	Fall-related outcomes	Number of falls Modified fear of falling scale	Number of falls: ns Modified fear of falling scale: #	Number of falls: ns Modified fear of falling scale: #		
	Psychological outcomes	Geriatric depression scale	Geriatric depression scale: IG↓ (cognitively impaired group)	Geriatric depression scale: IG↓ (cognitively impaired group)		
Peri [39]			IG vs. CG:	IG vs. CG:		
	Mobility	EMS TUG	EMS: ns TUG: ns	EMS: ns TUG: ns		
	Health-related outcomes	SF-36	SF-36: IG↑ for physical component	SF-36: ns		
	Psychological outcomes	LSI	LSI: ns	LSI: ns		
	Falls	Number of falls	Number of falls: ns	Number of falls: ns		
Non-randomised studies						
Opdenacker [43–45] Van Roie[a] [46]			IG1 vs. IG2:	IG1 vs. IG2:		
	Physical activity	Accelerometer Daily steps Flemish Physical Activity Computerized Questionnaire (FPACQ)	Accelerometer: ns Daily steps: IG1↑ FPACQ: IG1↑ for active transportation	Accelerometer: ns Daily steps: IG1↑ FPACQ: ns		
	Psychological measures	Rosenberg Self-Esteem Scale Physical Self-Perception Profile (PSPP) Self-Efficacy questionnaire	Rosenberg Self-Esteem: ns PSPP: ns Self-efficacy: ns	Rosenberg Self-Esteem: ns PSPP: ns Self-efficacy: ns		
	Cardiorespiratory fitness	Maximal exercise test	Maximal exercise test: IG2↑	Maximal exercise test:	Pretest ns	Posttest IG2↓
	Muscular fitness	Static knee strength Dynamic knee strength Total work (strength endurance test)	Static strength: IG2↑ Dynamic strength: IG2↑ Total work: IG2↑	Static strength: Dynamic strength: Total work:	IG2↑ ns ns	IG2↓ IG2↓ IG2↓
	Functional performance	Arm curl test Chair rise Vertical jump	Arm curl test: ns Chair stand test: ns Vertical jump: ns	Arm curl test: Chair rise: Vertical jump:	IG1↑ IG1↑ ns	IG2↓ IG2↓ IG2↓
Burton [40]	Balance	Functional reach Tandem walk Tandem walk errors	Functional reach: ns Tandem walk: ↑ Tandem walk errors: ns	–/–		
	Muscle strength	Chair rise	Chair rise: ns			
	Functional mobility	TUG	TUG: ns			
	Falls	Number of falls	Number of falls: ↑			
	Self-efficacy	FES ABC Scale	FES: ↑ ABC Scale: ns			

Table 3 (continued)

First author [Ref.]	Outcome dimension	Outcome measurements	Outcomes: post-intervention	Outcomes: long-term follow-up
	Health-related outcomes	Vitality Plus Scale LLFDI	Vitality Plus Scale: ns LLFDI: ↑ for function total	
	Function	PASE	PASE: ↑	
	Physical activity	Actical accelerometer	Actical accelerometer: ns	
Fleig [41]	Mobility	SPPB	SPPB: ns	–/–
	Psychological outcomes	Intention to engage in balance and strength Self-efficacy Action planning Action control Coping planning Automaticity Habit strength Self-identity	Intention: ns Self-efficacy: ns Action planning: PE # Action control: PE # Coping planning: ns Automaticity: PE# Habit strength: PE# Self-identity: PE#	
	Subjective health	EQ5D-5L	EQ5D-5L: ns	
Keay [42]	Mobility Function Falls Self-Efficacy	SPPB LLFDI Short FES-I	SPPB: ns LLFDI: ↑ for function Short FES-I: ↑	–/–

d, effect size (Cohen's *d*) for discriminating between different intervention groups; IRR, incidence rate ratio; PE, positive effect; NE, negative effect; #, insufficient or contradictory data and/or analyses; ↑, significant improvement; ↓, significant deterioration; ns, not significant; N/A, not available; TUG, Timed Up and Go test; FES, Falls Efficacy Scale; ABC, Activities specific Balance Confidence; LLFDI, Late Life Function and Disability Index; PASE, Physical Activity Scale for the Elderly; SPPB, Short Physical Performance Battery; EQ5D/EQ-VAS, health-related quality of life; SF-36, Short-form health survey; BBS, Berg Balance Scale; ADL, activities of daily living; EMS, Elderly Mobility Scale. [a] Results of the study were reported in 4 articles focusing on different outcome dimensions.

additionally evaluated effects on behaviour change [41]. One controlled trial compared a combined "Home-Based Lifestyle" (HBL) intervention and a gym-based structured exercise programme [43–46].

Sample sizes ranged from 8 [40] to 86 participants [43–46], mean age from 63.3 [43–46] to 80.8 years [40], and percentage of women from 50 [43–46] to 100% [41].

Interventions

Two feasibility studies [40, 42] adapted LiFE to different settings and target populations. One implemented LiFE in a restorative home care service. Allied healthcare managers (health professionals and nurses) delivered the programme over a short intervention period of 8 weeks (instead of 6 months) [40]. The other adapted LiFE for visually impaired fallers by providing the written manual and/or an additional audio version. LiFE was taught by orientation and mobility staff during 7 home visits over a 3-month period, with 1 follow-up phone call after 5 months.

A third study tested the feasibility of group-based LiFE [41]. Instead of individual teaching, a team (exercise physiologist, health psychologist, personal trainer) taught LiFE within 7 group sessions over a 4-month period. During group sessions, participants learned LiFE activities and developed an individual activity plan. Participants practised LiFE unsupervised in their everyday environment, similar to the original LiFE concept.

One controlled trial evaluated the HBL concept aimed at improving PA, cardiorespiratory and muscular fitness, and functional performance in sedentary older adults [43–46]. HBL is a combined programme including integrated functional exercise (e.g., climbing stairs, squatting while gardening), integrated PA (e.g., walking instead of taking the bus), and structured exercises focusing on balance (e.g., one-leg stand while standing behind a chair), strength (e.g., arm curls), and endurance (e.g., jogging, cycling, or hiking). Structured balance and strength exercises were performed for 8–20 repetitions 2–3 times a week, and endurance training at least 20 min, 3 times a week.

In the controlled trial, HBL was taught during an initial home visit by an exercise psychologist, 16 booster phone calls, and 5 monthly collective group sessions over a period 11 months [43–46]. Information on exercise content and behaviour change were provided by the trainer, a brochure, and a participants' manual. HBL was compared to a group-based structured, supervised programme including balance, strength, flexibility, and endurance exercises performed 3 times a week for 60–90

min in a gym. The control group, recruited separately (not randomised), did not receive any intervention [43–46].

Dropouts from Study

For LiFE, the percentage of dropouts ranged between 6.3% [42] and 23.1% [41] and was related to health problems [40, 41] and family emergencies [41], both unrelated to the programme. Dropout rates were similar for the HBL group (23%) compared with the gym-based exercise (18%) [43–46] and were related to health problems unrelated to the programme or a lack of motivation [43–46] (Table 2).

Adherence

No LiFE studies reported on adherence. For HBL, adherers were defined as those having completed 80% of their programme (not further specified), whereas participants in the gym-based group had to complete 5 out of 6 training sessions in 2 consecutive weeks [43–46]. Adherence was similar for HBL (78%) and gym-based exercise (80%) [43–45].

Adverse events

No study reported on adverse events.

Feasibility of the Intervention

LiFE was feasible in different settings and target populations given that adjustments to particular activities were made [40–46]. Care managers and clients found the LiFE manual clear and easy to understand, but tools for tailoring and monitoring the intervention were perceived as too time-consuming and were replaced by a routine functional assessment performed during home care visits in a subsequent RCT [35, 36].

For visually impaired, LiFE was generally suitable and easy to undertake [42]. Most of participants valued the improvements in balance, strength and overall performance in daily tasks. The delivery through their orientation and mobility instructors and the programme's focus on physical technique were especially emphasised. They appreciated being able to make their own decisions regarding appropriate, but also challenging, exercises and the integration into daily life, increasing the sustainability after completing the programme. However, participants commented on the excessive paper work and some found the manual too long. Both instructors and participants reported difficulties related to reduced vision which prevented participation in specific LiFE activities, including "stepping in different directions," "leaning side to side," and "leaning forwards and backwards." These activities were either too difficult to teach, or participants were unable to perform them, or they were perceived as uncomfortable due to a greater sensation of falling and sense of vulnerability related to their vision impairment. Instructors recommended increasing the number of sessions and enlarge the recording sheets in this specific target population.

For group-based LiFE, most participants valued the group format, appreciating the opportunity of social interaction and exchanging ideas about LiFE activities [41]. Some participants criticised the group setting as they experienced a slowdown in individual progress. Some requested individual face-to-face sessions. Among the different LiFE components (functional assessment, exercise demonstration, behavioural change, documentation), exercise demonstrations were rated as the most important aspects, emphasising the importance of an exercise physiologist in the team. While most participants valued action planning, using LiFE activity sheets, some criticised the administrative effort, as reported in other studies [40]. Most participants valued the behavioural change approach, particularly the contextual cues to overcome problems with remembering exercising during the day. In the controlled trial, feasibility of the intervention was not analysed.

Effects on Motor Performances

Feasibility studies on LiFE [40–42] reported exercise effects, although they were not specifically designed for measuring the effectiveness of the programme.

Balance. One LiFE study reported significant improvements in dynamic balance [40], whereas the others did not [41, 42]. The HBL study did not measure balance [43–46].

Lower-Limb Strength. One LiFE study measured lower-limb strength, but did not obtain effects [40]. For HBL, the gym-based exercise group showed significantly greater improvements in knee strength during short- [46] and long-term assessment [45] compared to HBL and controls.

Functional Performance. Two LiFE studies measured self-reported functional performance and reported significant improvements [40, 42]. In the HBL study, both intervention groups (HBL and gym-based) significantly improved in functional performance (chair rise, and vertical jump) compared to controls [46], but effects were sustained only in the HBL group [45].

Effects for Increasing PA

One LiFE study measured PA and reported significant improvements [40]. For HBL, both intervention groups (HBL and gym-based) significantly improved in PA compared to controls, but effects were sustained only in the HBL group [43].

Effects for Reducing Falls

One LiFE study measured fall rate, reporting a significant reduction ($t(7) = -2.65$, $p = 0.033$) [40]. The HBL study did not measure falls [43–46].

Effectiveness of the Behavioural Change Component

The group-based LiFE induced changes in habit strength and related psychosocial determinants, including automaticity of exercising, self-identity (integration of exercises into one's self-concept), action planning, action control, increase in autonomy, awareness of health-related benefits of exercising, and skills to anticipate potential barriers. No changes were found for the intention to exercise, exercise-related self-efficacy, and planning [41]. No other studies reported this outcome.

Discussion

This systematic review evaluated studies which integrated functional exercises into daily life of older adults. We found some evidence suggesting that integrated training has advantages including higher adherence and effectiveness compared with structured training in selected populations such as community-dwelling older fallers, although the number of RCTs is low. Furthermore, we found studies which combined structured exercise with integrated training, feasible and effective, particularly in impaired target populations such as nursing home residents. Both approaches increased PA level, related to the specificity of the integrated training content aiming to foster everyday activities.

RCT Designs

Long-term training is crucial to modify individuals' behaviour, promote self-efficacy, and gain full health benefits from exercise training. Long-term adherence has often been reported as challenging for structured exercise programmes [15, 16]. In this context, integrated training concepts have been specifically designed to increase adherence by embedding exercises into daily routines. Most RCTs showed that integrated training led to higher adherence rates, compared with structured training in the short [26, 35] and long term [26], while single studies reported similar adherence for both programmes in the long term [36]. One reason for the differences in long-term adherence might be the duration of the intervention (8 weeks [36] vs. 6 months [26]), being crucial for modifying individuals' behaviour (fostering behavioural change).

Importantly, there is no consensus on how adherence should be compared between integrated and structured training. The approach of Clemson et al. [26] was defining 100% adherence when LiFE was performed for ≥3 days/week, although participants were asked to practise daily to make LiFE activities habitual [25, 26]. Moreover, no information was provided about the daily frequency, duration, and intensity of LiFE training, and the exact exercise dosage remains unclear [25, 26]. While dosage can be estimated for structured training, this is difficult for integrated training as participants perform multiple short bouts of activities over the course of a day (e.g., knee bends each time when picking something up), making it hard to count the number of repetitions and estimate intensity. Theoretically, participants could try to document this information, but this would require time-consuming paperwork. Effort for documentation was often mentioned as a drawback in studies [40–42]. A potential solution for future trials might be the use of ICT technology such as smartphones or smartwatches for documenting adherence. Such an approach is currently developed within the EU project PreventIT (www.preventit.eu).

In studies comparing structured with integrated or combined training, very few adverse events were reported [26, 39]. While these results suggest that all approaches are generally safe, the number of adverse events reported in studies was too low to compare different training modes regarding safety. Furthermore, reporting of adverse events differed among studies with some using their own definitions (self-reported muscular aches and pains, fatigue, number of falls [38, 39]) and others not reporting adverse events, hampering comparability. Our findings are in line with a review showing that nearly 20% of exercise trials report no information on adverse events and 25% do not accurately define severity [51].

Structured programmes include fixed exercise sets, standardised according to type, frequency, intensity, and duration. Besides teaching participants correct exercise performance, little knowledge is needed for successful participation in these programmes. In contrast, integrated concepts require participants to understand the theoretical underpinnings, activity principles, implementation strategies, activity planning, and documentation of

adherence. When compared to structured programmes, integrated concepts can be seen as more complex interventions which require self-management strategies. Despite this increased complexity, our review shows that the interventions are feasible and acceptable to older adults [25, 26, 35–39]. Current studies suggest that successful delivery of integrated training requires well-qualified therapists, skilled in both exercise delivery and behavioural change theory [41].

Effectiveness of the Interventions

Effectiveness represents a major criterion for exercise programmes and therefore stands out within evaluation criteria. For effectively improving motor performances and reducing fall risk, exercise programmes need to be adequately challenging and progress in intensity over time [52]. For structured exercise programmes, established guidelines define optimal training modalities such as number of repetitions, and frequency [49].

While integrated training included principles for exercise progression [25, 26, 35, 36, 38, 39], frequency and number of repetitions are not specifically defined. Rather, they are determined by the frequency of the daily task in which an activity is integrated. A key question is whether these single bouts of exercises spread out over the course of the day are similarly effective compared with structured training.

We found several studies showing that LiFE training is similarly effective for improving motor performance when compared with structured training [26], and superior for selected outcomes related to balance [26, 35, 40], strength (i.e., ankle [26]), functional performance [26, 35, 36], and PA [26]. Authors discussed that the added value of LiFE might be related to the increased training dosage due to daily practice, increased level of PA (e.g. stair climbing), and higher adherence during long-term training interventions [26]. The additional effect of LiFE was particularly prominent for balance, but less for strength [25, 26, 35, 36]. For strength, an added value of integrated training is less clear, which might be related to a lack of standardised set of repetitive movements, as supposed in the strength training literature [14].

In structured programmes, participants often perform rather artificial movements, such as isolated knee extensions with weights, to improve strength of a particular muscle group. By comparison, integrated activities are functional and embedded into daily tasks, focusing on improving relevant activities of daily living such as crossing an obstacle or climbing stairs. For LiFE, studies showed that integrated training is superior to structured training for improving overall function and disability in daily life tasks [26, 35, 36], which suggests that integrated training is directly transferable into older adults' daily life and fosters mobility-related independence.

One pilot RCT on LiFE showed a reduction in falls by 80% compared with inactive controls [25]. Findings should be interpreted with caution due to a small, unrepresentative sample not allowing a generalisation of effects. Nonetheless, these findings were the impetus for a second and larger RCT which showed that LiFE reduced falls by 31% compared with active controls receiving gentle and flexibility exercises. This is comparable to effects reported for structured home exercise programmes in community-dwelling older adults (21%) [53].

Results showed that combined programmes were effective for improving balance [37–39], functional performance [37–39], PA [37], but neither strength [38, 39] nor fall-related outcomes [37–39]. While positive results on functional performances are comparable to other RCTs on integrated training in community dwellers, limited effects on strength [38, 39] and falls [38, 39] may suggest that it is more challenging to effectively implement these programmes in institutionalised older adults. Several participants complained about fatigue, which might be a potential barrier to adopting integrated exercises into everyday activities. Also, contamination effects related to the location of the RCT (nursing home) might have biased the results. The intervention and control groups were located in the same nursing home. It was not possible to prevent control participants from participating in the intervention group activities [39]. An advantage of combined programmes was the social interaction during sessions [41]. In contrast, lack of training partner was mentioned as a drawback of the LiFE programme [26]. In combined programmes, participants could share their experiences about integrated training and practise together during group sessions. On the same note, none of the combined exercise RCTs analysed whether the integrated component provided an added value compared with practising in a structured-only format. This could be evaluated in future trials.

NRS Designs

Integrated training is a rather novel concept and the number of RCTs is low. We therefore included NRS to provide additional information about feasibility and effectiveness, although they have lower evidence levels compared with RCTs.

Feasibility studies showed that LiFE was applicable in more impaired populations [40, 42] and implementable

into restorative home care services [40]. However, modifications were required, including downgrading some exercises for safety reasons [40], increasing the script size and providing audio material to compensate for vision loss [42], and reducing the amount of paperwork [40]. On the same note, it remained unclear whether these adjustments were generic or specific, as no comparison to other programmes was made [40–42]. Feasibility studies partly confirmed positive effects on motor performance [40, 42] and PA [40] compared with RCTs. However, results were limited to before-after studies. Future RCTs are needed to evaluate the modified version of the LiFE programme found in this systematic review.

Interestingly, 1 study transferred LiFE to a group format. Participants established their individual activity plan during group sessions (and not during individual home visits). Based on this activity plan, participants practised LiFE in their everyday environment. Authors discussed that the presence of a team of trainers with different backgrounds, including sports science and psychology, had advantages for teaching the exercise and behavioural change component of LiFE. Social interaction, which has been reported beneficial for behavioural change in previous studies [20], was particularly valued by study participants. The study on group-LiFE was limited to a before-after study design and did not compare group-based with individual teaching.

Inducing behavioural change is a major aim of integrated training [41]. However, our review suggests that evidence for behavioural change and automatised integration of functional exercise into daily life is limited. Only 1 before-after study evaluated the behavioural change paradigm related to LiFE and reported positive changes in habit strength and related psychosocial determinants. This proof of concept study indicates that participants are generally able to perform integrated exercises subconsciously after 4 months of practice [41]. Results may suggest that the concept of behavioural change, which is typically implemented in other areas such as dietary behaviour [54, 55], dental hygiene [56, 57], or chronic pain [58], can be transferred to the area of functional exercise training. However, study results are limited to a 4-month period, without long-term follow-up, and a sample of young-old (mean age: 66 years) in which behavioural change is less challenging than in older adults [59].

A controlled trial compared a combined training programme (HBL) with a gym-based exercise training. Positive effects on functional performance and PA measured at post-test were sustained only in the HBL group. Results suggest that HBL is more effective in the long term compared with structured gym-based exercise training. HBL includes a behavioural change approach for fostering integration of training into daily routines, and results suggest that this leads to increased sustainability of effects. Results are in line with the findings from RCTs on LiFE training [26, 36] insofar as the HBL training also led to high sustainability of functional training effects in sedentary older adults. This might be attributed to the principle of training specificity (i.e., HBL is closely aligned to daily tasks [29]). In contrast, the gym-based exercise group performed rather artificial movements focusing on muscular strength, not being directly transferrable into functional daily life activity. Gym-based exercises have been found highly effective for improving lower-limb strength [45, 46], functional performance [46], and PA [46] in several studies. Maintaining training effects requires constantly visiting the gym. If this is difficult for participants, they have to find other ways of being physically active. In such cases, integrated training might be a complement to gym-based training as it allows to continue the training routine adopted during the intervention.

Limitations

Studies included used different designs (RCTs vs. NRS), intervention types (integrated vs. combined approaches), intervention aims (effectiveness, feasibility), and control groups (usual care; passive; gentle and flexibility exercises; structured exercises). This heterogeneity limited the comparability of identified articles and did not allow performing additional analyses such as meta-analysis. Additionally, a lack of quality rating for NRS and a high risk of bias in selection and performance contribute to a lower evidence level of NRS compared with RCTs. However, NRS reported important aspects about feasibility and acceptance (i.e., delivery mode, adaptability of approaches to different populations). These aspects are helpful for designing future RCTs on integrated training.

Conclusion and Recommendations for Future Research

This systematic review provides a comprehensive overview of the available evidence concerning integrated functional exercise training in older adults. Some studies reported advantages of this training concept compared to structured exercise training, including higher adherence, increased effectiveness for improving selected motor performances, and simultaneously increasing PA and reduc-

ing falls. However, the number of RCTs was low, and studies used different training concepts hampering their comparability. NRS provided some evidence about the effectiveness of the behavioural change concept and the feasibility of integrated training in impaired target populations. More RCTs are required for generating a higher level of evidence.

This review helps to inform the design of future trials. Understudied target groups are young-older adults ("baby boomer" generation) as well as substantially impaired populations, such as nursing home residents or rehabilitation patients. One study questioned the feasibility of implementing integrated training in cognitively impaired older adults due to the requirement of self-regulation imposed upon participants [25]. Future research may test specifically adjusted programmes to fully or at least partially sustain the idea of integrated training in this population. For example, we found concepts using nursing home staff for supporting the arrangement and management of integrated training [37–39]. Though it was not specifically evaluated whether this approach fostered adherence. Extending this concept, for instance by placing prompts on objects in institutionalised settings to reinforce automatisation of training, might be an avenue for successful implementation.

Teaching an integrated training to participants within a group was found to be feasible [41], but future studies need to evaluate whether the group format is similarly effective compared to individual teaching and potentially more cost effective.

RCTs in young-older adults aged 60 to 70 years are lacking. The EU project PreventIT (www.preventit.eu) is currently developing an integrated training programme for this population including ICT-based behavioural change paradigm.

In summary, we found that integrated training represents a promising alternative or complement to structured exercise programmes, but future studies are needed to evaluate the true potential of this concept.

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Manuskript 2

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Feasibility of the lifestyle integrated functional exercise concept in cognitively impaired geriatric rehabilitation patients

Introduction

This study aimed to test the feasibility and acceptability of the exercise framework of the lifestyle integrated functional exercise (LiFE) program in cognitively impaired geriatric inpatients. In 2012 an Australian research group published this new concept in the BMJ and received worldwide attention [9]. This was originally developed for fall prevention and activity promotion in older community dwellers by integrating functional exercise into daily routines instead of explicit training sessions. An implicit approach which could be more effective compared to structured exercise programs with potential for higher adherence, greater uptake rate amongst men and its resource efficiency; however, so far the LiFE concept has not been tested in hospital settings [30]. Moreover, it has not been adapted for cognitively impaired patients.

Hospital settings are a crucial care point for older adults suffering from cognitive impairment. A 2016 prevalence study in German hospitals showed that up to 40% of all inpatients over 65 years old suffer from different levels of cognitive impairment and half of these suffered from undiagnosed dementia [26]. Based on demographic changes the number of cognitively impaired patients will increase across all departments, such as orthogeriatrics, vascular surgery and cardiology. Suffering from dementia and/or delirium as a comorbidity has an increasing impact on health care delivery, formal caregiver burden and cost [15]. Many hospital departments outside geriatric medicine are poorly prepared to deal with this patient population. The German Alzheimer's Association estimates that 2–3 million patients will be diagnosed with dementia as a comorbidity in Germany by 2050 [4].

Inpatients with dementia have poorer outcomes due to hospital acquired complications. While the medical problems leading to admission are often alleviated, functional and cognitive performance frequently deteriorates. Medication side effects as well as medical procedures, falls, nosocomial infections, poor ergonomic design and safety driven processes lead to restrictive actions causing muscle loss and balance deterioration [1, 6]. These iatrogenic factors can cause sarcopenia within a few days, which was shown by Kortebein et al. [19]. Major difficulties with balance, strength and other skills affect their ability to safely perform activities of daily living (ADL) [28]. Dementia patients additionally suffer mentally from hospital treatment indications due to the supply situation [20]. They have a higher risk of rapid functional decline and falls during the acute stay [24], whereby hospital stays can be prolonged and mortality is increased compared with cognitively intact inpatients [8]. These problems are caused by limitations in, for example executive functions and/or dynamic balance [27] and make their mobilization challenging.

Only a minority of these patients have access to geriatric evaluation and management (GEM) including physiotherapy, occupational therapy and proactive nursing enhancing early mobilization.

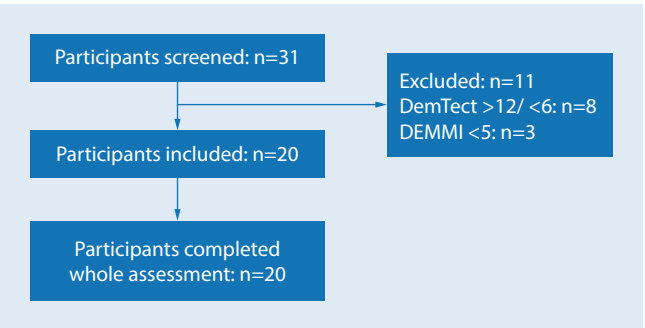

Fig. 1 ◄ Process of screening, inclusion and assessment. *DemTect* detection of dementia, *DEMMI* de Morton mobility index

Authors contribution
N. Belala and C. Becker were major contributors in the recruitment of the study participants and realisation of the study as well as the writing of the manuscript. N. Belala, C. Becker and M. Schwenk were involved in the conceptualization of the study design. A. Kroog as an occupational therapist was involved in the methodological development. All authors read and approved the final manuscript.

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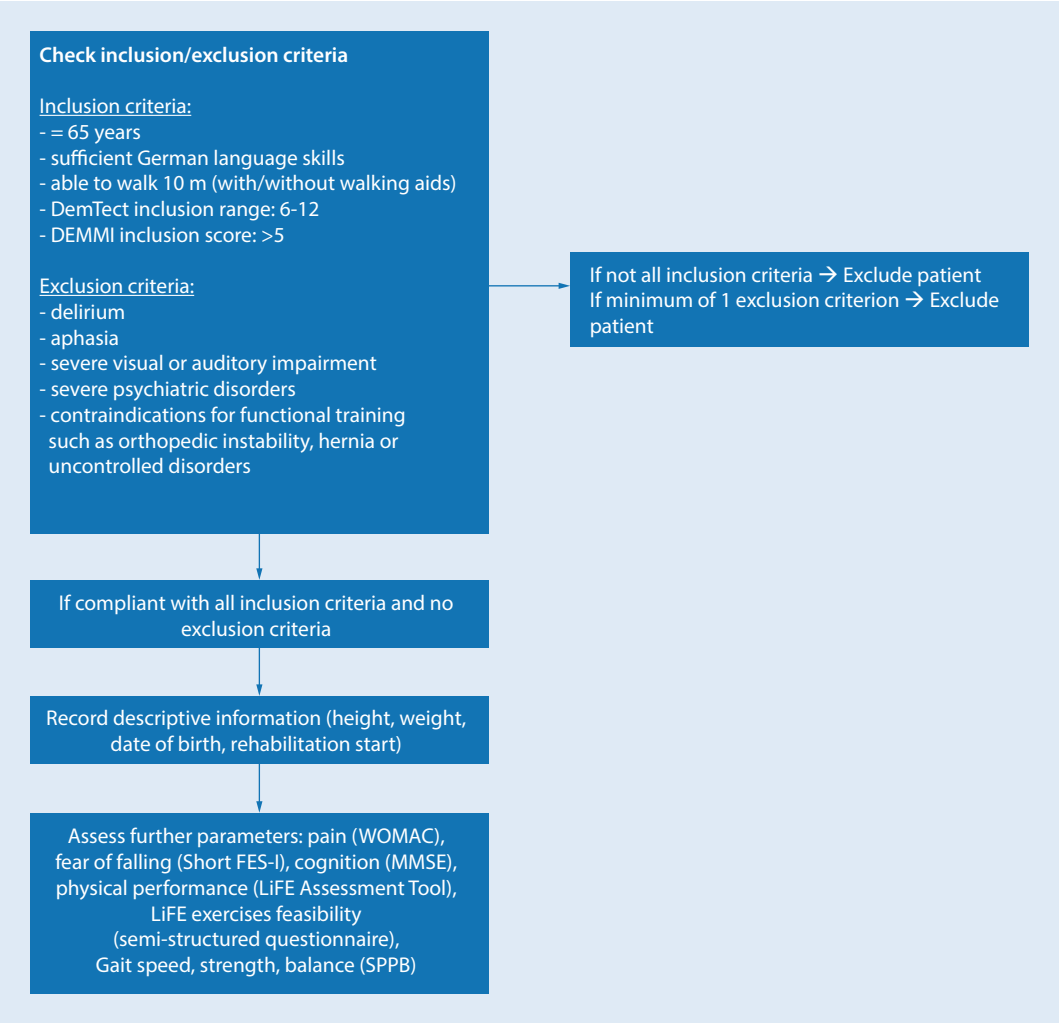

Fig. 2 ◄ Flow chart of inclusion and exclusion criteria. *DemTect* detection of dementia, *DEMMI* de Morton mobility index. *WOMAC* The Western Ontario and McMaster Universities Osteoarthritis Index, *Short FES-I* Falls Efficacy Scale – International (Short Version), *MMSE* Mini Mental Status Examination, *SPPB* Short Physical Performance Battery, *LiFE* Lifestyle integrated Functional Exercise Program

The introduction of the German diagnosis-related groups (DRG) system has created conflicts of interests in the access to early rehabilitation. Only patients that have an estimated length of stay (LOS) of 14 days or more are qualified for extra reimbursement schemes. This potentially discriminates short stayers with a LOS below two weeks and sometimes acts as an argument for delayed discharge.

To tackle this problem additional approaches are needed. The second challenge then is to make current approaches sustainable beyond hospital discharge. To date most training programs, physiotherapy and occupational therapy do not have a sound concept of what is supposed to follow after hospital discharge including concrete training recommendations regarding content, duration and professional support.

Exercise programs should increasingly incorporate transitional care components to improve discharge management in accordance with German legislative changes (October 2017). This model posits that an exercise intervention for functional decline prevention should ideally start in acute care and be continued in the home setting to be sustainable. If the home environment plays a pivotal role, occupational therapists (OT) appear to have a crucial part in developing and applying the program along with physiotherapists (PT) and exercise scientists (ES).

This study is planned as a first step in developing a suitable intervention which tackles the multiple issues regarding early rehabilitation and transitional care for cognitively impaired geriatric inpatients. The feasibility and acceptability of the LiFE exercise framework was tested in this pilot study with a sample during a subacute stay prior to moving to an acute care setting. The geriatric rehabilitation was chosen as a site using the Medical Research Council (MRC) concept for the development of complex interventions [11, 22]. The hypothesis was that the LiFE exercises in the original version would not be entirely feasible and possibly unsafe in this target group of older inpatients with cognitive impairment. It was expected that floor effects in this setting would imply non-feasibility in acute care due to the even frailer and volatile status of the acute patients.

Methods

Participants and study design

A total of 20 participants were recruited in a German geriatric rehabilitation center

(Fig. 1). Although the aim is to develop a transitional exercise intervention which is to start in acute care, it was decided to conduct this pilot study first in a subacute setting, due to MRC's evaluation framework advice [11, 22]. Inclusion criteria were a minimum age of 65 years, sufficient German language skills, the ability to walk 10 m with or without walking aids and a mild to moderate cognitive impairment measured via the DemTect which is scored from 0 to 18, with a lower score indicating greater cognitive impairment. A score from 9–12 shows a mild cognitive impairment, while a score below 9 is considered as a suspected dementia case, meaning a moderate cognitive impairment [17]. An inclusion range from 6 to 12 was included. DemTect was chosen as the measurement for cognition because of its high sensitivity and specificity for mild cognitive impairment and early dementia [17]. Exclusion criteria were delirium, aphasia, severe visual or auditory impairment, severe psychiatric disorders and contraindications for functional training, such as orthopedic instability, hernia or uncontrolled disorders (Fig. 2).

Eligibility was confirmed by a geriatrician (CB) from a medical perspective. Cognition was additionally measured by the use of the mini mental state examination (MMSE) [12] to enable comparison with other study populations as the MMSE is the most frequently used screening assessment for cognition worldwide. To assess physical functions, the de Morton mobility index (DEMMI) [23], which tests specific ADL appearing during a hospital stay, was complemented with the short physical performance battery (SPPB) [14], which measures physical capacities, such as strength, gait speed and balance. This also provided validated assessments for the parameter of physical performance in order to compare its results with the results from the LiFE assessment tool (LAT), developed for the LiFE program but not previously used in this target group. The short version of the falls efficacy scale-international (FES-I) [18] measured the participants' fear of falling. This 10-item, self-report questionnaire has a maximum score of 30 with a higher score displaying a stronger

Abstract · Zusammenfassung

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Feasibility of the lifestyle integrated functional exercise concept in cognitively impaired geriatric rehabilitation patients

Abstract

Background and objective. Increasing numbers of cognitively impaired older persons are admitted for inpatient hospital treatment. Therefore, new approaches are needed to prevent a loss of mobility during hospital stays and improve outcomes of this vulnerable patient group. The lifestyle integrated functional exercise (LiFE) concept uses activities of daily living (ADL) situations as opportunities to improve balance and strength. A pilot study was performed to test the feasibility and acceptability of the LiFE exercises in a geriatric rehabilitation setting.
Methods and patients. A sample of 20 moderately cognitively impaired rehabilitation patients (mean age 84.5 years) tested the feasibility and acceptability of the LiFE exercises.
Results. The testing resulted in floor effects for every tested exercise. Of the exercises two were too difficult for over the half of the participants, namely stepping over objects and walking on heels. In contrast, the sit to stand exercise was feasible for 95% of the patients. The frequency of floor effects for the remaining exercises varied between 20% and 40%.
Conclusion. In this group of moderately cognitively impaired rehabilitation patients the exercises were feasible mostly under supervised conditions and frequently included additional physical support. An adjustment of the LiFE exercises in this setting is required before a trial should be performed in the acute care setting.

Keywords

Cognitive impairment · Exercise program · Feasibility study · Functional decline · Geriatrics

Machbarkeit des Lifestyle-Integrated-Functional-Exercise-Konzeptes bei kognitiv eingeschränkten geriatrischen Rehabilitationspatienten

Zusammenfassung

Hintergrund und Zielsetzung. Eine steigende Anzahl kognitiv beeinträchtigter älterer Menschen wird stationär aufgenommen. Daher werden neue Ansätze benötigt, um einen Verlust der Mobilität während des Krankenhausaufenthalts zu verhindern und die Outcomes dieser vulnerablen Patientengruppe zu verbessern. Das LiFE-Konzept („lifestyle integrated functional exercise") verwendet Situationen der Aktivitäten des täglichen Lebens (ADL) als Gelegenheit zur Verbesserung des Gleichgewichts und der Kraft. Eine Pilotstudie wurde durchgeführt, um die Machbarkeit und Akzeptanz der LiFE-Übungen in der geriatrischen Rehabilitation zu testen.
Methodik und Patienten. Eine Stichprobe von 20 kognitiv mittelschwer beeinträchtigten Rehabilitationspatienten (84,5 Jahre) testete die Machbarkeit und Akzeptanz der LiFE Übungen.
Ergebnisse. Die Untersuchung ergab Bodeneffekte für jede getestete Übung. Zwei Übungen waren für über die Hälfte der Teilnehmer zu schwierig, nämlich „Steigen über Objekte" und „Fersengang". Im Gegensatz dazu war die „Sitz-zum-Stand"-Übung für 95 % der Patienten durchführbar. Die Häufigkeit der Bodeneffekte für die verbleibenden Übungen variierte zwischen 20 % und 40 %.
Schlussfolgerung. In dieser Gruppe kognitiv mittelschwer beeinträchtigter Rehabilitationspatienten waren die Übungen größtenteils unter supervidierten Bedingungen und häufig einschließlich zusätzlicher körperlicher Unterstützung durchführbar. Eine Anpassung der LiFE-Übungen in dieser Umgebung ist somit erforderlich, ehe eine Studie in der Akutstation durchgeführt werden kann.

Schlüsselwörter

Kognitive Beeinträchtigung · Bewegungsprogramm · Machbarkeitsstudie · Funktionsverlust · Geriatrie

Table 1 Baseline characteristics of the study population ($N = 20$)

Age, mean (SD) years	84.5 (6.2)
Sex female, *n* (%)	14 (70)
Height, mean (SD) cm	164.9 (9.7)
Weight, mean (SD) kg	65.0 (14.9)
Rehabilitation status, mean (SD) days	12.6 (6.6)
Number of diagnoses, mean (SD)	5.7 (3.2)
DemTect[a], mean (SD) score	8.3 (1.7)
DEMMI[b], mean (SD) score	45.3 (11.5)
Short FES-I[c], mean (SD) score	7.5 (6.8)
WOMAC[d], mean (SD) score	38.5 (21.6)
MMSE[e], mean (SD) score	20.5 (3.5)
SPPB[f], mean (SD) score	4.6 (2.0)

SD Standard deviation, *N* number
[a]Dementia detection test
[b]de Morton mobility index
[c]Falls efficacy scale-international (short version)
[d]The Western Ontario and McMaster Universities osteoarthritis index
[e]Mini mental status examination
[f]Short physical performance battery

fear of falling. Fear of falling has a strong influence on adherence and motivation in exercising. The Western Ontario and McMaster Universities osteoarthritis index (WOMAC) [3] was used to assess participant's pain, stiffness and difficulties during some ADLs. It has a maximum score of 96 points, with a higher score indicating increasing mobility restrictions due to pain and stiffness. The rehabilitation status shows the duration of the patient's stay in geriatric rehabilitation before the assessment took place. All participants gave written informed consent. The study was approved by the ethical committee of the University of Tübingen (project no. 335/2017BO1). The assessment was performed in the geriatric rehabilitation setting five days after admission, which was considered a reasonable time to avoid additional stress for the patients during the settling-in period (**Table 1**).

The feasibility testing contained the execution of every single exercise of the LiFE program, such as the tandem stand and walk, the one leg stand, leaning forwards and backwards, stepping over objects, e. g. a small box, bending knees, walking on toes and heels for a 1.5 m distance, getting up from a normal chair (sit to stand) and walking sideways.

Table 2 Floor effect occurrence in LiFE assessment tool exercise execution

Assessment position	Floor effects (%)
Tandem stand	25
Tandem walk	30
One leg stand	35
Leaning forwards/backwards	30
Stepping over objects	55
Bending knees	20
Walking on toes	40
Walking on heels	55
Sit to stand	5
Walking sideways	20

Outcome measures

To measure the feasibility of the LiFE program the LAT was performed with assistant's supervision (NB), an exercise scientist by profession, in a single round of exercise execution according to the standardized LiFE trainer's manual [10]. Rating was performed in ascending levels (level 0–4) including increasing difficulty of tasks to be performed until the test was terminated due to the participant's reaching the individual maximum strength or balance capacity or due to safety reasons. In addition to that, a semi-structured questionnaire was used to measure the acceptability of the LiFE exercises in the target group of cognitively impaired patients aged 65 years and older. The questionnaire contained questions regarding overall satisfaction, difficulty, safety and utility regarding balance and strength capabilities which were patient-rated on a 5-point Likert scale with higher scores indicating increasing safety, difficulty etc. Additionally, patients were asked to name the top three favored exercises and the least liked ones. Participants who scored more than three points for difficulty and less than three for overall satisfaction, safety and utility were asked to specify the reason for that scoring as far as possible. All answer patterns have been structured according to internationally stated recommendations. A semi-structured questionnaire with a repetitive response mode at least for the closed-ended questions was designed. Additionally, a visual support was used to offer the participants an easy way of scoring and rating. This displayed the 5-point-Likert scale, as circles of increasing sizes. The respective score was supported by a concrete naming. These adaptations to the Likert scale followed a review with dementia experts. For the open-ended questions (e. g. the nomination of preferred or disliked exercises, reasons etc.) pictures were used to support the decision-making and answering process. All participants managed to complete these questionnaires.

Statistical analysis

Descriptive statistics (mean, standard deviation, frequency, and percentage) were used to describe the characteristics of the participants and their ratings on the program. Feasibility and usability were acceptable if specific cut-off values were achieved in a semi-structured questionnaire. Qualitative responses have been summarized into categories, which are presented in the results section. Feasibility of assessments and used scales have been quantified as percentage of tests successfully completed. The floor effects have been calculated as the percentage of the sample scoring the minimum possible scores.

Results

Of 32 contacted patients 31 were willing to participate but 11 had to be excluded due to being ineligible for the predefined inclusion criteria. The mean age of the included patients was 84.5 years (SD 6.26 years). Cognitive assessment revealed a mild to moderate cognitive impairment severity (DemTect 8.3 ± 1.7; MMSE 20.5 ± 3.5). Characteristics of the study population are listed in **Table 1**. It displays a low fear of falling (short FES-I 7.5 ± 6.8) and a moderate score for pain and stiffness (WOMAC 38.5 ± 21.6) of the study cohort. These scores symbolize that the participants did not seem to feel a restriction in exercising during assessment due to concerns of falling or pain. No drop-outs, meaning no can-

Table 3 Relative frequency distribution for individual exercise convenience and displeasure

Exercise	Convenience (%)	Displeasure (%)
Sit to stand	22.2	0
Walking sideways	16.7	0
Bending knees	14.8	11.8
Tandem walk	11.1	11.8
Stepping over objects	9.2	17.6
Walking on toes	7.4	6
One leg stand	7.4	0
Leaning forwards/backwards	5.6	17.6
Walking on heels	3.7	17.6
Tandem stand	1.9	17.6

celling of assessment execution, and no adverse events or complications related to the study assessment were reported. Some participants were not able to perform the exercises at all, revealing floor effects for every exercise. Detailed results are shown in ◘ **Table 2**.

Reasons for inability of exercise performance varied from instability to lack of muscular strength in the lower extremities. With a mean SPPB score of 4.6 (±2.01) and an average DEMMI score of 45.3 (±11.5), the study participants displayed a below average physical performance for their age group. Only with assessor's support were the majority of the participants able to perform the exercises at least once, except for the stepping over objects and walking on heels exercises which appeared as the major challenging performance tasks. Gathered data regarding convenience, ascertained through response frequency distribution, showed insufficient results for the tandem stand (1.9%), walking on heels (3.7%) and leaning forwards and backwards (5. 6%) exercises, whereas satisfying results concerning the individual convenience were achieved for the sit to stand (22.2%), sideways walk (16.7%) and bending knees (14.8%) exercises (◘ **Table 3**).

The additional question for displeasing exercises strengthen these results, with the tandem stand, leaning forwards/backwards, stepping over objects and walking on heels exercises named each in 17.6% of the cases as being at a challenging difficulty level (50%) and reported instability (50%). Bending knees, sit to stand and walking sideways were the most favored and feasible tasks with higher positive patient response frequencies as well as lower rates of floor effects. Reasons for rating the exercises as too difficult (scoring >3) were strength or balance deficits, which was also the reason for considering the utility of the strength parameter as low. Patients who scored the utility of the strength parameter with less than three points were not able to perform the respective exercises, which indicated they had doubts concerning the benefit of these exercises. No other qualitative answers were collected due to absence of patients' rating below three points for other categories (overall satisfaction, safety and utility for balance; ◘ **Fig. 3**).

The participants needed around 75 min (76.9 ± 6.5 min) to complete the whole assessment, including the testing of the LiFE exercise framework, the questionnaires and the further physical performance tests. This indicated good acceptability of the overall process with no participants discontinuing prematurely.

Discussion

According to data from the World Health Organization (WHO) dementia is now the most costly disease based on acute and long-term care costs from a societal perspective [31], described by Jutkowitz et al. [16]. Hospital stays of patients with dementia are three times more likely to lead to institutionalization in long-term care facilities often as a consequence of cognitive and functional decline caused by the hospital stay [21]. The functional decline entails mobility losses for the affected persons up to months or even years [5, 7], which therefore also affects rehabilitation outcomes. This pilot study examined the feasibility and acceptability of the existing exercise framework of the LiFE program in cognitively impaired patients within a geriatric rehabilitation setting. It is obvious that this concept has the potential to achieve functional and sustainable improvements [9].

The results of this study show that in cognitively impaired geriatric rehabilitation patients the LiFE exercises were feasible under supervised conditions only and the patients mostly required additional support. The authors therefore recommend that further testing of the LiFE program in rehabilitation facilities as well as acute hospitals should incorporate supervision by occupational therapists or other therapists. Post-discharge continuation by lay instructors or family members should also be supervised by therapists at this stage. The acceptability of the exercises was satisfactory due to the familiarity of the tested tasks. This was verbally confirmed by the patients. The patients' answers regarding the usability of the intervention were in favor of the approach.

In this study the assessment using the LAT could be performed successfully. None of the exercises were free of floor effects. Using the SPPB, balance and muscular strength capacities were rated independently from the LiFE exercise execution. The SPPB results underline the mobility limitations found through the usage of the LAT.

Based on the future need of a proactive discharge management there is a need for more transitional care models. In Germany, around 70% of patients suffering from cognitive impairment, often even undiagnosed, are still living at home and this percentage is expected to rise [13]. These interventions should start at the inpatient phase and should be continued in the patient's home environment [25]. Such programs should be started early enough during the acute or subacute stay. The approach of transitional care is also based on the impact of even small reductions of functional decline by as little as 10% that can result in relevant

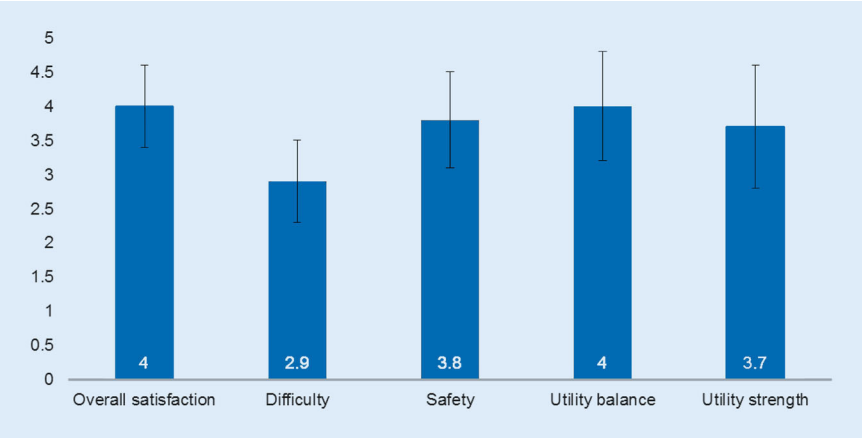

Fig. 3 ▲ Patient rating of their subjective impressions on the tested exercises (5-point Likert scale)

effects [16]. Transitional care models, which are suitable for patients with cognitive impairment, and which are easy to implement in daily routines are therefore of utmost importance.

There is an increasing demand for a rapid or as soon as possible (ASAP) rehabilitation initiation. In Germany, this is questioned especially for patients with an expected LOS of less than two weeks. These patients economically are considered ineligible for a reimbursement due to the current legal framework of the operation and procedure code (OPS 8-550.1). The coding practise of OPS 8-550.1 discriminates patients with a stay shorter than 14 days. This administrative decision leads to a zero reimbursement and is not backed by data or controlled trial evidence.

Next steps

The results regarding usability and acceptability as well as the nomination of convenience and displeasure with specific exercises provides a basis to refine the program to be suitable for cognitively impaired inpatients. The absence of drop-outs and adverse events during this short study provides support for developing it as an early rehabilitative and transitional care exercise intervention.

The LiFE concept appears to be suited in particular for an occupational therapy (OT) approach as it considers person-environment interactions as facilitators. This is a classical OT framework. The next phase of the study will therefore involve OTs in the customization of the LiFE programme including hospital routines during ADLs. All components will be complemented by educational tools for formal and informal caregivers. Processes such as toileting, transfers, clinical rounds and diagnostic procedures often can be used to counteract the toxic effects of immobility.

The original LiFE concept has two further components that are considered key operational tools to successful uptake. The activity planner captures daily routines by using a chart to list them. This timetable supports the finding and modifying of routines to make them more challenging. Particular aspects are "cues" for the patient and family, such as brushing the teeth, washing the dishes or having lunch, which are relevant for habit formation in order to incorporate new LiFE components into routines. The authors are therefore planning on analyzing structures and daily routines during inpatient care as well as in the home setting on a random basis. This analysis would then provide the information needed to develop the theoretical framework of the new intervention including the adjusted exercise framework following on from these results. It is further assumed that obtaining increased intramural physical activity implies structural changes in the daily procedures of hospitals and rehabilitation facilities, such as the integration of exercises during certain daily routines.

A limitation of the study is a relatively small sample size. A second aspect is that the choice of a subacute setting to test the feasibility limits to some extent the generalizability to the acute setting. Furthermore, the use of the WOMAC has to be questioned. Better assessments of pain are now validated. For future trials it is planned to change this assessment to a disease-specific assessment, such as the BESD ("BEurteilung von Schmerzen bei Demenz") [2, 29], which would also allow a different dementia severity inclusion range.

Conclusion

- In the target group of cognitively impaired older inpatients the LiFE exercises were mostly feasible only under supervised conditions with additional support.
- The acceptance of the tested exercise program was good.
- The program needs to be embedded into the clinical routines.
- Refinements and testing are required before an implementation in a transitional care approach including lay supervisors can be achieved.

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Compliance with ethical guidelines

Conflict of interest. N. Belala, M. Schwenk, A. Kroog and C. Becker declare that they have no competing interests.

All procedures performed in this study involving human participants were in accordance with the standards of the ethics committee of the University of Tübingen and with the 1964 Helsinki declaration and

its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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Early inpatient rehabilitation for acutely hospitalized older patients: a systematic review of outcome measures

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Abstract

Background: Selecting appropriate outcome measures for vulnerable, multimorbid, older patients with acute and chronic impairments poses specific challenges, which may have caused inconsistent findings of previous intervention trials on early inpatient rehabilitation in acutely hospitalized older patients. The aim of this review was to describe primary outcome measures that have been used in randomized controlled trials (RCTs) on early rehabilitation in acutely hospitalized older patients, to analyze their matching, and to evaluate the effects of matching on the main findings of these RCTs.

Methods: A systematic literature search was conducted in PubMed, Cochrane CENTRAL, CINAHL, and PEDro databases. Additional studies were identified through reference and citation tracking. Inclusion criteria were: RCT, patients aged ≥65 years, admission to an acute hospital medical ward (but not to an intensive medical care unit), physical exercise intervention (also as part of multidisciplinary programs), and primary outcome measure during hospitalization. Two independent reviewers extracted the data, assessed the methodological quality, and analyzed the matching of primary outcome measures to the intervention, study sample, and setting. Main study findings were related to the results of the matching procedure.

Results: Twenty-eight articles reporting on 24 studies were included. A total of 33 different primary outcome measures were identified, which were grouped into six categories: functional status, mobility status, hospital outcomes, adverse clinical events, psychological status, and cognitive functioning. Outcome measures differed considerably within each category and showed a large heterogeneity in their matching to the intervention, study sample, and setting. Outcome measures that specifically matched the intervention contents were more likely to document intervention-induced benefits. Mobility instruments seemed to be the most sensitive outcome measures to reveal such benefits.

Conclusions: This review highlights that the selection of outcome measures has to be highly specific to the intervention contents as this is a key factor to reveal benefits attributable to early rehabilitation in acutely hospitalized older patients. Inappropriate selection of outcome measures may represent a major cause of inconsistent findings reported on the effectiveness of early rehabilitation in this setting.

Trial registration: PROSPERO CRD42017063978.

Keywords: Acute care, Hospitalization, Aged, Rehabilitation, Exercise, Outcome measures

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Background

Older patients treated in hospital - and those who treat them - face complex challenges which arise from a multitude of negative health conditions. In addition to acute medical illness as the cause of the hospital admission and the high prevalence of multimorbidity in this patient population, older patients frequently show further associated geriatric conditions, such as malnutrition, cognitive impairment, delirium, impairments in (instrumental) activities of daily living ([I]ADL), incontinence, and sensory impairment [1]. Apart from the fact that each of these conditions will request a specific, often enough individualized response, the mass of negative conditions, and the advanced frailty status frequently observed in these patients, put them at an extraordinary risk for hospital-associated deconditioning. As an expected consequence, the prevalence of functional decline during hospital stay is high, varying from 30 to80% depending on the assessment methodology, medical status, and age cohorts included [2, 3]. The consequences of this decline during are manifold, ranging from re-hospitalization, nursing home placement [4], and subsequent mortality [5] to an increased number of falls, poor quality of life, and increased use of health-related resources [6].

For all patients admitted to acute medical care, the subsequent phase of immobilization is crucial as it will drastically impair their functional status to a level where autonomy is seriously endangered [7]. Consequently, hospital admission represents a vulnerable period in the treatment process in which an early onset of rehabilitation and physical training is of utmost importance, providing the basis for post-recovery and subsequent therapeutic and rehabilitative care.

The effect of early physical exercise interventions in acutely hospitalized older patients has already been examined in a number of previous systematic reviews [3, 8–13], reporting heterogeneous results across different outcomes and outcome categories such as hospital outcomes, adverse clinical events, or functional and mobility outcomes. A potential cause of this inconclusive evidence for the benefits of early physical exercise interventions has been addressed in one of these reviews, hypothesizing that the adaption level of the intervention to the capabilities of the patients might have played a critical role for the effectiveness of such interventions in acutely hospitalized older patients [13]. However, contrary to this hypothesis, patient-tailored physical exercise interventions were not found to be superior to those interventions that were not. Another potential cause for the still limited evidence might be the use of various outcome measures, which has been reported in most of the aforementioned reviews [3, 10, 11, 13]. However, none of these reviews specifically addressed the heterogeneity and the appropriateness of the outcome measures selected in the previous studies. The selection of the outcome measure(s), i.e. the operationalization of the outcome, is a critical step in designing a valid and useful clinical study [14]. In absence of an appropriate outcome measure, the impact of an intervention may be lost and benefits of the intervention may not be captured [14, 15]. Outcome measures used in clinical trials seem to have been most frequently evaluated focusing only on their psychometric properties [16, 17]. However, such focus fails to address also important questions about the suitability of the measures for their intended use. When reviewing and selecting an appropriate outcome measure for a tailored study design, the evaluation of the psychometric properties represents a first step, but also further requirements have to be considered. Most importantly, researchers should select outcome measures that match the intervention contents and specifically address the areas being targeted by them. If an intervention content is not well represented in the outcome measure, true changes in the relevant areas the researches expect to be influenced by the specific intervention may be lost because the selected outcome measure was unable to capture it. Further, it is important to determine whether the outcome measures are feasible in the target population. Feasibility aspects such as floor effects, indicating an overtaxation of patients, and ceiling effects, indicating an insufficient test challenge, must be considered, especially in the acute hospital setting with a highly heterogeneous patient population. Another criterion that must be considered when selecting appropriate outcome measures is to determine whether any features of the items could be problematic for use in the research setting. For example, IADL scales include items that assess an individual's ability to perform instrumental home or community activities such as housekeeping and going shopping, which cannot be appropriately assessed within the acute care hospital setting [14, 18]. Meeting these requirements in the early hospital-based geriatric rehabilitation poses a particular challenge based on the fact, that acutely hospitalized older patients represent a heterogeneous, multimorbid and vulnerable patient population in a complex environment during a critical phase of recovery [9]. Consequently, potential multiple goals in the treatment of these patients will go along with different intervention strategies and outcome measures to be amalgamated into a specifically tailored study design, which may not have been achieved in previous studies.

The aim of this systematic review was (1) to describe outcome measures as used in previous intervention trials for early rehabilitation in acutely hospitalized older patients and analyze their matching to the contents of the intervention, the study sample, and the acute care

hospital setting, and (2) to evaluate the effects of matching on the main findings reported in these intervention trials.

Methods

Search strategy and study selection

A systematic literature search was conducted in the electronic databases of PubMed, Cochrane CENTRAL, CINAHL, and PEDro from inception to December 2016. An extensive search strategy was developed for the PubMed database (Additional file 1: Table S1) and adjusted to the other electronic databases. Manual searching was also performed to identify additional studies by scanning reference lists of relevant review articles and included articles.

The inclusion criteria were as follows: (1) randomized, controlled intervention trial (RCT), (2) in older people aged 65 years or older (or 95% of participants aged at least 65 years), (3) admitted to an acute hospital medical ward but (4) not to an intensive medical care unit, (5) with a physical exercise intervention or a multidisciplinary program with physical exercise as a training component, both performed in an acute hospital medical ward, and (6) at least one primary outcome measure during acute care hospitalization. Studies were excluded if they were conducted in subacute hospital settings (e.g. rehabilitation wards), feasibility studies, or written in languages other than English.

The selection process was conducted following the methodology as described in the method guidelines of the Cochrane Collaboration [19]. Each step of the selection process was performed independently by two researchers (PH, NB), and disagreements were resolved by consensus or third party consultation (KH, JMB). The review followed the PRISMA guidelines for reporting systematic reviews and meta-analyses (see Additional file 2 for the completed PRISMA checklist [20]) and was registered at the PROSPERO International prospective register of systematic reviews (PROSPERO 2017: CRD42017063978).

Data extraction

Data extraction was completed by the two reviewers (PH, NB) using a standardized data collection form as recommended by the Cochrane Collaboration [21]. For each study, the following data were extracted: author, country, sample characteristics, primary and secondary outcome measures during hospitalization, time point of measurement, intervention contents, and main findings on primary outcome measures. The extracted data were structured into a table and systematically analyzed.

Data analysis

Matching of outcome measures

An initial set of guidelines to help evaluate the matching of outcome measures for clinical trials have been proposed by Coster (2013) [14]. Taking these guidelines into account, the primary outcome measures identified for each study during hospitalization were matched with the intervention contents, the sample included in the study, and the acute care hospital setting. The criteria used for this matching procedure were provided in Table 1. The matching procedure was performed independently by two researchers (PH, CW), and any disagreements were resolved by consensus or third party consultation (KH, JMB).

The main findings reported on the primary outcomes were subsequently related to the results of the matching procedure, with special focus on the matches between the outcome measures and the intervention contents, representing the most important factor to demonstrate the impact on the relevant areas being targeted by an intervention [14]. The evaluation of the intervention effects was based on the significance level of between-group differences in the primary outcomes. *P*-values ≤0.05 were considered statistically significant.

Quality rating

Each included study was assessed using the PEDro scale, which consists of 11 items for rating the methodological quality of RCTs [23]. When available, confirmed PEDro scores from the PEDro database were used for the quality rating [24]. If no confirmed PEDro score was available, the quality rating was performed independently by two researchers (PH, NB). Disagreements were resolved by consensus or third party consultation (KH, JMB). A study with a PEDro score of ≤5 points is considered to be of low methodological quality at high risk of bias [25].

Results

The search strategy yielded 17.074 potentially relevant articles (Fig. 1). After removing duplicates and screening of title and/or abstract, 184 articles were obtained in full text and evaluated for eligibility based on the predefined inclusion criteria. In total, 28 articles published between 1995 and 2016 were identified for inclusion. As four [26–29] and another two included articles [30, 31] reported each on the same RCT, the search finally resulted in 24 identified studies. The detailed data extracted for each of these studies were presented in Table 2.

Methodological quality

Total PEDro scores ranged from 2 to 8 points, with a mean score of 6.0 ± 1.7 points. High methodological quality and low risk of bias were found for 17 studies (70.8%), with a PEDro score of > 5 points [27, 31, 32, 34, 39–46, 48, 49, 51–53]. Seven studies (29.2%) did not exceed a score of 5 points, indicating a low methodological quality and high risk of bias [33, 35–37, 47, 50, 54]. The

Table 1 Criteria for the matching of an outcome measure with the intervention, study sample, and setting

Criteria		Rating	
Intervention	Did the outcome measure match an intervention content?	"Match"	The outcome measure specifically addressed the exercise intervention or an intervention content of the multidisciplinary program (e.g., 6-Meter Walking Test → treadmill walking training; discharge destination → discharge planning).
		"Limited match"	The outcome measure addressed the exercise intervention or an intervention content of the multidisciplinary program only to a limited extent and/or included only single items that specially matched to the intervention (e.g., Barthel Index [transfer, mobility, and stairs items] → strengthening and mobility exercises; physical activity monitoring → weight-bearing exercises)
		"No match"	The outcome measure did not directly address the exercise intervention or an intervention content of the multidisciplinary program or the construct of the outcome measure was not addressed in the intervention (e.g., Lawton IADL scale → no IADL training content or discharge destination → additional exercise intervention).
Study sample	Was the outcome measure feasible in the study sample?	"Match"	The outcome measure showed no floor or ceiling effects (continuous outcomes) or represented no rare event (dichotomous outcomes). Ceiling and floor effects were defined as (1) ≥ 15% of participants reaching a score within the best or worst 15% of the instrument's rating scale [22] or (2) when the mean score of the sample was within the best or worst 15% of the rating scale. Rare events were defined when the incidence of a dichotomous outcome (e.g., falls, mortality) was ≤15% in the sample.
		"No match"	The outcome measure showed floor or ceiling effects (continuous outcomes) or represented a rare event (dichotomous outcomes).
	How high was the missing data rate for the outcome measure in the study sample?	"Match"	The outcome measure had an acceptable missing data rate. Missing data included any outcome data that (1) could not be collected for reasons other than death or study withdrawal or (2) were collected but not presented. A missing data rate of < 15% was considered as acceptable.
		"No match"	The outcome measure did not have an acceptable missing data rate (≥ 15%).
Setting	Did the outcome measure match the acute care hospital setting?	"Match"	The outcome measure addressed a construct or activities that can be appropriately assessed within the acute care hospital setting (e.g., hospital costs or Barthel Index).
		"Limited match"	The outcome measure addressed a construct or activities that can be appropriately assessed only to a limited extent within the acute care hospital setting and/or included only single items or contents that were appropriate for use within the acute care hospital setting (e.g., combined ADL-IADL measures).
		"No match"	The outcome measure addressed a construct or activities that cannot be appropriately assessed within the acute care hospital setting (e.g., IADL measures).

detailed quality scores on the PEDro scale for each RCT are provided in Additional file 3: Table S2.

Study samples

The mean sample size was 357 ± 421 and varied considerably from 15 [36] to 1632 [47] participants, with half of the studies (n = 12, 50.0%) recruiting at least 200 participants [30, 32, 39, 42, 44, 46–51, 53]. Participants' age across studies averaged 80.0 ± 3.4, with a range from 71 [38] to 85 [33] years. Identified studies predominantly included older patients with general medical conditions (n = 12, 50.0%) [32–34, 36, 39, 40, 42, 44, 46–48, 50] or acute hip fracture (n = 8, 33.3%) [27, 30, 37, 41, 43, 49, 51, 53]. Other patient characteristics for study inclusion were acute exacerbation of chronic obstructive pulmonary disease (COPD) (n = 2, 8.3%) [38, 45], delirium (n = 1, 4.2%) [52], or abdominal surgery (n = 1, 4.2%) [35].

Interventions

Early inpatient rehabilitation interventions could basically be divided into two categories: (1) "hospital usual care" with an additional or modified exercise program as included in 14 studies [32–45] or (2) multidisciplinary programs with an exercise component as included in 10 studies [27, 30, 46–53]. In the following, we refer to these two categories as exercise interventions and multidisciplinary programs, respectively.

Multidisciplinary intervention teams usually consisted of geriatricians, nurses, physical therapists, occupational therapists, dieticians, and/or social workers. Apart from

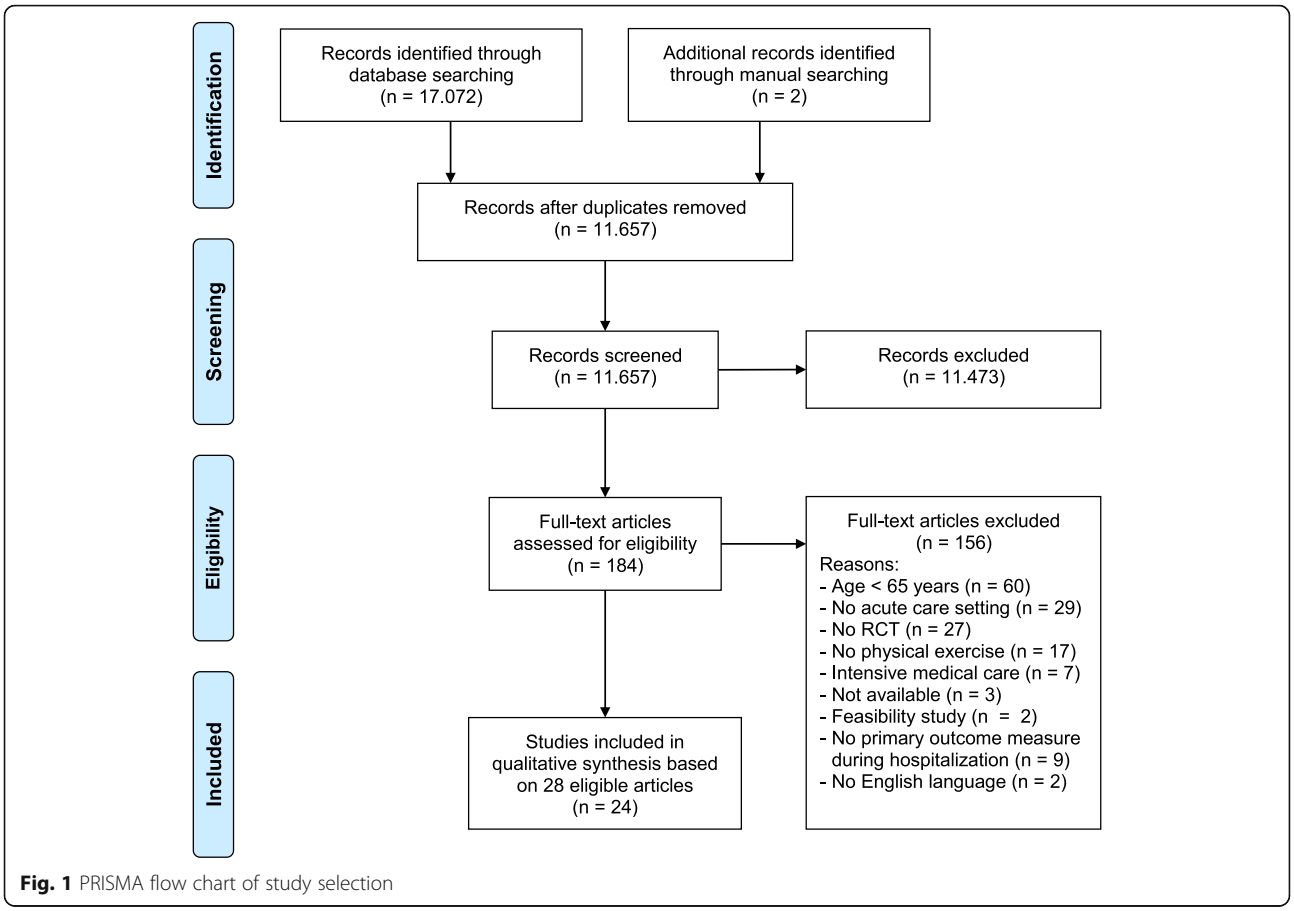

Fig. 1 PRISMA flow chart of study selection

the exercise component, multidisciplinary programs included components of comprehensive geriatric assessment [27, 30, 46–50, 52, 53], multidisciplinary team meetings and individual care planning [27, 30, 46–51, 53], discharge planning [30, 46–53], nutritional interventions [27, 30, 47, 48, 50, 52], prevention and treatment of complications (e.g., vitamin supplementation, screening of infections) [27, 51], cognitive interventions [26, 47, 48, 50, 52], psychological interventions [47, 48, 50, 52], staff education [27, 51], or specifically-designed environments [47, 48, 50].

The content of the exercise component of the multidisciplinary programs most frequently included ADL training [27, 30, 47–51] and/or strength training [27, 30, 51]. Three studies did not provide detailed information on the content of the exercise component apart from stating that it included physical and/or occupational therapy [46, 52, 53].

Exercise interventions were usually supervised by physiotherapists, occupational therapists, nurses, allied health assistants, or staff specifically trained by physiotherapists. Intervention contents included modified or additional exercises with walking training [36, 40–44], strength training [33, 39–41, 44], ADL training [32, 36, 37, 42], flexibility training [38, 44], lower-limb endurance training [38, 45], cognitive exercises [32, 39], balance training [40], transfer training [40, 41], physical activity (PA) behavior intervention [34, 38], IADL training [36], breathing exercises [38], and/or proprioceptive neuromuscular facilitation exercises [35].

Participants in the control groups of the studies generally received usual care according to the general routines of the hospital they were admitted to.

Outcome measures

Identified outcome measures varied considerably among the included studies, with a total of 33 different primary outcome measures. They can be grouped into the following eight categories: (1) functional status, which refers to measures of (I) ADL; (2) mobility status, which refers to measures of motor performance or PA behavior; (3) hospital outcomes, which refers to measures of healthcare utilization during hospitalization (e.g., length of stay [LOS], hospital costs]; (4) adverse clinical events, which refer to measures of falls, medical complications, or mortality; (5) psychological status, which refers to measures of health-related quality of life (HRQOL),

Table 2 Characteristics of the included studies

Study Country	Sample	Intervention	Outcome measures during hospitalization* (category: outcome measure) *primary outcome measure in bold	Time point of measurement (primary outcome)	Main findings
Abizanda 2011 [32] Spain	*n* = 400 Mean age, 84 yrs. Females: *n* = 227 (57%); Patients with acute medical illness (stroke, cardiopulmonary pathologies, or other diagnoses)	Intervention: - Additional occupational therapy by special trained therapists (daily 45-min sessions, 5 days/week) - Day 1: physical, functional, cognitive social and emotional assessment; preparation of individual therapeutic plan - Day 2 until discharge: cognitive exercises, ADL training (mobility in bed, sitting and standing, chair to bed transfers, wheelchair to bed/toilet transfers, dressing, bathing, personal hygiene, toilet use) - Day of discharge: a second 30-min session in addition to the regular 45-min daily intervention; instruction for relatives or caregivers; recommendations for ADL at home Control: Conventional treatment with usual physiotherapy	**FCT: Barthel Index** (improvement of ≥10 pt. from admission to discharge) COG: CAM	Admission Discharge	Between-group differences at discharge: - Improvement in Barthel Index of ≥10 pt. from admission to discharge: n.s. (total sample, stroke/ cardiopulmonary patients), ↑ (others) - Absolute improvement in Barthel Index: n.s. (total sample, stroke patients, others), ↑ (cardiopulmonary patients) Feasibility: - Missing data: Barthel Index = 0% (admission), 6% (discharge)
Blanc-Bisson 2008 [33] France	*n* = 76 Mean age: 85 yrs. Females: *n* = 55 (72%); Patients with acute medical illness	Intervention: - Additional early physiotherapy (start: day 1 or 2, 2 times/day for 30 min, 5 days/week), - Focus on leg extension exercises in the upright position - Nutritional supplements Control: - Walking with/without technical assistance or human help (start: day 3 to 6, 3 times/week until discharge) - Nutritional supplements - Physical therapy at home for 1 month	MOB: Handgrip strength (handheld dynamometry) **FCT: Katz ADL Index** BPN: Body weight, energy intake, protein intake, calf and arm circumferences, triceps skin fold, biochemical measures (serum albumin, C-reactive protein)	Admission Clinical stable condition	Changes from admission to clinical stable situation in total sample (time effect): - Katz ADL Index: ↓ Feasibility: - Missing data: Katz ADL Index = 0%
Brown 2016 [34] USA	*n* = 100 Mean age: 74 yrs. Females: *n* = 3 (3%) Patients with acute medical illness	Intervention: - Additional mobility protocol: Starting with basic transfers with progress to ambulation if tolerated (2 times/day, 15–20 min, 7 days/week) - Patients were encouraged to walk at each session - Physical activity behavioral strategy: goal setting, diary and interview to increase times out of bed Control: Usual care (physical therapy had to be ordered by physicians)	**FCT: Modified Katz ADL Index** HU: LOS, physical therapy ordered during hospitalization ACE: Falls	Admission Discharge	Between-group differences at discharge: - Modified Katz ADL Index: n.s. Changes during hospitalization in total sample: - Katz ADL Index: n.s. Group × time interaction during hospitalization: - Katz ADL Index: n.s. Feasibility: - Katz ADL Index: mean admission score in both groups was within the best 15% of the rating scale → ceiling effect
Czyzewski	*n* = 34	Intervention:	**MOB: 10MWT, TUG**	3 days prior	Within-group changes from 3

Table 2 Characteristics of the included studies *(Continued)*

Study Country	Sample	Intervention	Outcome measures during hospitalization* (category: outcome measure) *primary outcome measure in bold	Time point of measurement (primary outcome)	Main findings
2013 [35] Poland	Mean age: 76 yrs. Females: *n* = 14 (41%); Patients with major abdominal surgery	- Usual care with a modified exercise component based on the Proprioceptive Neuromuscular Facilitation concept (30 min/day) Control: Usual care (30 min/day)	**FCT: Lawton IADL scale MOB: UCLA scale, PPSA** BPN: Forced ventilation capacity, first-second forced expiratory volume, maximal expiratory flow (spirometry) HU: LOS	surgery 4 days after surgery	days prior surgery to 4 days after surgery: - 10MWT, TUG: ↓ in both groups - Lawton IADL scale, UCLA, PPSA: NA Between-group differences 4 days after surgery: - PPSA: ↑ - 10MWT, TUG: NA Feasibility: - Lawton IADL scale: mean admission score of the sample was within the best 15% of the rating scale → ceiling effect - Missing data (3 days prior & 4 days after surgery): 10MWT, TUG = 9%, SAP = 0%, UCLA, IADL: NA
Eyres 2005 [36] Australia	*n* = 15 Mean age: 80 yrs. Females: *n* = 9 (60%); Patients with acute medical illness	Intervention: - Daily additional occupational therapy - Self-care program (ADL), IADL training (e.g., cooking, laundry, café visits), community mobility (e.g., walking outdoors) Control: Usual care	**FCT: FIM PSY: Self-Efficacy Gauge, Life Satisfaction Index** HU: LOS, use of allied health services, use of community services, discharge destination	Admission Discharge	Within-group comparisons over time: - FIM ↑ (IG, CG) - Self-Efficacy Gauge: n.s. (IG, CG) - Life Satisfaction Index: n.s. (IG, CG) Feasibility: - Missing data: FIM, Self-Efficacy Gauge, Life Satisfaction Index = 0%
Hagsten 2004 [37] Sweden	*n* = 100 Mean age: 80 yrs. Females: *n* = 80 (80%); Patients with hip fracture	Intervention: - Additional occupational therapy (40–60 min, 5 days/week) - Self-care, independence at home (transfers, bathroom visits, morning activities, dressing), use of aids - Home visits - Instruction of a physiotherapist CG: Usual care from nursing staff, instruction of a physiotherapist	**FCT: Modified Klein-Bell ADL Scale (75 items of 4 areas: dressing, toilet visits, mobility, bathing/hygiene); mDRI with visual analogize scales for ADL, indoor IADL, and outdoor IADL** PSY: Study-specific mDRI items on fear of performing (I)ADL and for pain level during (I)ADL performance	Discharge	Between-group differences at discharge: - Modified Klein-Bell ADL scale: dressing ↑, toilet visits ↑, hygiene ↑, mobility: n.s. mDRI: ADL, indoor/outdoor IADLs, fear, pain: n.s. Feasibility: - Missing data: Klein-Bell ADL scale, mDRI = 0%
He 2015 [38] China	*n* = 101 Mean age: 71 yrs. Females: *n* = 11 (12%) Patient with acute COPD exacerbation	Intervention: - Patient education (physical activity behavior intervention): benefits and importance of daily exercise, pacing and energy-conservation technique to manage ADL - Stretching, endurance & strength training (endurance lower limb: walking with treadmill; upper limb: shoulder flexion and abduction with light weight; strength training: free weights or body weights) - breathing exercise: relaxation, breathing control, pursed-lip breathing, pacing during	**MOB: 6MWT DS: mMRC dyspnea grade, ADL-Dyspnea scale, CRQ-SAS, CAT** Borg dyspnea scale, Bode index BPN: Resting/exercise oxygen saturation (spirometry, arterial blood gas analysis)	Admission Discharge	Within-group differences from admission to discharge: - 6MWT: ↑ (IG), n.s. (CG) - mMRC dyspnea grade: ↑ (IG), n.s. (CG) - ADL-Dyspnea scale: ↑ (IG), n.s. (CG) - CRQ-SAS: ↑ (IG), n.s. (CG) - CAT: ↑ in both groups Feasibility: NA

Table 2 Characteristics of the included studies *(Continued)*

Study Country	Sample	Intervention	Outcome measures during hospitalization* (category: outcome measure) *primary outcome measure in bold	Time point of measurement (primary outcome)	Main findings
		exercise - 30 min 2 times/day Control: Usual care			
Jeffs 2013 [39] Australia	*n* = 649 Mean age: 79 yrs. Females: *n* = 340 (52%) Patients with acute medical illness	Intervention: - Graded physical activity and orientation program twice daily in addition to usual care - Physical activity program: progressive, variable resistance training against gravity, body or light weight (progression whenever a patient could perform 10 repetitions), - Cognitive exercise program: Orientation, (7 questions for improving orientation [day, month, year, date, ward, bed number, name of primary nurse]); - 2 times/day, 5 days/week, 20–30 min until discharge + self-training on weekends Control: Usual care (including: 24 h nursing care, daily medical assessment, allied health referral)	**COG: Number of delirious patients**, severity/duration of delirium (CAM) HU: Discharge destination, LOS	Admission Every 48 h until discharge	Between-group differences - Number of delirious patients: n.s. Feasibility: - No delirium in 94% of patients → rare event
Jones 2006 [40] Australia	*n* = 160 Mean age: 82 yrs. Females: *n* = 92 (58%) Patients with acute medical illness	Intervention: - Additional exercise program (2 times/day, 30 min) - Strengthening and mobility exercises (e.g., sit-to-stand transfer) specifically designed to be carried out in a hospital setting Control: Usual care with standard physiotherapy	**FCT: Barthel Index** MOB: TUG HU: Discharge destination, LOS ACE: Falls, mortality, deterioration in medical status	Admission Discharge	Between-group differences at discharge: - Barthel Index: n.s. Multivariable regression analyses: - Barthel Index: low admission Barthel Index & IG assignment = independent predictors of improving Barthel Index Feasibility: - Missing data: Barthel Index = 0%
Kimmel 2016 [41] Australia	*n* = 92 Mean age: 81 yrs. Females *n* = 59 (64%) Patients with hip fracture	Intervention: - Two additional physiotherapy sessions aimed to improve the functional advances achieved during the usual physiotherapy session (3 times/day, 7 days/week) Control: Usual care (physiotherapy: 1 time/day, 7 days/week)	**MOB: mILOAS**, TUG HU: LOS, Discharge destination, opioid equivalence score ACE: Postoperative complications PSY: Self-developed pain scale	Day 5	Between-group differences at post-operative Day 5: - mILOAS: n.s. Between-group differences controlled for confounding factors: - mILOAS: ↑ Feasibility: - Missing data: mILOA = 0%
Nikolaus 1999 [42] Germany	*n* = 545 Mean age, 81 yrs. Females: *n* = 400 (73%); Patients with acute medical illness	Intervention 1:Comprehensive geriatric assessment and interdisciplinary intervention in the hospital and at home, physical and occupational therapy (washing, eating, dressing, walking) twice a week up to twice a day for 30 min Intervention 2: Comprehensive geriatric assessment with recommendation in the hospital and usual care at	**FCT: Barthel Index, Lawton IADL scale** HU: Discharge destination, LOS	Admission Discharge	Between-group differences at discharge: - Barthel Index, Lawton IADL scale: n.s. Feasibility: - Barthel Index, Lawton IADL scale: mean discharge scores in both groups within the best 15% of the rating scale → ceiling effect - Missing data: Barthel Index, Lawton IADL scale = 0%

Table 2 Characteristics of the included studies *(Continued)*

Study Country	Sample	Intervention	Outcome measures during hospitalization* (category: outcome measure) *primary outcome measure in bold	Time point of measurement (primary outcome)	Main findings
		home Control: Assessment of ADL and cognition and usual care in the hospital and at home			(discharge)
Oldmeadow 2006 [43] Australia	*n* = 60 Mean age: 79 yrs. Females: *n* = 43 (68%) Patient with hip fracture	Intervention: - First walk at day 1 or 2 (early mobilization) (7 days/week) Control: Usual care (first walk at day 3 or 4) (7 days/week)	**MOB: mILOAS items: Transfer from supine to sitting, transfer from sitting to standing (independent vs. assisted), ambulation (walking distance), step negotiation (independent vs. failed/unable)** HU: Discharge destination, LOS	Day 7	Between-group differences at post-surgery day 7: - mILOAS: transfer item: ↑, walking distance: ↑, step negotiation: n.s. Feasibility at day 7: - mILOAS step negotiation item: > 15% (23%) of total sample with worst possible score ⟶ floor effect, 21% missing data - mILOAS transfer item = 15% missing data
Siebens et al., 2000 [44] USA	*n* = 300 Mean age: 78 yrs. Females: *n* = 182 (61%); Patients with acute medical illness	Intervention: - Hospital-based exercise program (twice a day) - Flexibility and strengthening exercises - Walking program (60 to 80% max. Heart rate, 5 min to 30 min) Control: Usual care	**HU: LOS** ACE: Mortality	Discharge	Between-group differences at discharge: - LOS: n.s. Feasibility: - Missing data: LOS = 0%
Torres-Sanchez 2017 [45] Spain	*n* = 58 Mean age: 74 yrs. Females: *n* = 16 (28%); Patients with acute exacerbation of COPD	Intervention: - Additional individually-adapted endurance training on a pedal exerciser - Cycling time, velocity, and resistance were adapted to patient and increased every day Control: Usual care (no supervised or progressive exercise)	**MOB: Lower limb strength (handheld dynamometer), balance (OLS), exercise capacity (30CST)**, physical activity/number of steps (SenseWear Armband)	Admission Discharge	Group × time interaction: - Lower-limb strength: ↑ - Balance: ↑ - Exercise capacity: ↑ Between-group differences at discharge: - Lower-limb strength: ↑ - Balance (OLS): ↑ - Exercise capacity (30STS): n.s. Feasibility: - Missing data: Lower-limb strength, balance (OLS), exercise capacity (30CST) = 0%
Asplund 2000 [46] Sweden	*n* = 444 Mean age: 81 yrs. Females: *n* = 251 (61%) Patients with acute medical illness	Intervention: - Multidisciplinary teamwork (internist, geriatrician, nurses, nurse aids, physiotherapist, occupational therapist, social worker, dietician) - Assessment by physiotherapist and occupational therapist - Early start of rehabilitation - Discharge planning Control: General medical unit care	**ACE: Mortality** HU: LOS, discharge destination, hospital costs	Admission Discharge	Between-group differences at discharge: - Mortality: n.s. Feasibility: - Missing data: mortality = 3% 97% survivals ⟶ mortality = rare event
Barnes 2012 [47] USA	*n* = 1632 Mean age: 81 yrs. Females: *n* = 1094 (67%) Patient with acute medical illness	Intervention: - Prepared environment (e.g., carpeting, handrails, uncluttered hallways) - Patient-centered care (daily assessment by nurse of physical, cognitive and psychosocial function - Protocols to improve of ADL	**HU: LOS, hospital costs,** process-of-care measures (physical therapy consults, orders for bed rest, use of physical restraints, documentation of discharge planning, discharge destination) FCT: Katz ADL Index (bathing, dressing, toileting, transferring,	Admission Discharge	Between-group differences at discharge: - LOS: ↓ - Hospital costs: ↓ - Feasibility: - Missing data: LOS, hospital costs = NA

Table 2 Characteristics of the included studies *(Continued)*

Study Country	Sample	Intervention	Outcome measures during hospitalization* (category: outcome measure) *primary outcome measure in bold	Time point of measurement (primary outcome)	Main findings
		(bathing/dressing, mobility/ transferring, toileting, feeding), nutrition, skin care, falls, cognition, mood etc., daily team rounds by physiotherapist, nurse, social worker, nutritionist) - Planning for discharge - Medical care review (daily by medical director) - Protocols to minimize adverse effects (e.g., urinary catheterization) Control: Usual care	eating), Lawton IADL scale (shopping, cooking, performing household chores, using transportation, managing money, managing medication, and using the telephone) MOB: 5-items hierarchical mobility scale ACE: Mortality		
Counsell 2000 [48] USA	$n = 1531$ Mean age: 80 yrs. Females: $n = 926$ (61%) Patients with acute medical illness	Intervention: - Prepared environment (e.g., carpeting, handrails, uncluttered hallways) - Patient-centered care (daily assessment by nurse of physical, cognitive and psychosocial function - Protocols to improve of ADL (bathing/dressing, mobility/ transferring, toileting, feeding) nutrition, skin care, falls, cognition, mood etc., daily team rounds by physiotherapist, nurse, social worker, nutritionist) - Planning for discharge - Medical care review (daily by medical director) - Protocols to minimize adverse effects Control: Usual care	**FCT: Modified Katz ADL Index** (bathing, dressing, toileting, transferring, eating), modified Lawton IADL scale (shopping, cooking, performing household chores, using transportation, managing money, managing medication, and using the telephone) MOB: PPME, 5-items hierarchical mobility scale HU: Process-of-care measures (nursing care plans, time from admission to initiation of discharge planning, social work consultation, orders for bed rest, physical therapy consults, use of urinary catheters, and application of physical restraints, inappropriate medications), LOS, hospital costs, discharge destination PSY: Caregiver satisfaction ACE: Mortality	Admission Discharge	Between-group differences at discharge: - Mortality: n.s.; Modified Katz ADL Index: n.s. Feasibility: - Missing data: Katz ADL Index = NA (admission & discharge)
Huusko 2000 [49] Finland	$n = 260$ Mean age: 80 yrs. Females: $n = 184$ (72%) Patients with hip fracture No dementia (MMSE 24–30): $n = 99$ (41%) Suspected severe dementia (MMSE 0–11): $n = 28$ (12%) Suspected moderate dementia (MMSE 12–17): $n = 36$ (15%) Suspected mild dementia (MMSE 18–23): $n = 77$ (32%)	Intervention: - Multidisciplinary teamwork (geriatrician, general practitioner, nurses, social worker, neuropsychologist, occupational therapist, physiotherapist) - Geriatric team assessment - Physiotherapy (2times/day), ADL training by nurses - Weekly meetings by physiotherapists and nurses - Discharge plan Control: Discharged to local hospitals	**HU: LOS**	Discharge	Between-group differences at discharge: - LOS: severe dementia (MMSE score: 0–11 pt): n.s.; moderate dementia (MMSE score: 12–17 pt): ↓; mild dementia (MMSE score: 18–23 pt) ↓; normal (MMSE score: 24–30): n.s. Feasibility: - Missing data: LOS = 0%
Landefeld 1995 [50] USA	$n = 651$ Mean age: 80 yrs. Females: $n = 435$ (67%)	Intervention: - Prepared environment (e.g., carpeting, handrails, uncluttered hallways)	**FCT: Modified Katz ADL Index** (bathing, dressing, toileting, transferring, eating), Lawton IADL scale	Admission Discharge	Between-group differences at discharge: - Katz ADL Index: ↑ Multivariable regression

Table 2 Characteristics of the included studies *(Continued)*

Study Country	Sample	Intervention	Outcome measures during hospitalization* (category: outcome measure) *primary outcome measure in bold	Time point of measurement (primary outcome)	Main findings
	Patients with acute medical illness	- Patient-centered care (daily assessment by nurse of physical, cognitive and psychosocial function - Protocols to improve of ADL (bathing/dressing, mobility/transferring, toileting, feeding) nutrition, skin care, falls, cognition, mood etc., daily team rounds by physiotherapist, nurse, social worker, nutritionist) - Planning for discharge - Medical care review (daily by medical director) - Protocols to minimize adverse effects (e.g., urinary catheterization) Control: Usual care	MOB: Walking ability HU: Discharge destination, LOS, hospital costs PSY: GDS, overall health status COG: MMSE		analyses controlled for confounding baseline patient characteristics: IG assignment = significant independent predictor of an increase in the number of independently performed ADLs Feasibility: - Katz ADL Index: > 15% of participants reaching a score within the best 15% of the instrument's rating scale → ceiling effect - Missing data: Katz ADL Index: 0% (admission & discharge)
Naglie 2002 [51] Canada	*n* = 279 Mean age 84 yrs. Females *n* = 223 (80%); Patients with hip fracture	Intervention: - Multidisciplinary teamwork (physiotherapist, occupational therapist, nurse, social worker) - Special education of staff - Prevention of complications (e.g., delirium, urinary problems, malnutrition) - Physiotherapy: early full weight bearing, ADL training, (2 times/day for 5 day/week) - Discharge plan, pre-discharge home visits - 2 times/week meeting for monitoring treatment plan Control: Usual care	**HU: Discharge destination,** LOS	Admission Discharge	Between-group differences at discharge: - Discharge destination: ↑ (in community-dwellers, relative's/retirement home residents), n.s. (in nursing home residents) Feasibility: - Missing data: Discharge destination: 0%
Pitkälä 2008 [52] Finland	*n* = 174 Mean age: 83 yrs. Females: *n* = 128 (74%) Patients with delirium	Intervention: - Comprehensive geriatric assessment (physical examination, cognition, nutrition, screening of depression, review of medication) - Administering antipsychotics for hyperactive/psychotic symptoms - Cholinesterase inhibitors - Orientation (calendars, clocks) - Physiotherapy - Nutritional supplements - Comprehensive discharge planning (e.g., occupational home visits) Control: Usual care	**PSY: 15D HRQOL questionnaire, self-developed subjective health scale**	Admission Discharge	Between-group differences at discharge: - HRQOL: ↑ - Self-developed subjective health sale: ↑ Feasibility: - Missing data: 15D questionnaire: 9%; self-developed subjective health sale: NA (admission & discharge)
Prestmo 2015 [30] Taraldsen 2014 [31] Norway	*n* = 397 Mean age: 83 yrs. Females: *n* = 293 (73%) Patients with hip fracture	Intervention: - Multidisciplinary teamwork (geriatricians, nurses, physiotherapists, occupational therapists, with special competence in geriatrics) - Comprehensive geriatric assessment (somatic and mental health, function, social situation)	**MOB: SPPB**, **PA (activPAL: time spent in upright**, number of upright events), Cumulated Ambulation Score HU: LOS, discharge destination, hospital costs	Day 4 after surgery (activePAL) Day 5 after surgery (SPPB)	Between-group differences at day 4 (activePAL) and 5 (SPPB): - SPPB: ↑ - Time spent in upright: ↑ Feasibility: - Missing data: SPPB = 13% (5 days after surgery) - activPAL: > 15% missing data

Table 2 Characteristics of the included studies *(Continued)*

Study Country	Sample	Intervention	Outcome measures during hospitalization* (category: outcome measure) *primary outcome measure in bold	Time point of measurement (primary outcome)	Main findings
		- Interdisciplinary team meetings - Adequate nutrition, - Individual rehabilitation plan based on cognition and motivation - Early mobilization, functioning in ADL, weight-bearing exercise program - Early discharge planning Control: Usual care (standard orthopedic care)			
Siebens et al., 2000 [44] USA	*n* = 300 Mean age: 78 yrs. Females: *n* = 182 (61%); Patients with acute medical illness	Intervention: - Hospital-based exercise program (twice a day) - Flexibility and strengthening exercises - Walking program (60 to 80% max. Heart rate, 5 min to 30 min) Control: Usual care	**HU: LOS** ACE: Mortality	Discharge	Between-group differences at discharge: - LOS: n.s. Feasibility: - Missing data: LOS = 0%
Stenvall 2007a,b, 2012 [27–29] Lundström 2007 [26] Sweden	Total sample: *n* = 199 Mean age: 82 yrs. Females: *n* = 148 (74%) Patients with hip fracture	Intervention: - Multidisciplinary teamwork (nurses, physiotherapists, occupational therapists, dietician, geriatrician) - Staff education in prevention of postoperative complication - Individual care planning (all team members assessed each patient as soon as possible, planning of process and goals twice a week) - Prevention and treatment of complications (falls, delirium etc.) - Pain treatment (contained assessment of underlying causes) - Saturation (oxygen-enriched air during first two postoperative days) - Nutrition (protein-enriched meals during the first four days) - Mobilization: (ADL training with focus on fall risk factors, high-intensity weight-bearing exercises) Control: Usual care (no corresponding team work)	**ACE: Falls, fallers,** and time lapse to first fall after admission; **AIS,** postoperative complications (urinary tract infections, decubitus ulcer, sleeping disturbances, mortality) **MOB: COVS walking item** **FCT: ADL staircase** (Katz ADL Index with IADL items) **HU: Discharge destination,** LOS **COG: Number of delirious days (OBS scale), MMSE** **PSY: GDS** BPN: Nutritional problems assessed by care/nursing staff	Discharge	Between-group differences at discharge: - Falls: ↓ - Fallers: ↓ - AIS: minor or moderate injuries:↓, serious injuries: n.s. - COVS walking item: n.s. - ADL staircase: NA (Katz ADL Index: n.s., IADL: NA) - Discharge destination: n.s. - Number of delirious days: ↓ - MMSE: n.s. - GDS: n.s. Feasibility: - Falls: 81% = non-fallers → rare event - AIS: not assessable in 81%; 42% of fallers with an AIS score of 0 pt. → floor effect - GDS: missing data at discharge in 20% - ADL staircase: > 15% of patients reaching a score within the best 15% of the best possible score → ceiling effect
	Subsample: *n* = 64 (32%) Mean age: 82 yrs. Females: *n* = 47 (73%) Patients with hip fracture & dementia Mean MMSE score: 8.6 (IG), 6.9 (CG)		**ACE: Postoperative complications** (pneumonia, urinary tract infection, decubital ulcers, new fracture, falls, fallers, fall incidence rate, mortality) **COG: Number of delirious days (OBS scale)** BPN: Nutritional problems assessed by care/nursing staff **MOB: COVS walking item** **FCT: ADL staircase** (Katz ADL Index with IADL items)		Between-group differences at discharge: - Postoperative complications: total: NA; urinary tract infection: ↓; fallers: ↓; Fall incidence rate: ↓; mortality, pneumonia, decubital ulcers, new fracture: n.s. - Number of delirious days: ↓ - COVS walking item: n.s. - ADL staircase: NA (Katz ADL Index: n.s., IADL: NA)
Vidan 2005 [53] Spain	*n* = 319 Mean age: 82 yrs. Females: *n* = 260	Intervention: - Multidisciplinary teamwork (geriatrician, rehabilitation	**HU: LOS** **ACE: Mortality, postoperative complications**	Admission Discharge	Admission to discharge: - LOS: n.s. - Mortality: ↓

Table 2 Characteristics of the included studies *(Continued)*

Study Country	Sample	Intervention	Outcome measures during hospitalization* (category: outcome measure) *primary outcome measure in bold	Time point of measurement (primary outcome)	Main findings
	(82%) Patients with hip fracture	specialist, and specific social worker) - Geriatric assessment (medical, psychosocial problems and functional capability) - Interdisciplinary meeting to elaborate a comprehensive therapeutic plan (weekly repeated) - Daily visits by geriatrician - Rehabilitation specialist planned physiotherapy (schedule, intensity and duration) - Social worker assessed the social environment Control: Usual care	COG: CAM		- Postoperative complications: ↓ Feasibility: - LOS: 0% (admission to discharge) - Mortality: 97% survivals → rare event - Postoperative complications: 47% of patients without complications (admission to discharge) → rare events

10MWT 10-Meter Walking Test, *30CST* 30-Seconds Chair Stand Test, *6MWT* 6-Minute Walk Test, *ACE* Adverse clinical events, *ADL* Activities of daily living; AIS, Abbreviated Injury Scale, *BPN* Body constitution, physiological or nutritional status, *CAM* Confusion Assessment Method, *CAM* Confusion Assessment Method, *CAT* COPD Assessment Test, *CG* Control group, *COG* Cognitive functioning, *COPD* Chronic obstructive pulmonary disease, *COVS* Clinical Outcome Variables Scale, *CRQ-SAS* Chronic Respiratory Questionnaire Self-Administered Standardized, *DSM-IV* Diagnostic and Statistical Manual of Mental Disorders, *FCT* Functional status, *FIM* Functional Independence Measure, *GDS* Geriatric Depression Scale, *HRQOL* Health-related quality of life, *HU* Hospital outcomes, *IADL* Instrumental activities of daily living, *IG* Intervention group, *LOS* Length of stay, *mDRI* modified Disability Rating Index, *mILOAS* Modified Iowa level of Assistance, *mMRC* modified Medical Research Council, *MMSE* Mini-Mental State Examination, *n.s* not significant ($p > 0.05$), *NA* Not available, *OLS* One Leg Stance, *PPAS* Postoperative patient activity scale, *PPME* Physical Performance and Mobility Examination, *PSY* Psychological status, *SPPB* Short Physical Performance Battery, *TUG* Timed Up and Go, *UCLA scale* University of California, Los Angeles Activity scale; ↑, significant increase ($p \leq 0.05$); ↓, significant decrease ($p \leq 0.05$)

anxiety, depression, or confidence; (6) cognitive functioning, which refers to measures of global cognitive status or transient cognitive dysfunction (e.g., delirium); (7) body constitution, physiological or nutritional status, which refers to measures of lean and fat tissue mass, body weight, nutritional intake, or biochemical outcomes (e.g., serum albumin); and (8) disease-specific outcomes (e.g., COPD *severity, exacerbation* rates*)*. In the following, the different primary outcome measures used across the included studies were described for each category. Due to their specificity, the disease-specific outcome measures were not further analyzed and discussed in this review.

Functional status

Functional status was assessed in 11 studies (45.8%; 8 exercise interventions [32–37, 40, 42] and 3 multidisciplinary programs [28, 48, 50]) using an (I) ADL measure only [32–36, 40], both an ADL and IADL measure [37, 42, 48, 50], or a combined (I) ADL measure [28]. The most frequently used (I) ADL instruments were the Katz ADL Index [33, 34, 48, 50], the Barthel Index [32, 40, 42], and the Lawton IADL scale [35, 42]. Other functional status measures included the Functional Independence Measure (FIM [36]), modified Disability Rating Index (mDRI) and modified Klein-Bell [KB] ADL scale [37], or the ADL staircase (Katz ADL Index extended by further IADL items) [28].

Mobility status

Mobility status was assessed in seven studies (29.2%; 5 exercise interventions [35, 38, 41, 43, 45] and 2 multidisciplinary programs [28, 30]). Nine different motor performance measures were identified, including the modified Iowa Level of Assistance Scale (mILOAS) [41, 43], the Timed Up and Go (TUG) [35, 41], the walking item of the Clinical Outcome Variables Scale (COVS) [28, 29], the Short Physical Performance Battery (SPPB) [30], a lower extremity handheld dynamometry strength measurement [45], the One Leg Stance (OLS) and 30-s Chair Stand Test (30CST) [45], the 10-Meter Walking Test (10MWT) [35], the 6-Minute Walk Test (6MWT) [38], and a self-developed postoperative patient activity scale (PPAS) [35]. PA measures were reported in only two studies, including the self-administered University of California, Los Angeles Activity (UCLA) scale [35] or an accelerometer-based PA monitor (activPAL) [31].

Hospital outcomes

Hospital outcomes were assessed in six studies (25.0%; 5 multidisciplinary programs [28, 47, 49, 51, 53] and 1 exercise intervention [44]). LOS was reported in all these studies. Further outcome measures included discharge destination [28, 47, 51] or hospital costs and other process-of-care measures (e.g., physical therapy consults, orders for bed rest) [47].

Adverse clinical events

Three studies (12.5%; 3 multidisciplinary programs) assessed mortality [46, 53], different complications during hospitalization [53], or falls/fall-related outcomes (Abbreviated Injury Scale [AIS]) [27].

Psychological status

Psychological factors were assessed in three studies (12.5%; 2 multidisciplinary programs [26, 52] and 1 exercise intervention [36]), using the Geriatric Depression Scale (GDS) [26], the 15D HRQOL questionnaire [52], or the Self-Efficacy Gauge and Life-Satisfaction Index [36].

Cognitive functioning

Two studies (8.3%; 1 exercise intervention [39] and 1 multidisciplinary programs [26]) used the Confusion Assessment Method (CAM) to assess the number of delirious patients [39] or the Organic Brain Syndrome (OBS) scale to screen for the number of delirious days during hospitalization and the Mini-Mental State Examination (MMSE) to screen the global cognitive status [26].

Matching of outcome measures

Table 3 presents the results of the matching procedure and the intervention effects reported for each outcome measure identified among studies. In the following, the results of the matching procedure were initially summarized for each outcome category.

Functional status

Most frequently, functional measures matched the intervention contents only to a limited extent with items not part of the functional intervention component (e.g., Katz ADL Index ➔ only basic transfer and ambulation training) [28, 32, 34, 36, 37, 40, 42]. Functional measures that specifically addressed the functional intervention contents (e.g., Katz ADL Index → ADL training to improve bathing/dressing, mobility/transferring, toileting, feeding) were used in only three studies [37, 48, 50]. In another three studies, we identified functional measures that did not directly match the interventions, which did not include a functional training component (e.g., Lawton IADL scale → no IADL training content) [33, 35, 42].

Six studies suggested ceiling effects for at least one of their functional measures, with > 15% of participants reaching a score within the best 15% of the rating scales (Katz ADL Index [50], Barthel Index [40], ADL staircase [28]), or mean scores of the sample within the best 15% of the rating scale (Barthel Index [42], Katz ADL Index [34], Lawton IADL scale [35]). A missing data rate of ≥15% for functional measures were reported in two studies, which did not present any data for the Lawton IADL scale [35] or incomplete data for the ADL staircase (only ADL items presented) [28] at discharge.

Two studies used the Lawton IADL scale [35, 42], which did not match to the acute care hospital setting with inappropriate items addressing instrumental home or community activities such as washing, housekeeping, or shopping. Two studies used functional measures (mDRI [37], ADL staircase [28]) that matched to the acute care hospital setting only to a limited extent, including both setting-specific basic ADL items but also setting non-specific IADL items.

Mobility status

Most frequently, mobility measures specifically matched the mobility intervention component (e.g., 6MWT → lower limb endurance training) [28, 30, 38, 41, 43]. Limited matches in which the mobility measure covered the mobility intervention component only to a limited extent (e.g., OLS → chair-based pedal exercises; mILOAS transfer, step negotiation and ambulation items → only walking training) were found in four studies [31, 35, 43, 45].

Only one study suggested a floor effect, with almost one fourth (23.3%) of the total sample reaching a score within the worst 15% of rating scale of the mILOAS step negotiation item [43]. A missing data rate of ≥15% for mobility measures were reported in three studies [31, 35, 43]. Two of them did not present any or incomplete data for the UCLA (missing data: 100%) [35] or single mILOAS items (missing data: 15% [transfers]; 21% [step negotiation] [43]). The other study reported that in 19% of the sample, sensor-based PA data were missing due to reasons such as sensor removing, technical problems, or medical reasons [31].

Most studies used mobility measures specifically addressing mobility or physical activities that can be appropriately assessed within the acute care hospital setting (e.g., SPPB ➔ functional mobility; 10MWT → walking) [28, 30, 38, 41, 43, 45].

Only one study used the UCLA to assess PA behavior, which matched to the acute care hospital setting only to a limited extent, with inappropriate response items addressing intensive physical activities (e.g., swimming, bicycling) or impact sports [35] rather than rehabilitation-specific activities.

Hospital outcomes

Three studies used hospital outcomes (LOS, hospital costs, discharge destination) that specifically addressed their intervention components [47, 49, 51]. All these studies conducted a multidisciplinary program that included multidisciplinary team meetings with individual care planning, comprehensive geriatric assessments, and/or discharge planning. Limited matches were found

Table 3 Results of the matching procedure and intervention effects reported for each outcome measure

Outcome measures		Study	Matching				Intervention effects
Category	Instrument		Intervention	Sample		Setting	
				Floor/ceiling effects or rare event	Missing data		
FCT	(modified) Katz ADL Index	Blanc-Bisson 2008 [33]	–	+	+	+	NA
		Brown 2016 [34]	±	–	+	+	n.s.
		Counsell 2000 [48]	+	+	+	+	n.s.
		Landefeld 1995 [50]	+	–	+	+	↑
	Barthel Index	Abizanda 2011 [32]	±	+	+	+	n.s.
		Jones 2006 [40]	±	–	+	+	n.s.
		Nikolaus 1999 [42]	±	–	+	+	n.s.
	Lawton IADL scale	Czyzewski 2013 [35]	–	–	–	–	NA
		Nikolaus 1999 [42]	–	+	+	–	n.s.
	ADL staircase	Stenvall 2007, 2012 [28, 29] Lundström 2007 [26, 28]	±	–	–	±	NA
	FIM	Eyres 2005 [36]	±	+	+	+	NA
	mDRI	Hagsten 2004 [37]	±	NA	+	±	n.s.
	mKB ADL scale	Hagsten 2004 [37]	+	+	+	±	↑
MOB	6MWT	He 2015 [38]	+	+	+	+	NA
	10MWT	Czyzewski 2013 [35]	±	+	+	+	NA
	30CST	Torres-Sanchez 2017 [45]	±	+	+	+	↑
	mILOAS						
	total score	Kimmel 2016 [41]	+	+	+	+	n.s.
	ambulation item	Oldmeadow 2006 [43]	+	NA	+	+	↑
	step negotiation item	Oldmeadow 2006 [43]	±	–	–	+	n.s.
	transfer items	Oldmeadow 2006 [43]	±	NA	–	+	↑
	activPAL	Taraldsen 2014 [31]	±	+	–	+	↑
	Handheld dynamometry	Torres-Sanchez 2017 [45]	±	+	+	+	↑
	OLS	Torres-Sanchez 2017 [45]	±	+	+	+	↑
	PPAS	Czyzewski 2013 [35]	±	NA	+	+	↑
	SPPB	Prestmo 2015 [30]	+	+	+	+	↑
	TUG	Czyzewski 2013 [35]	±	+	+	+	NA
	UCLA scale	Czyzewski 2013 [35]	±	NA	–	±	NA
	COVS	Stenvall 2007, 2012 [28, 29] Lundström 2007 [26]	+	NA	+	+	n.s.
HU	LOS	Barnes 2012 [47]	+	+	+	+	↑
		Huusko 2000 [49]	+	+	+	+	↑
		Siebens 2000 [44]	–	+	+	+	n.s.
		Vidan 2005 [53]	±	+	+	+	n.s.
	Discharge destination	Naglie 2002 [51]	+	+	+	+	↑
		Stenvall 2007 [28]	±	+	+	+	n.s.
	Hospital costs	Barnes 2012 [47]	+	+	+	+	↑
ACE	Medical complications	Stenvall 2012 [29]	+	NA	+	+	NA
		Vidan 2005 [53]	+	+	+	+	↑
	Mortality	Asplund 2000 [46]	±	–	+	+	n.s.

Table 3 Results of the matching procedure and intervention effects reported for each outcome measure *(Continued)*

Outcome measures		Study	Matching				Intervention effects
Category	Instrument		Intervention	Sample		Setting	
				Floor/ceiling effects or rare event	Missing data		
		Vidan 2005 [53]	±	–	+	+	↑
	AIS	Stenvall 2007,2012 [27–29]	+	–	–	+	↑
	Falls	Stenvall 2007 [27]	+	+	+	+	↑
PSY	Self-Efficacy Gauge	Eyres 2005 [36]	±	+	+	+	NA
	Life Satisfaction Index	Eyres 2005 [36]	–	+	+	+	NA
	GDS	Lundström [26]	–	+	–	+	n.s
	15D HRQOL	Pitkälä 2008 [52]	±	+	+	+	↑
COG	CAM	Jeffs 2013	±	–	+	+	n.s
	OBS scale	Lundström 2007 [26]	+	–	+	+	↑
	MMSE	Lundström 2007 [26]	±	+	+	+	n.s.

6MWT 6-Minute Walk Test, *10MWT* 10-Meter Walking Test, *30CST* 30-Seconds Chair Stand Test, *AIS* Abbreviated Injury Scale, *CAM* Confusion Assessment Method, *COVS* Clinical Outcome Variables Scale, *FIM* Functional Independent Measure, *GDS* Geriatric Depression Scale, *HRQOL* Health-related Quality of Life, *LOS* Length of stay, *mDRI* modified Disability Rating Index, *mILOAS* modified *Iowa* Level of Assistance Scale, *mKB ADL scale* modified Klein-Bell ADL scale, *MMSE* Mini-Mental State Examination, *OBS scale* Organic Brain Syndrome scale, *OLS* One Leg Stance, *PPAS* Postoperative Patient Activity Scale, *SPPB* Short Physical Performance Battery, *TUG* Timed Up and Go, *UCLA scale* University of California, Los Angeles Activity scale

+, "match"; ±, "limited match"; –, "no match"; NA, not available; ↑, significant between-group differences in favor of the intervention group ($p \leq 0.05$); n.s., no significant between-group differences in favor of the intervention group ($p > 0.05$)

for two other multidisciplinary intervention studies which assessed LOS [53] or discharge destination [28]; however, without including specific discharge planning procedures within their multidisciplinary program. No match was found for one study, which was the only one that assessed the unspecific effect of an additional exercise intervention on a hospital outcome (LOS) [44].

Ceiling and floor effects or rare events were not apparent for any of these setting-specific hospital outcomes, and none of the six studies reported missing data.

Adverse clinical events

Two studies analyzing adverse clinical events used outcome measures that specifically matched to the intervention. Both of them assessed the incidence of medical complications during hospitalization to evaluate the specific effect of their intervention contents focusing on the identification, prevention and treatment of these complications [29, 53]. One of these studies also assessed the effect of a systematic assessment and treatment of fall risk factors by the number of falls/fallers and the AIS that specifically matched to this specific intervention component [27, 29]. Two studies assessed mortality during hospitalization, which were addressed to a limited extent by the increased, multidisciplinary diagnostic progress, the improved therapeutic care planning, and the increased patient contact time during acute hospitalization [46, 53].

In both studies assessing mortality, a mortality rate of only 3% during hospitalization was observed [46, 53], indicating a rare event. The AIS used to assess fall-related injury severity showed a ceiling effect with 42% of fallers reaching the best possible AIS score and missing data for 81% of participants who had not fallen [27]. For medical complications, falls, and mortality, no missing data were reported in all studies [27, 46, 53].

Adverse clinical events were appropriately assessed based on nursing/medical records or patient charts in all studies [27, 29, 46, 53].

Psychological status

None of the studies focusing on psychological status used a psychological measure that specifically matched their intervention contents [26, 36, 52]. Limited matches were found in two studies, using the 15D HRQOL with single items that were addressed by the intervention contents (15D HRQOL mobility dimension → physiotherapy, 15D HRQOL mental function dimension → orientation training) [52] or the Self-Efficacy Gauge, which has been specifically developed to assess self-perceived confidence in occupational performances, to evaluate an additional occupational therapy program [36]. Psychological measures (Life-Satisfaction Index [36], GDS [26]) that did not match a specific content of their interventions were found in two studies.

Ceiling or floor effects were not identified for any psychological measure [26, 36, 52], and only one study reported a missing data rate of 20% for the GDS at discharge [26].

All psychological measures used in the studies addressed constructs that can be appropriately assessed within the acute care hospital setting.

Cognitive functioning

In one of the two studies analyzing cognitive functioning, the number of delirious days as assessed by the OBS scale specifically matched the intervention contents of active preventing, detecting, and treating delirium [26]. The same study also used the MMSE, which matched this intervention component only to a limited extent not including any further cognitive training contents [26]. In the other study, the CAM also only to a limited extent matched in evaluating the effect of additional orientation exercises on the number of delirious patients [39].

For the number of delirious days, a ceiling effect was identified, with 65% of patients having no delirious day [26], and the number of delirious patients represented a rare event, with only 5.4% of patients having a delirium episode during hospitalization [39].

All cognitive measures could be rated as appropriate for use in the acute care hospital setting.

Intervention effects in relation to the matches

In the following, the main findings reported on the primary outcomes were related to the results of the matching procedure. Details on the intervention effects on the outcome measures identified among studies can be found in Table 3.

Functional status

Seven studies (4 exercise interventions [32, 34, 37, 40, 42] and 2 multidisciplinary programs [48, 50]) reported on between-group differences in functional status at hospital discharge, whereas four studies (3 exercise interventions [33, 35, 36] and one multidisciplinary programs [28]) did not. In those studies ($n = 5$) with no or only limited matches between functional measures and exercise intervention, no significant benefits of the intervention could be documented [32, 34, 37, 40, 42]. Only in those two studies where the functional measures specifically addressed the exercise intervention [37], or an intervention component of the multidisciplinary program [50], a significant superior effect of the intervention on the functional status was identified.

Mobility status

Six studies (5 multidisciplinary programs [28, 47, 49, 51, 53] and 1 exercise intervention [44]) reported on between-group differences in mobility status after surgery or at hospital discharge based on a variety of 11 different mobility measures. One study only analyzed within-group changes for the mobility outcomes at hospital discharge [38].

Out of the four mobility measures with intervention-specific matches, two (SPPB, mILOAS ambulation item) revealed a significant benefit of the additional exercise intervention [43] or the multidisciplinary program [30] over the usual care on motor performance, whereas the other two did not (COVS walking item [28], mILOAS [41]). All other seven mobility measures with limited intervention-related matches (handheld dynamometry, OLS, 30CST, mILOAS step negotiation and transfer items, PPAS, activPAL) revealed significant beneficial effects in the experimental groups (3 exercise interventions [35, 43, 45] and 1 multidisciplinary program [31]), except for one (mILOAS step negotiation) [43].

Out of the mobility measures that did not reveal significant between-group differences, two covered single subjective rating items of more comprehensive assessment scales (COVS walking item, mILOAS step negotiation item) [28, 43], with partly floor effects in the sample (mILOAS step negotiation item) [43], and one was a comprehensive assessment scale combining subjective rating and objectively-measured items (mILOAS total score) [41].

Hospital outcomes

Six studies (5 multidisciplinary programs [28, 47, 49, 51, 53] and 1 exercise intervention [44]) analyzed between-group differences in LOS, discharge destination, and/or hospital costs at hospital discharge. Significantly shorter LOS, more patients reintegrated into the community, and lower hospital costs among the intervention group were found only for these three studies in which the hospital outcomes specifically matched the intervention components of the multidisciplinary programs [47, 49, 51]. No significant between-group differences could be documented [28] in multidisciplinary studies with only limited matches between the hospital outcomes (LOS, discharge destination) and their intervention components [28] and in the exercise intervention study showing no match [44].

Adverse clinical events

Between-group differences in adverse clinical events at hospital discharge were analyzed in three multidisciplinary intervention studies [29, 46, 53]. Two studies assessing adverse clinical events that specifically matched their intervention components reported a significant lower number of falls, fallers and minor to moderate fall-related injuries [27] and reduced medical complications in favor of the intervention [53]. Out of the two studies that analyzed (also) mortality, which matched as an outcome measures only to a limited extent to the multidisciplinary interventions during early inpatient rehabilitation in the acute care hospital setting, one reported a significant effect of their intervention in reducing mortality during hospitalization [53], whereas the other study did not [46].

Psychological status

Two multidisciplinary studies analyzed between-group differences in HRQOL [52] and/or depression [26] at hospital discharge. In these two studies, a significant psychological benefit of the intervention compared to usual care was observed only by using the 15D HRQOL that showed a limited match, with single dimensions specifically addressing an intervention component [26, 52]. The GDS, as used in one of these studies, did not match the intervention and revealed no significant between-group differences [26].

Cognitive functioning

Two studies (1 multidisciplinary program [26] and 1 exercise intervention [39]) analyzed between-group differences in cognitive functioning during hospitalization. For the cognitive measures with limited matches to the intervention (CAM [delirious patients], MMSE), both studies reported no significant benefit of the intervention compared to the usual care [26, 39]. Only for the number of delirious days as assessed by the OBS scale, which specifically matched the intervention component of active prevention, detection and treatment of delirium within the multidisciplinary program, significant between-group differences in favor of the intervention group were reported [26].

Discussion

The aim of this review was to analyze the matching of outcome measures used in previous RCTs on early rehabilitation in acutely hospitalized older patients to the specific study characteristics (intervention, sample, and setting) and to evaluate the effects of matching on the main findings reported in these RCTs. In the 24 studies included in this review, the selection of primary outcome measures differed considerably, with a total of 33 different outcome measures across six different outcome categories. The matching process indicated also a large heterogeneity in the appropriateness of the selected outcome measures for the intervention contents, the study sample, and the acute geriatric hospital setting. Our findings suggest that a good match especially between the outcome measure and the intervention contents seems to have increased the likelihood for documenting significant intervention-induced benefits among the included studies.

Functional status

Functional status defined as (I) ADL functioning has become a key outcome during hospitalization in older patients [55]. The ability to perform (I) ADL is a crucial part of human functioning, disability and health, as located centrally in the model of the International Classification of Functioning, Disability and Health (ICF) from the World Health Organization [56], and a major established outcome for rehabilitation. It was therefore not surprising that the primary outcome measures most frequently used in the included studies focused on (I)ADL. However, there was a large heterogeneity in assessing (I) ADL functioning, with seven different (I) ADL instruments identified among the studies. Our findings supports the lack of consensus regarding measuring the functional status of acutely hospitalized older patients in clinical research, as previously reported in a systematic review on the variability of (I) ADL measures in this patient population [57].

Most frequently, the various functional measures addressed ADL rather than IADL. This might be related to the fact that ADL measures assess basic activities essential for an individual's direct self-care (e.g., bathing, dressing, walking) which are primarily targeted by treatments during the early rehabilitation phase in the acute care hospital setting. In contrast, IADL measures assess more complex activities that are not necessarily a precondition for basic functions, but that are more concerned with self-reliant functioning in the home (e.g., food preparation, housekeeping) or community environment (e.g., shopping, transportation), being rather addressed in the later rehabilitation phases or after hospital discharge. None of the studies using an IADL measure specifically targeted such home or community activities by their intervention [35, 42]. Based on these mismatches of IADL measures with the acute care hospital setting and the intervention contents, none of these studies reported favorable IADL outcomes for their intervention groups [35, 42]. The majority of the studies with a primary IADL or a combined (I) ADL measure even did not present any data for the IADL measures [35] or analyzed only ADL items but not IADL items of the combined (I) ADL measure at hospital [28], which might suggest that IADL functioning was not assessed, potentially also due to the mismatch of measuring IADL in the acute care hospital setting, as discussed before.

For studies using ADL measures, we predominantly found only limited matches between these instruments and the intervention contents [28, 32, 34, 36, 37, 40, 42]. None of these studies revealed a beneficial intervention effect on the functional status. This might be related to the fact that their interventions specifically addressed only a limited number of ADL items such as transferring, walking, or bathing; while other items (e.g., bowel and bladder control), which show limited responsiveness to available interventions, were not addressed. Even if a beneficial effect on addressed items occurred, the impact on ADL instrument's overall scores, as analyzed in all these studies, might have been too small to reveal significant benefits related to the intervention.

The only two studies reporting better ADL functioning in their intervention groups at discharge used modified ADL instruments, excluding the items that were not contents of their interventions (e.g. eating, incontinence) [37, 50]. Such modifications may increase the specificity and sensitivity of the outcome measure and, in turn, seem to increase the probability to capture significant intervention effects, as suggested by the significant findings of the two studies. However, it must be kept in mind that modified assessment instruments are no longer validated, thus requiring further psychometric testing before their application [16].

Another potential explanation for insufficient intervention effects on (I) ADL functioning might be related to the ceiling effects identified for most of the ADL instruments already at hospital admission (Barthel Index [40], (modified) Katz ADL Index [34, 50], ADL staircase [28], Lawton IADL scale [35]), indicating a mismatch between these instruments and the characteristics of the sample. If patients' scores are close to the top of the scale (i.e. at the ceiling) already at baseline, there is only little room for further subsequent improvements, substantially reducing an instrument's sensitivity as well as a study's ability to detect significant changes in those patients [14, 58]. As already recommended previously [8], future studies may therefore use functional measures that cover a broader range of ability levels for acutely hospitalized older patients to explore the effects of early rehabilitation in this highly heterogeneous patient population.

Mobility status

Mobility is fundamental to healthy aging and quality of life in older adults [59], and a loss of mobility can result in a decline in autonomy [60]. Consequently, measuring mobility can determine the level of independence and the health care needs in the older population [61]. Measures addressing the patients' mobility status formed the second largest category of primary outcome measures. Surprisingly, we identified an even greater heterogeneity of instruments on mobility status than reported above for functional status. None of the primary mobility instruments was used in more than one study, except for the mILOAS. However, also the mILOAS was used differently in two studies, analyzing either the total score [41] or only individual items (walking, step negotiation, transfers) [43]. Our findings on this heterogeneity are in line with a previous systematic review on instruments used to evaluate mobility of older patients during hospitalization [62], highlighting that the lack of consensus not only includes functional but also mobility measure in this setting.

For none of the mobility measures, we identified a total mismatch with a study's intervention contents, probably based on the fact that this review considered only studies which included a physical exercise intervention [32–45] or a multidisciplinary program with physical exercise as a training component [27, 30, 46–53]. Even if the specific physical intervention content was not directly matched by most of the mobility measures – for example, in terms of conducting physical exercise on specific motor abilities (e.g., pedal exercise → endurance) but assessing other motor abilities (e.g., OLS → balance) – both the mobility measure and the intervention content were related to the overarching construct of mobility, leading to at least limited matches between those. Most frequently, these mobility measures with limited intervention-specific matches still revealed significant effects in favor of the intervention groups compared to the usual care groups. This finding suggests that mobility measures seem to be more sensitive to detect potential intervention-induced effects than the functional measures discussed above, for which a rather high specificity ("perfect match") to the intervention content was required to reveal such significant between-group differences.

Another advantage of the mobility measures and rationale for their higher potential to detect intervention-induced changes compared to the functional measures might be seen in their coverage of a broader spectrum of patients' abilities in the highly heterogeneous population of older patients. We identified no ceiling or floor effects for primary mobility measures, except for one study reporting a floor effect for a single item of the mILOAS (negotiation item) [43]. However, no floor effects occurred when its total score was used, as reported in another study [41].

Considering the instrument format of the mobility measures used in the studies analyzing between-group differences (i.e. subjective, observation-based or more standardized, objective measurement methods), it is conspicuous that those measures which did not reveal intervention effects were based on subjective, observation-based rating items (COVS walking item [28], mILOAS step negotiation item [43]) or a more comprehensive assessment scale including predominantly subjective items (mILOAS) [41]. In contrast, all objective mobility measures, for which between-group differences were analyzed (SPPB, handheld dynamometry, OLS, 30CST, mILOAS ambulation item [walking distance], activPAL), revealed favorable mobility outcomes for the intervention group [30, 43, 45], suggesting that this instrument format seems to be more sensitive to show the benefit of exercise-based interventions.

The mobility measures most frequently used addressed key motor functions such as standing, walking, and/or transferring (e.g., SPPB, 10MWT, 30CST, TUG) [30, 35, 45], which are crucial for functional mobility and

independence in daily life [62, 63]. PA behavior as a more complex, multidimensional construct was primarily investigated in only 2 studies (UCLA [35], activPAL [31]), with only one of them presenting PA data at discharge [31]. This study revealed a positive intervention effect on PA behavior assessed by a sensor-based PA monitor. Using such highly objective PA assessment instruments might be a promising approach to demonstrate intervention-induced effects; however, it might also be associated with feasibility issues in the sample of older patients, as a high missing data rate was reported in this study (19%). As indicated in a previous review on the utility and accuracy of PA sensors in older hospitalized patients, further research is required to examine their feasibility as well as their validity in this patient population [64].

Hospital outcomes

LOS, hospital costs, or discharge destination are outcomes associated with healthcare utilization or medical service use in a broad sense and are related to a series of potential cost-saving factors for healthcare [65]. For example, a reduction of LOS can decrease inpatient hospital costs and increase hospital bed availability, increasing the overall cost-efficiency of hospitals [66]. Given the great importance of such cost-related outcomes, it was not surprising that they were the third largest category of primary outcomes identified in this review. LOS was the most frequently evaluated hospital outcome, which might be related to the fact that this hospital outcome may be considered as the key driver of inpatient costs [38] and as an indicator of hospital efficiency [67].

Within our matching procedure, it was initially assumed that changes in hospital outcomes require an optimized organizational proceeding between different in-hospital disciplines, i.e. a multidisciplinary intervention program. This assumption was based on previous findings made by de Morton (2007), suggesting that improvements in these outcomes might result from a better coordination of care provision, increased medical, nursing or allied health interventions, a combination of improved team goal setting and discharge planning, and/or increased patient contact time during acute hospitalization [8]. Therefore, matches or limited matches between hospital outcomes and intervention contents were given only for multidisciplinary studies. Among these multidisciplinary studies, however, only those with intervention contents strictly optimized to the hospital outcome (e.g., discharge destination → discharge planning) revealed significant intervention-induced benefits [47, 49, 51]. All other multidisciplinary studies that used hospital outcomes with only limited matches to the intervention contents (e.g., discharge destination → only individual care planning but no specific discharge planning) could not document such beneficial effects [28, 53]. The only study evaluating an exercise-only intervention by using LOS as a primary outcome [44], which resulted in a mismatch with the intervention contents, was unable to detect significant between-group differences. Hospital outcomes seem not to be sufficiently specific and sensitive enough to document unspecific effects of an exercise intervention and may therefore not be considered as the first choice for the evaluation of interventions with a mere exercise focus in the acute geriatric hospital setting [9]. Our findings support the initial assumption that hospital outcomes might be able to reveal benefits of multidisciplinary programs; however, only if the intervention contents were specifically addressed by the intervention contents.

On the other hand, hospital outcomes are based on a simple data acquisition with high specificity to the hospital setting, as indicated by the overall lack of missing data in all the studies primarily analyzing hospital outcomes [28, 44, 47, 49, 51, 53]. Outcomes such as LOS, hospital costs, or discharge destination are usually based on highly objective, reliable and precise data, which are already captured within the routine hospital records, requiring only little additional effort for data acquisition.

Adverse clinical events

An adverse clinical event can generally be described as an acute clinical problem that newly occurred during hospitalization and was not present at hospital admission [68]. According to previous systematic reviews on the effects of physical exercise intervention in acutely hospitalized older patients [8, 63], the identified outcome measures such as falls, medical complications, and mortality were categorized as clinical adverse events also in this review. This category of outcome measures stands out as it does not focus on functioning and disability following the established rehabilitation paradigm of the ICF framework [56] but rather focuses on patients' acute clinical problems and medical conditions. This might also provide a reasonable explanation for the non-frequent use of primary outcome measures out of this category. If adverse clinical events were investigated in the included studies, they were most frequently (6 out of 9 studies) defined as a secondary outcome [34, 40, 41, 44, 47, 48], and only three studies, defined them as a primary outcome [27, 46, 53], with all of them evaluating multidisciplinary program.

More or less, all outcome measures of this category represent rather rare events (e.g., injuries falls, mortality), with the consequence that even in high-risk groups for such outcomes, it may need very large sample sizes and/or highly specific and extraordinary effective intervention

strategies to reveal significant improvements over the limited time period of acute care hospitalization. In addition, adverse clinical events can be related to a variety of different factors such as system failures, involuntary errors, or negligence [69]. A multidisciplinary approach was therefore considered to be an essential basic requirement for a match between the outcome category of adverse clinical events and the intervention. In studies analyzing the effects of a multidisciplinary program on medical complications or falls, the intervention contents were indeed strictly optimized to reduce such adverse clinical events (e.g., treatment of fall risk factors → number of falls; identification, prevention and treatment of complications ➔ postoperative complications), leading to significant benefits induced by their multidisciplinary programs compared to usual care [29, 53].

Mortality was used as a primary outcome in two multidisciplinary studies [46, 53]. Reducing mortality is certainly one of the most desirable goals in clinical health care. Mortality can be easily, objectively and reliably measured, as also indicated by lack of missing data among these two studies [46, 53]. However, it can also be described as the "hardest outcome of all", as mortality rates can be affected by many factors other than the contents or quality of clinical care [70] that cannot all be controlled for in a RCT. Based on the complexity of mortality, only limited matches to the intervention approach with primary focus on functional rehabilitation had been achieved in both studies, even if the multidisciplinary programs included intervention contents that might be beneficial for preventing mortality (e.g., increased patient contact time, multidisciplinary diagnostic progress). The very low mortality rates (< 3%) emphasize the assumption that mortality fortunately represents a rare event, even in the high-risk group of acutely hospitalized older patients. To allow for the documentation of a successful intervention on such rare events, large sample sizes combined with highly effective intervention strategies are required to allow for documentation of a successful intervention. Based on low mortality rates and the limited matches to the interventions, it was surprising that one of them reported a significant between-group difference in favor of their intervention group [53]. However, as also mentioned by the authors of this study, this finding has to be interpreted with caution. Although the relative intervention-induced reduction in mortality seems huge (– 89%), because the absolute number of deaths was low in both groups (control group: $n = 9$ vs. intervention group: $n = 1$), they could not formally exclude that this between-group difference was due to chance.

Psychological status

The psychological measures used as primary outcomes addressed different psychological constructs such as depression, self-efficacy, life satisfaction, or quality of life. Only three studies defined such measures as a primary outcome, indicating that psychological constructs were not a main focus of the studies identified in this review. None of the interventions of the studies with a primary psychological measure had a clear interventional approach to target psychological factors [26, 36, 52], suggesting that in these studies it was assumed that intervention contents might be indirectly associated with relevant psychological side effects. Out of the 2 studies analyzing between-group differences in psychological outcomes [26, 36, 52], only one study revealed a psychological benefit of the intervention. The fact that this study used a multidimensional psychological measure (15D HRQOL) with dimensions (e.g., mobility, mental function) that addressed some intervention contents at least to a limited extent (e.g., psychotherapy, orientation training) might explain this rather unspecific effect [52]. The other study could not document intervention-induced psychological benefits, which might be a direct consequence of the mismatch between the selected psychological outcome measure (GDS) and the intervention program [26].

Cognitive functioning

Cognitive functioning also was not a main focus of the identified studies, as only two of them defined global cognitive status (MMSE) and/or delirium (OBS scale, CAM) as a primary outcome [26, 39]. Among these two studies, only the specific multidisciplinary intervention with focus on active prevention, detection and treatment of delirium showed beneficial effects [26]. The same study was, however, not able to document intervention-induced effects on the patients' global cognitive status, which may be related to the fact that in addition the delirium-related, acute cognitive intervention contents, the multidisciplinary program included no further cognitive intervention contents that specifically addressed cognitive functioning more globally as assessed by the MMSE.

The other study could not document an intervention-induced effect on the number of delirious patients as assessed by the CAM during hospitalization; however, the intervention of this study only included a cognitive intervention content that seemed not specific enough for delirium treatment, in terms of an orientation program [39]. Another potential explanation might be the low incident of delirium in the sample of this study (< 6%), reducing the power to detect a significant intervention effect, especially when having in mind that in such rare events highly specific and effective intervention strategies are required to reach significance. The study reporting beneficial effects on delirium showed also a ceiling effect, with more than half of participants

(65%) having no delirious day during hospitalization [26]; however, the more specific delirium-related intervention contents and the selection of a non-dichotomous, more sensitive scaling procedure for delirium (number of delirious days vs. delirious patients) might have still led to significant intervention effects. The lack of significant intervention effects documented by the MMSE [26] and the CAM [39] might also be related to their instrument type. Both were primarily developed as screening instruments, either for global cognitive functioning (MMSE) or for delirium (CAM), which may have limited the sensitivity of these instruments to detect intervention-induced changes among these two studies.

Limitations

This review has some limitations. First, the matching procedure was based on subjective appraisals of the authors; however, standardized criteria were used which were derived from recommended guidelines [14]. To our knowledge, this review is the first to evaluate the selection of outcome measures in studies on early rehabilitation in the acute care hospital setting by such criteria, representing the most innovative feature of this review. Second, due to the international nature of this review and the inherent differences in the health care systems of the countries in which the studies were conducted, it was sometimes difficult to determine if the study took place in the acute care hospital setting. Consequently, the selection process might be affected by inconsistent terminology of the acute care hospital setting among different countries. Third, the main findings of this review were related to the primary outcome measures identified among the included studies. A clear definition of the study's primary outcome measures in the method section of the included articles was sometimes lacking. The identification of the primary outcome measures was therefore based on the researchers' critical appraisal of the information provided in the articles, considering especially the study aims mentioned in the articles. The identification of the primary outcome measures was also performed independently by two researches with disagreements resolved by consensus or third party consultation. Fourth, only information provided in the included articles was evaluated in this review, although the authors may have used additional or more detailed methodology not stated or unclearly described in the articles.

Conclusions

The present systematic review provided for the first time a detailed overview and critical appraisal of the primary outcome measures used in previous RCTs to evaluate early inpatient rehabilitation for acutely hospitalized older patients. Current findings highlight that the matching of the outcome measures with especially the contents of the intervention to be evaluated represents a key factor to reveal significant benefits attributable to the intervention. Among the different categories of outcome measures, those assessing the mobility status seem to be more sensitive to intervention-induced effects of early rehabilitation programs than those assessing the functional, psychological or cognitive status, hospital outcomes, or adverse clinical events. For future studies, it is recommended to identify not only outcome measures with established psychometric properties in the different sub-samples of the acute geriatric hospital setting, but also to select outcome measures that match the specific intervention contents. Inconsistent findings on the effectiveness of early rehabilitation programs in this setting might have been partly due to the inappropriate selection of outcome measures.

Additional files

Additional file 1: Table S1. Search strategy used in PubMed. (DOCX 15 kb)

Additional file 2: PRISMA checklist. (DOCX 31 kb)

Additional file 3: Table S2. Methodological quality scores on the PEDro scale for each included study. (DOCX 56 kb)

Abbreviations

(I)ADL: (instrumental) Activities of Daily Living; 10MWT: 10-Meter Walking Test; 30CST: 30-seconds Chair Stand Test; 6MWT: 6-Minute Walk Test; AIS: Abbreviated Injury Scale; CAM: Confusion Assessment Method; COPD: Chronic Obstructive Pulmonary Disease; COVS: Clinical Outcome Variables Scale; FIM: Functional Independence Measure; GDS: Geriatric Depression Scale; HRQOL: Health-Related Quality of Life; ICF: International Classification of Functioning, Disability and Health; LOS: Length of stay; mDRI: Modified Disability Rating Index; mILOAS: Modified Iowa Level of Assistance Scale; mKB ADL scale: Modified Klein-Bell ADL scale; MMSE: Mini-Mental State Examination; OBS: Organic Brain Syndrome Scale; OLS: One Leg Stance; PA: Physical activity; PPAS: Self-developed postoperative patient activity scale; RCTs: Randomized controlled trials; SPPB: Short Physical Performance Battery; TUG: Timed Up and Go; UCLA scale: University of California, Los Angeles Activity scale

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Authors' contributions

KH, JMB, PH, and CW conceived and designed the review. PH, NB, and CW completed acquisition of data. All authors analyzed and interpreted the data and were involved in drafting and critical revision of the manuscript. All authors have read and approved the final manuscript.

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Availability of data and materials
All data were retrieved from published RCTs and extracted in Table 2. The exact references can be found in the list of references. The relevant data supporting the conclusions of this review are included within this article and its additional files.

Ethics approval and consent to participate
Not applicable.

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Competing interests
The authors declare that they have no competing interests.

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Manuskript 4

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A pilot observational study to analyze (in)activity and reasons for sedentary behavior of cognitively impaired geriatric acute inpatients

Introduction

The numbers of cognitively impaired geriatric inpatients in German hospitals are constantly rising [5]. It is well known that this patient group has a particularly high risk of functional decline compared to cognitively healthy older patients [27]. These complications also lead to prolonged hospital stays, increased institutionalization and mortality rates [9]. Data regarding physical (in)activity of cognitively impaired patients during a hospital stay exist only to a limited extent [16, 18]. Inactive behavior is a common phenomenon in geriatric inpatients [28, 32]. Proximal effects are a loss of muscle mass and aerobic capacity [2, 7, 22, 26]. This growing patient group [29] urgently needs more detailed coverage because contextual information regarding activity behavior as well as reasons and triggers for sedentariness are lacking to the best of our knowledge. Therefore, this study aimed to analyze daily routines of geriatric acute care and to quantify and categorize physical activity behavior of cognitively impaired geriatric inpatients. It is known that inactivity during waking hours also leads to increased neuropsychiatric symptoms (NPS), such as aberrant motor behavior ("sundowning") [11]. This challenges hospital staff and might lead to an inappropriate use of psychotropic medication [18].

To increase physical activity during a hospital stay it is of importance to understand the organizational processes that lead to immobility. Context data collected by direct observations might provide information on reasons and triggers for inactivity and sedentariness of this patient group. Patient self-reports and caregiver interviews are relevant but might be biased by recall and reporting bias, which is why observations are considered the preferred approach [12]. This study aimed to describe contextual factors and circumstances via direct observation in order to understand cognitively impaired inpatients' activity behavior during acute hospitalization.

Methods

Patients

In this study 20 patients were recruited on a German geriatric acute care ward especially for patients suffering from cognitive impairment. Study participants were mainly accommodated in two-bed rooms, with two exceptions spending their hospital stay in a three-bed room. Special offers of this ward include a service team member spending time with the patients from 8 a.m. until 2 p.m. in the common room if patients agree. This staff member plays games and sings songs with the patients and supports them during breakfast and lunch if necessary. Inclusion criteria were a minimum age of 65 years, sufficient German language skills, the ability to stand with or without walking aids and a mild to moderate cognitive impairment measured via the DemTect [21] with a score range of 6–12. Exclusion criteria were delirium, aphasia, severe visual or auditory impairment, severe psychiatric disorders and contraindications for functional training, such as orthopedic instability, hernia or uncontrolled disorders as well as required isolation. Eligibility was confirmed by a geriatrician from a medical perspective (CM) on the day of admission. On day 2 at the earliest, depending on the availability of the patient due to treatment schedules and only if the geriatrician confirmed the patient's eligibility, the research assistant (NB) contacted the patient and relatives for informed consent. Afterwards, the assessment took place. To assess physical function, the de Morton mobility index (DEMMI) [13] was used, which is routinely completed after admission with a physiotherapist on this ward. Barthel index (BI) scores were recorded to rate patients' capacity in activities of daily living (ADL) [24].

Table 1 Baseline characteristics of the study population ($N = 20$)

Age, mean (SD), range years	84.0 (6.8) 68–99
Sex female, *N* (%)	12 (60)
Height, mean (SD) cm	165.2 (8.4)
Weight, mean (SD) kg	70.5 (17.8)
Days since admission, mean (SD), time frame days	4.6 (2.2) (2–9)
Length of stay, mean (SD) days	16.9 (16.9)
Number of diagnoses, mean (SD) *N*	5.2 (1.4)
DemTect[a], mean (SD) score	7.4 (1.9)
DEMMI[b], mean (SD) score	48.8 (14.7)
Barthel Index[c], mean (SD) score	50.0 (21.5)
Admitted from home, *N* (%)	16 (80)
Discharge destination home, *N* (%)	8 (40)
Institutionalized, *N* (%)	12 (60)
Primary reason for admission, N (%)	
Urinary tract infection	2 (10)
Fall	6 (30)
Renal insufficiency	1 (5)
Pain	1 (5)
Collapse	1 (5)
Stroke	1 (5)
Hypertension	2 (10)
Anxiety disorder	1 (5)
Infection	5 (25)

SD Standard deviation, *N* number
[a]Dementia detection test
[b]de Morton Mobility Index
[c]Barthel Index—Activities of daily living

Table 2 Activity behavior and difficulty of action

Activity	Category	Classification	Level of difficulty
(1) Lying in bed	Downtime in bed	Passive/iatrogenic[a]	No action
(2) Talk, read, watch TV, eat in bed		Passive	Nontherapeutic action
(3) Supported sitting in bed			
(4) Supported sitting out of bed	Sitting	Active/iatrogenic[a]	Minimal therapeutic action
(5) Transfer with support or hoist		Active	
(6) Unsupported sitting in bed		Active/iatrogenic[a]	Moderate therapeutic action
(7) Unsupported sitting out of bed		Active	
(8) Supported standing	Upright activity		
(9) Supported walking			
(10) Supported bending knees			
(11) Unsupported standing activities			High therapeutic action
(12) Unsupported walking			
(13) Unsupported bending knees			
(14) Unsupported transfer with feet on floor			

[a]Measures suggested by hospital staff and activity which led to unnecessary immobility (e.g. wheelchair use despite patient's ability to walk, lying in bed due to missing activities or time constraints of service staff)

All participants gave written informed consent or relatives in cases of a more severe cognitive impairment. The study was approved by the ethical committee of the University of Tübingen (project no. 881/2018BO2). The assessment was performed 2 days after admission at the earliest, which was considered a reasonable time to avoid additional stress for the patients during the settling-in period (**Table 1**).

Staff participants

A total of five different professional group members (physician, occupational therapist, physiotherapist, certified nurse, service staff) were recruited on the geriatric acute care ward for cognitively impaired patients of a German hospital to obtain an overview of the employees' experience with respect to daily procedures and the patient's activity behavior. Inclusion criteria were at least 1 year of work experience as well as sufficient German language skills. All included staff gave written informed consent. Afterwards, a semi-structured interview was conducted to assess daily routines of the healthcare professionals (HCP). They were asked to describe their professional activities in sessions of roughly 15 min from their own experience and schedules. Furthermore, they characterized these procedures in detail and explained if these contain patient contact or not.

Outcome measures

Information on patients' activity behavior, difficulty of action, context of activities, location and persons attending the patients were collected through behavioral mapping. Information on daily hospital routines and procedures were collected via semi-structured interviews with HCP to compare perceived structures with real-life data.

Observation

To gain context information patients were directly observed by the method of behavioral mapping (NB). Each observation took place only on the following day of the patient's individual assessment. Obser-

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A pilot observational study to analyze (in)activity and reasons for sedentary behavior of cognitively impaired geriatric acute inpatients

Abstract

Background and objective. Mobility decline and worsening of the cognitive status are all too often the result of acute hospital treatment in older patients. This is particularly pronounced in patients with pre-existing cognitive impairment. This study strived to analyze the routines of geriatric acute care and identify reasons and triggers for sedentary behavior during acute hospitalization of cognitively impaired inpatients.
Methods and patients. A sample of 20 moderately cognitively impaired geriatric inpatients (average age 84 years) were recruited on an acute care ward. Information on persons attending the patient, daytime, location, context, patient's activity behavior and difficulty of action were collected by behavioral mapping over a period of 35 1-min timeslots and extrapolated to a period of 525 min. Routines were further analyzed via semi-structured interviews with five healthcare professionals (HCP).
Results. Relevant relations between various categorical and ordinal variables, such as patients' activity behavior, persons attending the patient, daytime, location, difficulty of action and contextual factors were found. Extrapolated data showed that patients spent 396.9 min (75%) in their room, 342.0 min (65%) were spent alone and 236.2 min (45%) lying in bed. The time patients spent alone was grossly underestimated by HCP.
Conclusion. Time spent without company, lacking meaningful activities and continuous bedridden periods due to missing demands to leave the room might have led to time spent inactive and alone. These seem to be strong predictors for sedentariness. Routines of acute care should be reorganized to increase physical activity and thereby reduce sedentary behavior of this patient group.

Keywords

Physical activity · Acute care · Hospitalization · Functional decline · Cognitive impairment

Eine Pilotbeobachtungsstudie zur Analyse von (In-)Aktivität und Gründen sedentären Verhaltens kognitiv eingeschränkter, geriatrischer Akutpatienten

Zusammenfassung

Hintergrund und Zielsetzung. Mobilitätsstörungen und Verschlechterungen des kognitiven Status sind oft Folge einer akuten Krankenhausbehandlung älterer Patienten. Besonders ausgeprägt ist dies bei Patienten mit vorbestehender kognitiver Beeinträchtigung. Diese Studie hat zum Ziel, Routinen der geriatrischen Akutversorgung, Gründe und Auslöser für Bewegungsmangel bei akutem Krankenhausaufenthalt von kognitiv beeinträchtigten, stationären Patienten zu analysieren.
Methodik und Patienten. Eine Stichprobe von 20 stationären Patienten (Durchschnittsalter 84 Jahre) mit mittelschwerer kognitiver Beeinträchtigung wurde auf einer Akutstation rekrutiert. Informationen zu Patientenbetreuern, Tageszeit, Aufenthaltsort, Kontext sowie Aktivitätsverhalten und Handlungsschwierigkeit wurden mithilfe von „behavioral mapping" gesammelt, die dann zu einem 525 min dauernden Zeitraum von 9 bis 19 Uhr hochgerechnet wurden. Routinen wurden in halbstrukturierten Interviews mit 5 Angehörigen unterschiedlicher Gesundheitsberufe analysiert.
Ergebnisse. Es wurden relevante Zusammenhänge zwischen verschiedenen kategorialen und ordinalen Variablen wie Patientenaktivität, Patientenbetreuern, Tageszeit, Aufenthaltsort, Handlungsschwierigkeiten und Kontextfaktoren festgestellt. Extrapolierte Daten zeigen, dass die Patienten 396,9 min (75 %) in ihrem Zimmer, 342,0 min (65 %) allein und 236,2 min (45 %) im Bett liegend verbrachten. Die Zeit, die Patienten allein verbrachten, wurde von Angestellten stark unterschätzt.
Schlussfolgerung. Ohne Gesellschaft verbrachte Zeit, fehlende sinnvolle Aktivitäten und ununterbrochene Bettlägerigkeit aufgrund fehlender Anreize, führten möglicherweise dazu, dass die Zeit inaktiv und allein im Patientenzimmer verbracht wurde. Dies scheinen starke Prädiktoren für Bewegungsmangel zu sein. Routinen der Akutversorgung sollten neu organisiert werden, um körperliche Aktivität zu steigern und sedentäres Verhalten dieser Patientengruppe zu verringern.

Schlüsselwörter

Körperliche Aktivität · Akutstation · Hospitalisierung · Funktionsverlust · Kognitive Beeinträchtigung

vations were conducted on working days for 1 day and every 15 min from 9 a.m. to 7 p.m. with 2 breaks lasting 45 min in between as soon as patients were served lunch or dinner. These breaks were therefore not included in the observational data. In total 35 observed time slots were remaining, which were then extrapolated to an observation period of 525 min. By making the researcher a team member of the staff being regularly on the ward, it was assumed that the observed daily routines and procedures would be in accordance with the reality of the everyday work and the observer effect might turn out as small as possible. The observer recorded the patient's activity, context information, persons attending the patient, and the patient's location at each time point. When patients were out of view (in the bathroom or off the ward), activity was acquired retrospectively by questioning either the patient, the caregiver or the staff accompanying the patient. Non-retrievable data were recorded as not observed. The patients were observed for 1 min at each time point. As is routine in these kinds of observational studies using behavioral mapping as the method, the highest observed level of activity was counted for the whole observed session [3, 15]. All the observations were performed by two well-trained observers (NB, CL) after training, which included assessment of agreement resulting in great accordance before starting

Table 3 Patient's results regarding activity, company, location and context of action

Activity	Duration in minutes *M (SD)*	% of the observed time *M (SD)*
Downtime	236.2 (121.9)	45.0
Sitting	216.0 (115.6)	41.1
Upright	72.7 (65.1)	13.9
Attending person		
No one	342.0 (96.6)	65.1
Relatives/Friends	52.5 (64.6)	10.0
Service team member[a]	45.0 (54.0)	8.6
Therapist	37.5 (22.5)	7.1
Nurse	37.5 (28.6)	7.1
Physician	10.5 (18.9)	2.0
Location[b]		
Bedroom	396.9 (81.6)	75.6
Belonging bathroom	19.5 (18.9)	3.7
Common room	50.2 (61.3)	9.5
Hallway	39.0 (50.7)	7.4
Examination room[c]	7.5 (15.7)	1.4
Off ward[d]	12.6 (21.9)	2.4
Context of action		
Sleeping	99.7 (78.3)	19.0
Activities of daily living	93.7 (57.6)	17.8
Hospital routines	67.5 (41.1)	12.9
Neuropsychiatric symptoms[e]	126.0 (82.8)	24.0
Leisure activities[f]	138.0 (91.9)	26.3

[a]Service assistants, patient transport
[b]Time which could not be observed due to patients being out of sight (3.9%) could be recorded via proxy information for all parts
[c]e.g. MRI, X-ray
[d]Waiting room, newsstand, prayer room or green area
[e]113.9 min/21.7% apathy; 12.0 min/2.3% agitation
[f]Reading newspaper, writing, watching TV, looking out of the window, talking to hospital staff without medical or caring reason

the study. To test the extent of inter-rater reliability and to ensure objectivity and the absence of any observer biases, they tested the observation in a group of patients who were not included in this study.

Activity behavior and difficulty of action

At each observation 14 activities could be recorded. Activities were then sorted into three predefined categories and classified into active, passive and iatrogenic. They were furthermore categorized into five different levels of difficulty, which were chosen following rehabilitation studies using behavioral mapping ([3, 15]; ◘ **Table 2**).

Context information

Data were rated by the use of predefined categories, which were: (a) sleeping, (b) ADL (bathing, grooming, dressing, toileting, walking, eating and transfers), (c) leisure time activities (reading, writing, watching TV, looking out of window, talking to hospital staff or room neighbor), (d) hospital routines (caring/medical procedures, therapy sessions); (e) NPS (agitation, apathy) and (f) visits (interactions with relatives/friends).

Location and persons attending the patient

Further information regarding persons attending the patient (physician, nurse, therapist, service, relatives/friends, none) and location where the patient resided (patient room, bathroom, common room, hallway, examination room, off ward) was noted.

Statistical analysis

All statistical analyses were performed using SPSS Version 25.0 [31]. Descriptive statistics were used to analyze the characteristics of the participants. To examine the bivariate relation of the variables including 1) activity behavior, 2) persons attending the patient, 3) location, 4) difficulty and 5) context of the action, the χ^2-test of independence was performed due to the presence of categorical variables besides ordinal ones. Each χ^2-test calculation was therefore performed on the basis of all 700 observation units. Cross tables were chosen to analyze significant findings and relationships in more detail by means of the adjusted residuals. Therefore adjusted residuals were computed for each cell of the contingency tables. For all tests a significance level of $\alpha = 0.05$ was chosen. To later interpret the strength of the associations between the variables, Cramer's V coefficient was tested, giving a value between 0 and +1, while a value above 0.25 is considered a very strong relationship for a minimum table dimension of 5, while a value above 0.35 is considered very strong in cases of a minimum table dimension of 3 as it is partly the case in this study [1, 10].

For the observational part, the highest of the predefined activity levels occurring during every 1-min interval was recorded in the database (SPSS 25.0). Recorded activity levels were put into one of the three predefined categories (downtime, sitting out of bed, upright activity) and one of the five predefined levels of difficulty (no activity, nontherapeutic action, minimal therapeutic action, moderate therapeutic action, high therapeutic action). The proportion of time spent in each of the categories of variables was furthermore calculated as a percentage of all observed 35 time slots and then extrapolated for the whole observation period. The reported estimated means are based on these percentages.

Table 4 Found associations with the action's level of difficulty, Adjusted residuals

	Nurse	Physician	Therapist	Service	Relatives	None
No action	−2.9**	/	−5.1***	−5.9***	−4.6***	11.0***
Nontherapeutic action	/	/	/	−2.7**	6.7***	−2.5*
Minimal therapeutic action	/	/	2.5*	11.4***	/	−8.3***
Moderate therapeutic action	2.0*	/	/	/	/	/
High therapeutic action	/	/	4.2***	/	/	−2.5*
$\chi^2(20) = 283.23, p < 0.001, V = 0.32$						
	Room	**Bathroom**	**Com.room**	**Hallway**	**Exa.room**	**O. ward**
No action	11.1***	−3.8***	−6.3***	−5.5***	−2.3*	−3.1***
Nontherapeutic action	5.0***	/	−2.9**	−2.5*	/	/
Minimal therapeutic action	−7.8***	−2.2*	9.4***	/	4.8***	5.7***
Moderate therapeutic action	−2.0*	/	2.5*	/	/	/
High therapeutic action	−11.1***	9.3***	−2.6**	12.4***	/	2.3*
$\chi^2(20) = 490.92, p < 0.001, V = 0.42$						

	9AM	10AM	11AM	1PM	2PM	3PM	4PM	6PM
No action	−3.2*	−2.2*	−3.6***	3.7***	3.5***	2.0*	/	/
Nontherapeutic action	−2.4*	/	−2.2*	−2.0*	/	2.4*	2.5*	2.9**
Minimal therapeutic action	3.8***	/	4.0***	/	−2.1*	−2.4*	−2.6**	/
Moderate therapeutic action	2.6**	/	/	/	/	/	/	/
High therapeutic action	/	2.7**	/	/	/	/	/	/
$\chi^2(28) = 128.04, p < 0.001, V = 0.21$								

/ = no significant association
*Significant association $p < 0.05$, **significant association, $p < 0.01$, ***significant association $p < 0.001$

Results

Patient data

Out of 30 contacted patients 28 were willing to participate, 7 had to be excluded due to being ineligible to the predefined inclusion criteria and 1 dropout due to premature discharge against medical advice was reported. The mean age of the included patients was 84.0 years (±6.8 years). Cognitive assessment revealed a moderate cognitive impairment severity (DemTect 7.4 ± 1.9) with 12 patients having a suspected dementia disease (DemTect ≤9) with further prescribed medical clarification. Reasons for hospitalization as well as further diagnosed diseases varied widely as can be seen in **Table 1**.

The study population displayed an average BI score of 50.0 (±21.5) meaning need for help in ADL which results in dependency on care. The average DEMMI score of 48.8 (±14.7) supports this tendency. Half of the study sample admitted from home was institutionalized after discharge. Characteristics of the study population are listed in **Table 1**. No adverse events or complications related to the study assessment were registered.

Activity behavior, persons attending the patient, location, and context of action

Extrapolated data regarding patient activity, persons attending the patient, location where the patient resided, as well as context of action are displayed in **Table 3**. It becomes clear that the patients spent almost half of the waking hours (45%) with downtime, while only 13.9% were designed with upright activity. They stayed in their bedroom for 75.6% of the observed time and were on their own for 65.1% of the period.

Factors Associated with Patients' Activity Behavior

Difficulty level of action

The results show a significant association between activity difficulty level and persons attending the patient, location and daytime. These are displayed in detail in **Table 4**. Data show that the activity difficulty level is higher during the morning than during the afternoon. Especially the "no action" level of difficulty is promoted in the afternoon. Spending time in the hallway or the bathroom seem to be associated with a higher action level of difficulty, while the own room is associated with lower levels of difficulty. Furthermore, data displayed an interaction between the category of "no action" when patients were on their own, while the presence of relatives and friends were associated with nontherapeutic action. The attendance of a service staff increased minimal therapeutic action, and only the presence of a therapist supported high therapeutic action.

Daytime

The results show an interaction between activity category and daytime. It becomes clear that downtime increases directly after lunch time (1 p.m.) and is more frequent during the whole afternoon (1 p.m.–7 p.m.) (**Fig. 1**).

Table 5 Found associations with the context category, Adjusted residuals

	Sleeping	ADL	Leisure time	Hospital routines	Neuropsychiatric symptoms	
No action	17.5***	−9.1***	−11.1***	−4.6***	7.1***	$\chi^2(16) = 604.96$, $p < 0.001$, $V = 0.47$
Nontherap. action	−4.3***	−2.5*	8.5***	/	−2.0*	
Min. therap. action	−5.5***	/	5.5***	5.3***	−5.4***	
Mod. therap. action	−8.6***	5.3***	4.0***	/	/	
High therap. action	−3.9***	8.5***	−4.1***	3.5***	−2.5*	
Downtime	14.2***	−10.2***	−5.5***	−4.9***	5.6***	$\chi^2(8) = 405.13$, $p < 0.001$, $V = 0.54$
Sitting	−10.7***	3.5***	9.5***	/	−4.3***	
Upright	−5.1***	9.6***	−5.6***	4.7***	/	
Active	−14.0***	9.5***	5.8***	4.5***	−5.2***	$\chi^2(8) = 359.73$, $p < 0.001$, $V = 0.51$
Passive	14.7***	−10.6***	−5.3***	−5.7***	5.9***	
Iatrogenic	−2.0*	3.4***	/	3.7***	−2.3*	
9AM	−3.4***	4.6***	/	/	/	$\chi^2(28) = 154.86$, $p < 0.001$, $V = 0.24$
10AM	−2.5*	/	/	5.6***	/	
11AM	−2.2*	2.6**	/	3.6***	−2.5*	
1PM	5.1***	/	−2.7**	/	/	
2PM	4.5***	−2.3*	/	/	/	
3PM	/	/	/	/	/	
4PM	/	/	/	/	/	
6PM	/	/	/	−3.2**	3.5***	

/ = no significant association
*Significant association $p < 0.1$, **significant association, $p < 0.05$, ***significant association $p < 0.001$

Context of action

Significant associations between the context of action and activity category, daytime and action level of difficulty were found. While ADL and hospital routines seem to be associated with upright activity, especially in the morning, leisure time activities promote sitting out of bed. The NPS displayed an interaction with the evening hours and downtime in particular as can be seen in **Table 5**.

Interview data

Of nine contacted HCPs five were willing to participate who were all female. One employee of each profession (physician, occupational therapist, physiotherapist, (certified) nurse, service staff) could therefore be included for an interview. The mean age of the included staff was 32.5 years (SD 5.6 years) and they had on average 7.3 years (±5.2) of professional experience. Interview data regarding perceived patient activity connected to daily routines and procedures showed small differences in the distribution compared to observational data of the patients' observed activity (**Fig. 2**).

Collected information on the persons attending the patient over the day again showed differences in the expected distributions expressed by the ward staff compared to observational data (**Fig. 3**).

Discussion

Functional decline and mobility disability are commonly observed in older hospital patients and in patients suffering from cognitive impairment in particular. The HCPs often consider these as inevitable consequences (side effect) of hospital stays. If mobility disability reaches certain thresholds, such as the inability to climb stairs or insufficient capacity to perform a sit to stand transfer, discharge to the home environment is threatened. Cognitively impaired patients are 3 times more likely than cognitively healthy patients to become institutionalized in long-term care facilities after a hospital stay due to cognitive and functional decline caused by sedentariness during the stay [23] and affecting the patients in the long run [6, 8]. These trajectories could also be observed in this study sample where 50% of patients admitted from home were institutionalized after discharge, although the medical condition had been successfully treated, due to functional and cognitive decline. Increasing care costs associated with these discharge failures [4] are expected to create increasing problems and highlight the need of action.

This study showed that patients spent 45.0% of the observed time lying in bed, complemented by 41.1% of sitting, resulting in 86.1% of sedentary time. Hartman et al. examined sedentariness in non-hospitalized dementia patients (average age 79.6 years) and cognitively healthy persons (average age 80.0 years). They could show that dementia patients spent 57% (cognitively healthy patients: 55%) of their waking hours sedentary and additionally 16% with very light intensity activity (cognitively healthy patients: 15%). The authors thought these numbers to be alarming and pointed out the harmful effects of inactivity and a lack of interruption of the sedentary periods. The importance of even very short breaks of light intensity activities is furthermore highlighted [20].

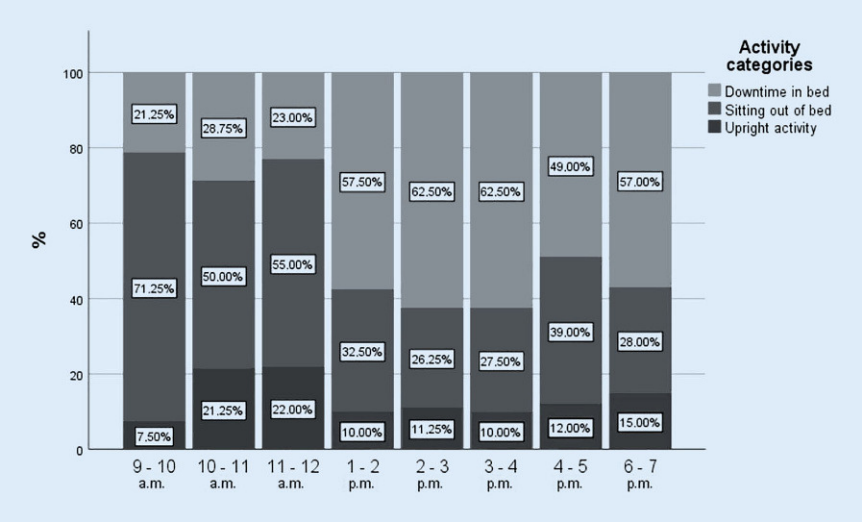

Fig. 1 ▲ Distribution of the patients' activity categories during the day

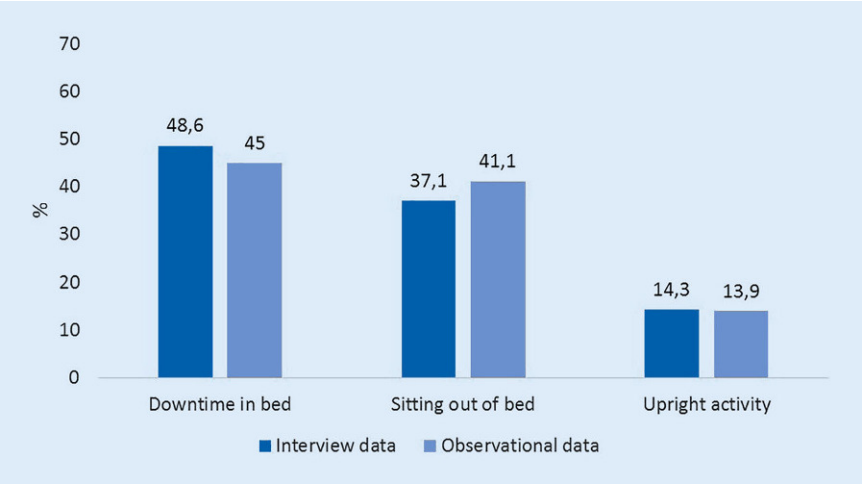

Fig. 2 ▲ Expected and observed activities of patients (9 a.m. to 7 p.m.)

To increase physical activity and reduce sedentary behavior of this patient group at risk of functional decline by reorganizing routines of the acute care, it is of importance to understand the reasons for sedentariness during a hospital stay. These reasons vary between patient and staff factors, such as attitude and self-efficacy concerning physical activity in general or the patient's physical activity level before hospitalization [30]. They are also influenced by a lack of motivation for mobility during the hospital stay and poorly planned medical and nursing procedures leading to unjustified immobilization. This pilot observational study was meant to describe in which contexts and under which circumstances certain activities occur in order to undertake a first attempt to disentangle the connection between patients' activity behavior and different covariates, such as daytime, persons attending the patient, location, difficulty of action and context information. It was performed during 35 observed minutes from 9 a.m. until 7 p.m., which were extrapolated to an observational period of 525 min.

Persons attending the patient

Therapists and nurses seem to promote upright activity, especially high level therapeutic action by therapy sessions and ADL support. These upright activities were furthermore observed during the morning hours. The same pattern was noticed for sitting with service staff spending time with the patients in the common room; however, it has to be added that sitting due to hospital regulations seemed to occur frequently in the company of service staff. This might be associated with limited competencies being linked to hospital restrictions. Service staff are not allowed to mobilize the patients, which could result in prolonged and harmful sitting.

The' presence of nurses in the room was more frequent in the evening than at any other time of the day. This might be due to procedures for the night or due to caring routines because of NPS. Phases of mandatory sitting occurred significantly more frequently in their company during ADL performance and hospital routines in the evening, although it needs to be kept in mind that these two context categories are also associated with active time in the morning as could be observed in this study. This difference might occur due to time constraints on different times of the day. Research showed that nurses state to drop activity promotion first when time pressure occurs [30]. These results are in accordance with the current findings. Whereas all HCPs seem to decrease downtime in some way, this is not yet the case for physicians. They are the only group that seem to have no positive effect on the patient's activity behavior although they have an important role in activity promotion in general [30]. Leisure time activities are promoted by the presence of relatives; however, neither sitting out of bed nor upright activities are significantly affected by their company. Physicians and relatives therefore seem to be the only persons attending the patient without any positive effect on their activity.

Location and daytime

Downtime occurred significantly more often during the afternoon hours. It seems that meaningful activities during this period are probably missing. Interviewees underestimated the time patients spent alone (210.0 min) compared to observational data (342.0 ± 96.6 min) which might lead to inactivity and more time in bed sleeping and watching TV, while sitting out of bed and walking is less fre-

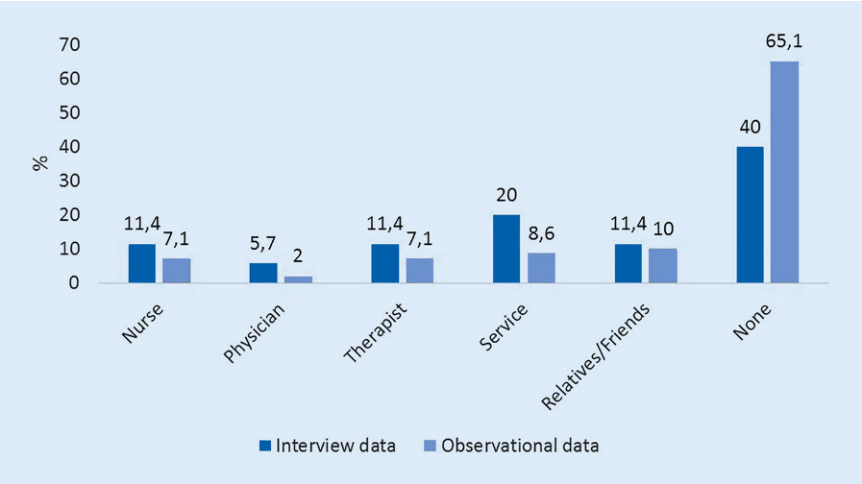

Fig. 3 ▲ Expected and observed time patients spent with other persons (9 a.m. to 7 p.m.)

quent. Apathy and agitation occurred significantly more often in the evening hours when the patients were on their own instead of using a wheelchair. Time spent alone in the patient room constituted a significant trigger for sedentariness in this study. In contrast, the hallway and the bathroom promoted upright activity as long as patients were engaged to walk supported or unsupported on their own. This points out that patients should at least walk on the ward and should not be placed in a wheelchair for transfers between rooms.

Proposed measures

The execution of ADL might play an important role in reducing sedentary time through increasing physical activity in an individual manner. Particularly patients with a moderate cognitive impairment suffer the strongest decline in ADL performance [17] and become more dependent. Designing ADL more actively might therefore result in positive effects regarding mobility outcomes, whereby the gap between the patient's physical capacity and actual activity needs to be considered. Patients capable of physical activity should therefore be encouraged to be active and ADL especially promoted transfers, standing as well as walking. Routinely implemented procedures might therefore serve as facilitators for activity, such as regular toileting during waking hours instead of diaper usage, not eating in bed but on the table or encouraging the patient to get up during medical and care procedures. The part played by physicians and relatives in activity promotion needs to be strengthened and supported especially in the case of relatives, e.g. by material on how physical activity can be safely increased in their company since relatives spent the most time with patients on average (52.5 ± 64.6 min). Moreover, restrictions regarding competencies of service staff need to be reconsidered because at the moment they are only associated with sitting activities although spending more time with patients than any other HCP. Prolonged sitting can be harmful and might not even be compensated by high levels of moderate physical activity from a certain point on [14]. In addition, the presence of service staff in the afternoon would be desirable to reduce downtime.

The usefulness of health insurance guidelines regarding therapy sessions lasting more than 15 min but occurring only once a day is furthermore debatable. Split sessions of around 10 min could be a better alternative to interrupt sedentariness over the daytime and increase physical activity especially during the afternoon which is currently characterized by immobility. Furthermore, the hazardous effects of sedentariness can no longer be undone by a single period of 30 min of exercise but only by regular interruptions of sedentary periods which need to be spread over the day [19]. This is in particular the case in hospitalized older adults who suffer from hospital stays the most but show positive effects when exercising during the stay, resulting in an increased quality of life [25].

Limitations

A limitation of this study is the relatively small sample size. Furthermore, typically for observational studies there is a potential for bias which can never be completely excluded. Patient behavior may have been affected by the observers' presence. This issue was therefore discussed with a group of researchers from the field before this study. The consensus reached was the approach used in this study, namely making the observing research assistant a team member on the ward to create a basis of trust and habit between all present persons on the ward. Observation periods of 1 min might not be representative for the whole 15 min time slot. The observed activity behavior may be different than during the remaining unobserved time or activity may be missed. This issue could only be resolved by permanent observation, which is not feasible due to its time intensity and impact on the patient's behavior; however, behavioral mapping by direct observation provides researchers with a profile of patients' activity behavior and context information which cannot be acquired by sensor measures. Furthermore, the results of the data analyses should be interpreted with caution because no adjustments for multiple testing were performed.

Conclusion

- Patient sedentariness is associated with time spent alone, in the patient room, during the afternoon and by NPS such as apathy.
- Meaningful activities for the patient as well as staff involved with the patient are missing during the afternoon, which might lead to sedentariness. This could be addressed by split therapy sessions taking place in the afternoon or more personnel.
- Prolonged sitting might also occur due to competency restrictions, such as service staff not being allowed to

mobilize the patient or due to time constraints in caring procedures.
- Physical activity, especially upright activity is insufficiently promoted by relatives and physicians.

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Compliance with ethical guidelines

Conflict of interest N. Belala, C. Maier, P. Heldmann, M. Schwenk and C. Becker declare that they have no competing interests.

Written informed consent was obtained from all individual participants included in the study prior to data collection. All procedures performed in this study involving human participants were in accordance with the standards of the ethic committee of the University of Tübingen and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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