Aus dem Institut für Allgemeinmedizin
der Heinrich-Heine-Universität Düsseldorf
Direktor: Univ.-Prof. Dr. med. Stefan Wilm

ABLYMED - ability to self-administer medication in non-demented in-hospital patients

Entwicklung eines neuen Instruments zur Bewertung der Fähigkeit zum Medikamentenselbstmanagement älterer Patienten

Dissertation
zur Erlangung des Grades eines Doktors der Public Health der Medizinischen Fakultät
der Heinrich-Heine-Universität Düsseldorf

vorgelegt
von Anneke Lügering
2023

Angabe der Gutachter

Als Inauguraldissertation gedruckt mit der Genehmigung der Medizinischen Fakultät der Heinrich-Heine-Universität Düsseldorf

gez.:

Dekan/in: Prof. Dr. med. Nikolaj Klöcker

Erstgutachter/in: Univ.-Prof. Dr. med. Stefan Wilm

Zweitgutacher/in: PD Dr. med. Martin Neukirchen

Auflistung der Publikationen

Teile dieser Arbeit wurden veröffentlicht:

Maiworm, A., Langner, R., Wilm, S., Hermann, D.M., Frohnhofen, H., Gronewold, J., (2022), Developing a novel tool to assess the ability to self-administer medication in nondemented in-hospital patients: ABLYMED study protocol. BMC Geriatr, (22) 466

Luegering, A., Langner, R., Wilm, S., Doeppner, T.R., Hermann, D.M., Frohnhofen, H., Gronewold, J., (2023), Developing a novel tool to assess the ability to self-administer medication – A systematic evaluation of patients´ video recordings in the ABLYMED study. Frontiers in Medicine, (10)

I Zusammenfassung (deutsch)

Mit steigendem Lebensalter steigt die Krankheitslast, wodurch die Medikationsregime älterer Patienten zunehmend komplexer werden. Gleichzeitig führen Multimorbidität und altersbedingte Veränderungen zu funktionalen und kognitiven Einschränkungen der Patienten. Diese konträren Entwicklungen münden häufig in Barrieren im Selbstmanagement der Medikation mit einem Risiko für Nonadhärenz. Probleme im Selbstmanagement der Medikation bleiben bei älteren unabhängig lebenden Patienten mit Polypharmazie häufig unerkannt, da sie nicht ersichtlich sind und die Patienten nicht darüber berichten. Eine Überprüfung der Medikamentenselbstmanagement-fähigkeiten ist von hoher Relevanz, um ein Erreichen der Therapieziele möglich zu machen. Eine solche Überprüfung hat bislang keinen Einzug ins geriatrische Assessment gefunden. Es ergibt sich daher folgende Fragestellung für diese Dissertation: Wie können die tatsächlichen Leistungen der Patienten im Selbstmanagement ihrer Medikation erfasst und bewertet werden und welche Faktoren beeinflussen diese? Ziel ist die Entwicklung eines Assessmentinstruments, das die Fähigkeiten zum Selbstmanagement der Medikation älterer unabhängiger Patienten mit Multimorbidität prüft. Die auf Grundlage dieser Fragestellung entwickelte ABLYMED-Studie untersucht ein Patientenkollektiv älterer, nicht-dementer, stationärer Patienten mit eigenständigem Medikamentenmanagement. Die Datenerhebung setzt sich aus einer Patientenbefragung, einem geriatrischen Assessment sowie der videodokumentierten Aufzeichnung des Umgangs der Studienteilnehmer mit Medikamenten in fünf verschiedenen Darreichungsformen zusammen. Ein erstes Ergebnis der ABLYMED-Studie ist ein reliables und valides Bewertungsverfahren zur systematischen Auswertung der Videoaufnahmen. Die Videos werden mit Hilfe eines Bewertungsbogens und -regeln nach einer vorherigen Schulung von zwei Experten mit einer zufriedenstellenden Übereinstimmung bewertet. Die videobasierte Erfassung und quantitative Auswertung von Leistungen im Medikamentenselbstmanagement sind neu. In Anbetracht der unzuverlässigen Selbsteinschätzung der Patienten und der alternden Bevölkerung hat diese Untersuchung hohe praktische und klinische Relevanz für Verordner, unabhängig von der Disziplin. Um ein Assessmentinstrument ableiten zu können, muss der Zusammenhang zwischen subjektiven Maßen aus dem Fragebogen, den Ergebnissen des geriatrischen Assessments und den Ergebnissen der Videoauszeichnungen untersucht werden. In Folgestudien müssen Interrater- und Test-Retest-Reliabilität für das Instrument gezeigt werden.

II Zusammenfassung (englisch)

The number of diseases increases with age, making medication regimes for older patients more complex. Besides, multimorbidity and age-related disorders lead to impairments in physical and mental functions in patients. These contrary processes often lead to barriers of self-administration of medication with an increasing risk of non-adherence. Medication management problems often remain unrecognized in independently living patients because they are not obvious, and patients do not report them. An assessment of medication self-management abilities is of high relevance to make sure that the intended therapy goals can be achieved. Such an assessment is not yet established in geriatric assessment. The research question of the present dissertation is how patients' actual abilities to handle the self-administration of their medication can be assessed and evaluated as well as which factors influence the medication management capacity. We aim to develop an assessment instrument for everyday use, that evaluates the medication self-management skills of older independent living patients with multimorbidity. The ABLYMED study, which was developed based on the research question, examines a collective of elderly, non-dement inpatients with an autonomous medication management. The data collection contains an interview, a geriatric assessment and video recording of the medication management performance with five different medication dosage forms of each patient. A first result of the ABLYMED study is a valid and reliable assessment procedure for systematic evaluation of the video recordings. The videos were rated with satisfactory agreement by two experts, using an assessment form and rating rules after prior training. The video-based recordings of handling all common dosage forms and the quantitative evaluation of performance in medication self-management are new. Due to the unreported medication management problems and the aging society, this study has high practical and clinical impact for prescribers, independently from the medical subject. To create an assessment instrument for everyday use, the relationship between subjective measures from the interview, the results of the geriatric assessment and the results of the video recordings need to be examined. In further studies, interrater reliability and test-retest reliability must be shown for the newly developed assessment instrument.

III Abkürzungsverzeichnis

ABLYMED	ability to self-administer medication in non-demented in-hospital patients
DRKS	Deutsches Register Klinischer Studien
DRUGS	Drug Regimen Unassisted Grading Scale
HIOPP	Hausärztliche Initiative zur Optimierung der Patientensicherheit bei Polypharmazie
MedMaIDE	Medication Management Instrument for Deficiencies in the Elderly
MMAA	Medication Management Ability Assessment

IV Inhaltsverzeichnis

1 Einleitung

1.1 Hinführung zum Thema

Mit zunehmenden Lebensalter steigt die Anzahl der gleichzeitig vorliegenden Erkrankungen (1). In Deutschland liegen bei ungefähr 50% der Bevölkerung im Alter von 50 bis 59 Jahren mindestens zwei chronische Erkrankungen gleichzeitig vor, im Alter von 80 Jahren bei 75% der Bevölkerung (2). Bei älteren Patienten sind die häufigsten chronischen Erkrankungen Bluthochdruck, Hyperlipidämie, ischämische Herzkrankheiten, Diabetes, Arthritis und Herzinsuffizienz (3). Diese Patienten mit zwei und mehr chronischen Erkrankungen werden definitionsgemäß als multimorbide bezeichnet (1). Menschen im Alter von über 80 Jahren haben im Durchschnitt sogar drei Diagnosen (4). Eine steigende Krankheitslast geht mit einer erhöhten Anzahl von Medikamenten einher, was als Polypharmazie bezeichnet wird (4). Es gibt keinen einheitlichen Grenzwert für die Anzahl der Medikamente, auf den man sich für die Definition der Polypharmazie festlegen konnte (5). Üblicherweise wird ein Grenzwert von fünf Arzneimitteln verwendet (6). Die Pharmakotherapie von Patienten mit Polypharmazie kann hochkomplex sein. Auch für die Komplexität von Medikationsregimen gibt es keine einheitliche Definition. Vielmehr fokussieren verschiedene Autoren unterschiedliche Faktoren, um die Komplexität zu bewerten wie beispielsweise: Anzahl der Arzneimittel, Dosierungshäufigkeiten, Anzahl der Medikamente, die zum gleichen Zeitpunkt angewendet werden müssen, Verabreichungsanweisungen wie z.B. Nüchterneinnahme (7).

Durch den Alterungsprozess kommt es zu kognitiven und funktionalen Einschränkungen der Menschen. Bezüglich der Kognition sind beim alternden Menschen das Arbeitsgedächtnis und das episodische Gedächtnis deutlich vermindert (8). Funktionale Einschränkungen können unter anderem verminderte Speichelproduktion mit Schluckbeschwerden, Sehschwäche, mangelnde Handkraft und Verluste in der Feinmotorik sein (9, 10). Einschränkungen der Nieren- und Leberfunktion können zudem den Metabolismus von Arzneistoffen beeinflussen und Auswirkungen auf dessen Wirkung haben (3). Unerwünschte Arzneimittelwirkungen und inadäquate Verschreibungen können die altersbedingten kognitiven und funktionalen Einschränkungen weiter verstärken. Das trifft beispielsweise für Arzneimittel mit hoher anticholinerger Last zu (11).

Zusammenfassend unterliegt die Pharmakotherapie älterer Patienten der besonderen Situation, dass einerseits krankheitsbedingt eine komplexe Medikation notwendig ist, andererseits leiden ältere Menschen an alters- und krankheitsbedingten Einschränkungen, die den praktischen Umgang mit einer solchen Medikation erschweren (8). Die tägliche Medikamentenanwendung bedeutet für diese Patientengruppe einen herausfordernden und hohen Arbeitsaufwand (12). Die einzelnen Prozessschritte in chronologischer Rheinfolge, die von den Patienten im Selbstmanagement von Medikamenten verlangt werden, sind: Lesen und Verstehen des Medikationsplans, Identifikation und Auswahl des richtigen Arzneimittels, Öffnen der Originalverpackung und Entnahme der Primärverpackung, Entnahme der Darreichungsform aus der Primärverpackung, z.B. einem Blister, gegebenenfalls Präparation der Darreichungsform zum Beispiel Teilen einer Tablette und Ablage in die korrekte Vertiefung einer Dosette (13).

1.2 Wissenschaftlicher Hintergrund

Es konnte in mehreren Studien beobachtet werden, dass ältere Personen Probleme bei der selbstverantwortlichen Anwendung ihrer Medikamente haben (8, 12, 13). Beispielsweise konnte in einer Studie aus Schweden anhand von fast 500 Patienten ab 77 Jahren aus einer nationalen repräsentativen Stichprobe gezeigt werden, dass 66,3% mindestens ein Defizit in den Fähigkeiten Handfunktion (Flasche öffnen), Sehvermögen (Kennzeichnung lesen) oder Medikamentenkompetenz (Verständnis und Reichweitenberechnung) hatten (8). Eine Studie der Berliner Charité zeigte anhand von 20 selbstständig lebenden Patienten ab 65 Jahren, dass das Öffnen von kindersicheren Verschlüssen von Tropfflaschen und das Teilen von Tabletten problematisch ist (13). Obwohl bereits Wissen zu Problemen im Selbstmanagement der Medikation durch ältere Patienten besteht, bleiben diese häufig unerkannt (14). Das liegt unter anderem an der verzerrten Selbsteinschätzung der Patienten bezüglich ihrer Fähigkeiten im Umgang mit Medikamenten. Patienten schätzen sich im Umgang mit ihren Medikamenten zu häufig als kompetent ein (13). Sie entwickeln im Laufe der Therapie eigene Managementstrategien, um die tägliche Anwendung ihrer Medikamente bewältigen zu können. Zum Beispiel berichten Patienten darüber, andere Verpackungen für ihre Medikamente zu nutzen, wenn die Originalverpackungen schwierig zu Öffnen sind. Oder Patienten nehmen Bruchstücke einer Tablette ein, wenn diese beim Teilen in mehrere Stücke zerbrochen ist. Diese Strategien werden von den älteren Patienten nicht als Abweichung zur Verordnung wahrgenommen und werden folglich nicht berichtet, obwohl sie zu Medikationsfehlern

und klinischen Konsequenzen führen können (10, 13). Da Barrieren im Selbstmanagement der Medikation von multimorbiden Patienten nicht erkannt werden, können entgegenwirkende Maßnahmen nicht bedarfsgerecht und in vollem Umfang ausgeschöpft werden. Gezielte Maßnahmen wären unter anderem die Anpassung der Verordnung hinsichtlich praktikabler Darreichungsformen und Dosierungsfrequenzen, sowie die gezielte Schulung von Patienten z.B. über die sachgerechte Anwendung. Sollten diese Maßnahmen nicht ausreichen, kann ein Pflegedienst die korrekte und sichere Arzneimittelanwendung sicherstellen (10, 15). Letztlich dienen alle genannten Maßnahmen der Vorbeugung von Nonadhärenz, welche als Kernproblem in der Arzneimittelanwendung durch Ältere gilt (16). Der Begriff Adhärenz beinhaltet im Gegensatz zum früheren Begriff Compliance die Zustimmung des Patienten zum Therapievorschlag des Verordners. Compliance bedeutet das Ausmaß der Übereinstimmung zwischen dem Verhalten eines Patienten in Bezug auf die Anwendung von Medikamenten und den medizinischen Empfehlungen des Verordners. Laut der Definition von Compliance spielt der Patient eher eine passive Rolle (17). Polypharmazie, Medikamentenkomplexität, Multimorbidität und Medikamentenmanagementdefizite sind Risikofaktoren für Nonadhärenz (17, 18). Im Fall von älteren Patienten bedeutet Nonadhärenz meistens, dass die Patienten weniger als vereinbart anwenden. Nonadhärenz, insbesondere das Weglassen von Medikamenten, ist kritisch, da es zur weiteren Morbidität bis hin zur Mortalität führen kann (3). Durch den korrekten und sachgerechten Umgang mit Arzneimitteln kann die Adhärenz erhöhen werden, was den Therapieverlauf der Patienten günstig beeinflusst und die Lebensqualität steigert (17). Zudem wird das Gesundheitswesen weniger mit den finanziellen Folgen von Ereignissen durch Nonadhärenz belastet (17).

Um die Nonadhärenz aufgrund von Problemen im Medikamentenselbstmanagement zu minimieren, muss das Medikamentenselbstmanagement der Patienten überprüft werden. Zu einer umfassenden Überprüfung gehört sowohl die Selbsteinschätzung (berichtete Fähigkeiten) der Patienten, als auch die Bewertung des praktischen Umgangs mit Medikamenten (tatsächliche Fähigkeiten) (13). Die Erhebung der tatsächlichen Medikamentenmanagementfähigkeiten ist nicht trivial. Hausbesuche können dabei helfen, Medikationsmanagementprobleme aufzudecken, sie sind jedoch nicht flächendeckend realisierbar (19). Ein praktikables Instrument, das in Arztpraxen angewendet werden kann und die Medikamentenselbstmanagementfähigkeiten prüft, ist derzeit nicht verbreitet (15, 20).

1.3 Übergeordnete Fragestellung

Welche patientenbezogenen und medikationsbezogenen Faktoren beeinflussen das Selbstmanagement der Medikation bei älteren und unabhängig lebenden Patienten mit Polypharmazie und ohne wesentliche kognitive Einschränkungen? Wie sieht ein alltagstaugliches Instrument aus, das die Fähigkeiten dieser Patienten im Selbstmanagement ihrer Medikation erfassen kann?

1.4 Publikationen

Diese Dissertationsschrift umfasst zwei Publikationen. Die erste Publikation mit dem Titel „Developing a novel tool to assess the ability to self-administer medication in non-demented in-hospital patients: ABLYMED study protocol" wurde im Mai 2022 im BMC Geriatrics veröffentlicht und beinhaltet das Protokoll der ABLYMED-Pilotstudie (21). Die Studie dient der Entwicklung eines alltagstauglichen Assessmentinstruments zur Bewertung der Selbstmanagementfähigkeiten von älteren Patienten bezüglich ihrer Medikation. In der ABLYEMED Studie werden Patienten eingeschlossen, die ein erhöhtes Risiko für Handhabungsprobleme ihrer Medikation aufweisen (≥ 70 Jahre alt sind und regelmäßig ≥ 5 verschiedene Medikamente einnehmen), diese aber noch eigenverantwortlich anwenden. Das Studienprotokoll sieht eine Befragung der Patienten vor, in der unter anderem demografische und klinische Informationen, die Medikamentenanamnese, die Adhärenz, möglicherweise Adhärenz beeinflussende Faktoren und der praktische Umgang mit den Arzneimitteln erhoben werden. Die Kognition und der funktionelle Status der Patienten werden innerhalb eines geriatrischen Assessment gemessen. Zur Bewertung der Fähigkeit in der eigenverantwortlichen Anwendung von Medikamenten werden die Patienten nach vorheriger Instruktion bei der Anwendung verschiedener Placeboarzneimittel gefilmt. Die entstandenen Videoaufnahmen werden von verschiedenen Experten bewertet. Anschließend sollen die von den Patienten angegebenen Fähigkeit im Umgang mit ihrer Medikation aus der Befragung mit der beobachteten Leistung aus den Videoaufnahmen korreliert werden und Faktoren ermittelt werden, die mit der Fähigkeit zum Selbstmanagement von Medikamenten zusammenhängen (21).

Die zweite Publikation mit dem Titel „Developing a novel tool to assess the ability to self-administer medication – A systematic evaluation of patients´ video recordings in the ABLYMED study" wurde im Februar 2023 in Frontiers in Medicine publiziert und beschäftigt sich mit der Methodik zur systematischen Bewertung der Videoaufnahmen

aus der ABLYMED-Studie (22). Die erhobenen Daten umfassten unter anderem Videoaufzeichnungen von 67 Patienten, die die Medikationsmanagementleistungen der Patienten anhand von fünf Darreichungsformen zeigen. Die Publikation beschreibt eine systematische Methodik zur qualitativen Bewertung der Videoaufnahmen. In einer Pilotphase wurde das Bewertungsverfahren validiert. Die umfassende Bewertung aller Videos erfolgte dann durch zwei unabhängige Experten (Psychologin und Epidemiologin/Neurologe) mit Hilfe eines Bewertungsbogens, schriftlichen Bewertungsregeln und einer vorherigen Schulung. Im gesamten Bewertungsprozess wurde regelmäßig die zufriedenstellende Interrater- und Intrarater-Reliabilität sichergestellt. Das Ergebnis der Videobewertung ist ein Score, der die individuelle Patientenleistung im Selbstmanagement pro Darreichungsform abbildet. Die Erkenntnisse aus der ABLYMED-Studie sind wichtig, da sie die tatsächlichen Fähigkeiten der Patienten im Selbstmanagement der Medikation valide darstellen. Sie dienen der Identifikation von Faktoren, die mit der berichteten und tatsächlichen Fähigkeit zum Selbstmanagement von Medikamenten korrelieren (22).

1.5 Ethikvotum

Alle Studienteilnehmer haben schriftlich dem Einschluss in die Studie zugestimmt. Die Studie wurde durch die Ethikkommission der medizinischen Fakultät der Heinrich-Heine-Universität Düsseldorf genehmigt (Referenznummer 2021-1435) und im Deutschen Register klinischer Studien unter der DRKS-ID: DRKS00025788 (Registrierungsdatum: 07/09/2021) gelistet.

1.6 Ziele der Arbeit

Die Ziele der Arbeit gliedern sich in die Ziele der gesamten ABLYMED-Studie und in die untergeordneten Ziele der einzelnen Publikationen.

Die Ziele der ABLYMED-Studie sind:

A. Die Fähigkeiten von älteren, nicht-dementen, stationären Patienten im Selbstmanagement ihrer Medikation zu erfassen und anhand der Selbstauskünfte der Patienten (Befragung) sowie anhand der Leistungen im praktischen Umgang mit Medikamenten (Videoaufnahmen) zu bewerten.

B. Faktoren (medikationsbezogen oder patientenbezogen) zu identifizieren, die das Selbstmanagement der Medikation beeinflussen.

C. Die Entwicklung eines alltagstauglichen Assessmentinstruments zur Erfassung der Fähigkeiten der eigenverantwortlichen Anwendung von Arzneimitteln durch ältere Patienten.

Langfristiges Ziel ist die Etablierung dieses Instruments in das geriatrische Assessment. Es soll die Managementfähigkeiten von älteren und unabhängig lebenden Patienten bezüglich ihrer Medikation wahrheitsgemäß und unkompliziert bewerten. Aus den patientenindividuellen Ergebnissen können dann Maßnahmen wie die Anpassung des Medikationsplans, Schulungen und die Verordnung eines Pflegedienstes abgeleitet werden. Der Bedarf für ein solches Instrument besteht, da Probleme im Selbstmanagement der Medikation bei der untersuchten Patientengruppe häufig unentdeckt bleiben.

Das Ziel der ersten Publikation ist die Entwicklung eines Studiendesigns, um ein Assessmentinstrument zur Erfassung der Fähigkeiten der eigenverantwortlichen Anwendung von Arzneimitteln durch ältere Patienten zu entwickeln. Ein detailliertes Studienprotokoll beinhaltet alle möglichen medikationsbezogenen und patientenbezogenen Faktoren, die die Fähigkeiten im Selbstmanagement der Medikation beeinflussen können. Darüber hinaus müssen Daten zu den Leistungen der eingeschlossenen Patienten im Selbstmanagement ihrer Medikation erfasst werden. Da die bestehende Literatur bestätigt, dass die Selbstauskunft zur Erfassung der Leistungen nicht ausreichend ist, müssen auch die tatsächlichen Leistungen erhoben und dokumentiert werden. Zusammenfassend soll ein praktikables Studiendesign auf Grundlage von Literaturrecherche, Expertenmeinungen und eigenen klinischen Erfahrungen entwickelt werden.

Das Ziel der zweiten Publikation bezieht sich auf die Auswertung der Daten der ABLYMED-Studie. Die Daten umfassen unter anderem Videoaufnahmen zur Erfassung der tatsächlichen Leistungen der Patienten im Selbstmanagement ihrer Medikation. Die Videoaufnahmen müssen für die weitere Auswertung der Daten bewertet werden. Die individuellen Leistungen der Patienten sollen mit einem Score abgebildet werden. Ziel ist daher ein Bewertungsverfahren zu konzipieren, mit dem die Leistungen der Patienten aus den Videoaufnahmen quantifiziert werden können. Dazu sollen ein Bewertungsbogen und Bewertungsregeln entwickelt und validiert werden und anschließend die Videos durch zwei Experten damit bewertet werden.

2 Developing a novel tool to assess the ability to self-administer medication in non-demented in-hospital patients: ABLYMED study protocol, Maiworm, A., Langner, R., Wilm, S., Hermann, D.M., Frohnhofen, H., Gronewold, J., BMC Geriatr, 22: 466, (2022)

BMC Geriatrics

STUDY PROTOCOL

Open Access

Developing a novel tool to assess the ability to self-administer medication in non-demented in-hospital patients: ABLYMED study protocol

Anneke Maiworm[1], Robert Langner[2,3], Stefan Wilm[4], Dirk M. Hermann[5], Helmut Frohnhofen[6,7] and Janine Gronewold[5*]

Abstract

Background: Older people often suffer from multimorbidity resulting in polypharmacy. The correct administration of medication is a crucial factor influencing treatment efficacy. However, tools for evaluating the ability to self-administer different dosage forms of medications are lacking. The objectives of the ABLYMED study are to 1) assess the ability to self-administer different dosage forms of medication in older non-demented in-hospital patients who report autonomous management of medication, 2) identify factors influencing the ability to self-administer medication, and 3) develop a standardized tool to validly assess the ability to self-administer different dosage forms of medications based on the final study results.

Methods: One hundred in-patients from the department of orthopedics and trauma surgery of the University Hospital Düsseldorf $\geq$ 70 years of age and regularly taking $\geq$ 5 different drugs autonomously will be prospectively recruited into the observational cross-sectional single-center ABLYMED study. Patients undergo an interview addressing demographic and clinical information, medication history (which medications are taken since when, in which dose and dosage form, and subjective proficiency of taking these medications), medication adherence, and factors possibly influencing adherence including personality traits and perceived quality of the medication regimen. Quality of the medication regimen is also rated by clinicians according to validated lists. Further, patients receive a comprehensive geriatric assessment including measures of cognition, mobility, and functional status. The ability to self-administer medication is assessed by having patients perform different tasks related to medication self-administration, which are video recorded and rated by different experts. The patients' self-reported ability will be correlated with the observed performance in the self-administration tasks. Further, factors correlating with the reported and observed ability to self-administer medication will be evaluated using correlation and regression models. Based on the final study results, a novel tool to assess the ability of older patients to self-administer medication will be developed.

Discussion: In addition to guideline-based pharmacotherapy, correct intake of prescribed medication is crucial for optimal therapy of multimorbidity in older people. Tools to validly assess the ability of older patients to self-administer different dosage forms of medications are lacking, but should be included in comprehensive geriatric assessments to secure functional health.

*Correspondence: janine.gronewold@uk-essen.de

[5] Department of Neurology and Center for Translational Neuro- and Behavioral Sciences (C-TNBS), University Hospital Essen, University Duisburg-Essen, Hufelandstr. 55, 45122 Essen, Germany
Full list of author information is available at the end of the article

Trial registration: Development of an assessment instrument to evaluate the ability to manage various dosage forms**,** DRKS-ID: DRKS00025788, (date of registration: 07/09/2021).

Keywords: Self administration, Aged, Treatment adherence and compliance, Geriatric assessment, Real-life behavior

Background

More than half of the older population ≥ 65 years of age suffers from chronic diseases and multimorbidity [1]. As a result, polypharmacy also increases with age [2] and is associated with negative clinical outcomes such as adverse drug events, drug interactions, potentially inappropriate prescriptions, functional decline, cognitive impairment, falls, hospitalization, and reduced adherence to medication [3]. Of note, underuse of adequately prescribed drugs is associated with negative clinical outcomes as well [4]. Higher complexity of a medication regimen including different dosage forms (e.g., pills, drops, pens, patches, or inhalers), high frequency of intake, or special intake requirements is associated with lower medication adherence leading to underuse of prescribed drugs [3]. Older individuals with polypharmacy are especially at risk of reduced adherence to a complex medication regimen because of their higher rate of impairment in physical and mental function including reduced vision, hearing, manual dexterity, mobility, and cognitive abilities [5].

Up to now, only the influence of handling errors of inhaler devices on the treatment efficacy of obstructive pulmonary disease has been investigated in more detail in older subjects [6–8]. These studies showed a high prevalence of problems with handling different inhalers [6–8] and a moderate association between the number of attempts required to ensure the correct use of the inhalers and the patients' manual dexterity and cognitive skills [6]. The ability of geriatric patients to take pills out of different kinds of packaging has been investigated before showing that about 10% could not open blister packages, while more than 50% could not open child-resistant packaging. Failure to open pill packaging was associated with poor vision, cognitive function, and manual dexterity [9]. Additionally, the process of handling different dosage forms of medication has not been evaluated in an objective manner, even though this knowledge is crucial for the success of pharmacotherapy and the planning of support by nursing staff.

Therefore, the aims the ABLYMED study are to 1) assess the ability to self-administer different dosage forms of medication in older non-demented in-hospital patients who report autonomous management of medication, 2) identify factors influencing the ability to self-administer medication, and 3) develop a standardized tool to validly assess the ability to self-administer different dosage forms of medications based on the final study results.

Practical consequences of the ABLYMED study include prescription of nursing support in case of insufficient patient abilities to self-administer medication and adaptation of the medication regimen to the preserved abilities to handle medication in case patients can still partially handle their medication. This will improve patients' quality of life and help to allocate limited healthcare resources in a reasonable way.

Methods/design

Study design and setting

This cross-sectional single-center observational study takes place at the department of orthopedics and trauma surgery at the University Hospital Düsseldorf, Germany. With more than 50,000 in-patients per year and more than 1,200 beds, the University Hospital Düsseldorf is the largest hospital of the state capital of North Rhine-Westphalia, Germany. About 9500 employees work in 29 clinical departments and 30 institutes. The percentage of patients ≥ 70 years of age treated in the department of orthopedics and trauma surgery is about 25%. These elderly patients are being taken care of in a specialized geriatric subdivision.

Study population

Eligible for inclusion in the study are patients ≥ 70 years of age regularly taking ≥ 5 different drugs autonomously who are admitted to the department of orthopedics and trauma surgery electively or via the emergency department. We intend to include 100 patients as a pilot sample to obtain a sufficiently large dataset for performing correlational and regression analyses. Since there is no previous evidence, it was not possible to perform sample size calculation for our specific research question. The only previous study analyzing a related research question, which observed that the ability of geriatric patients to open pill packaging was significantly associated with vision, cognitive function, and manual dexterity [9], recruited a similar sample size as planned in or study (n = 119). Patients are recruited continuously until the planned sample size is reached. Study participation is voluntary and does not affect further treatment.

Inclusion criteria

- In-patient at the department of orthopedics and trauma surgery at the University Hospital Düsseldorf, Germany
- Age ≥ 70 years
- Regularly taking ≥ 5 different drugs autonomously
- Written informed consent

Exclusion criteria

- Dementia diagnosis (ICD-10-code F00-F03)
- Legal care
- Insufficient ability to self-administer medication at home (nursing service or help from family/friends)
- Insufficient ability to communicate (language barrier for foreign or migrant patients, severe presbyakusis)
- Poor vision (not able to read information written on medication packaging)
- Agraphia (inability to write)
- Alexia (inability to read)
- Instable clinical condition (intensive care requirement)
- Permanently bedridden
- Palliative condition (life expectancy < 6 months)

Objectives

Main objectives

- Identification of problems to handle medication in different dosage forms
- Identification of factors which are associated with the ability to self-administer medication
- Identification of the need for support in handling medication
- Development of a standardized tool to assess the ability to self-administer medication

Secondary objectives

Analysis of the interdependency between

- adherence
- complexity and quality of medication regimen
- observed ability to self-administer medication
- reported ability to self-administer medication
- cognitive abilities and personality traits
- demographic / clinical characteristics

Study procedures

Inclusion of patients

After arrival at the ward of the department of orthopedics and trauma surgery of the University Hospital Düsseldorf, all eligible patients receive an information brochure and are asked to participate in the study by the principal investigator (HF). The patients are given sufficient time to discuss participation with their family, friends, or general practitioner. Further, they can clarify remaining questions with the principal investigator. After informed consent is given and signed by the patient, he/she enters the study. The study was approved by the ethics committee at the faculty of medicine of the Heinrich Heine University Düsseldorf. Patients should use their daily support such as glasses and hearing aids during the study assessments.

Measures

Patient characteristics In a face-to-face interview, the following patient characteristics are assessed:

- Sex (male, female, diverse)
- Age (years)
- Body weight (kg)
- Height (cm)
- Handedness (right, left, ambidextrous)
- Housing situation (single-person household, multi-person household, nursing home)
- Marital status (open response format, later classified as single = never married, married = living together with a partner, living apart = married but separated, widowed)
- Education level (open response format, later classified according to International Standard Classification of Education [10])
- Last profession (open response format, later classified according to International Standard Classification of Occupations [11])
- Reason for the current hospitalization (open response format, later classified according to the German modification of the International Classification of Procedures in Medicine [OPS])

Medication history In a face-to-face patient interview with supporting medication lists, the following information regarding current medication are assessed:

- Drug name, active ingredient, Anatomical Therapeutic Chemical (ATC) code, strength

- Dosage form
- Dose
- Duration of prescription
- Self-rated proficiency of taking the respective medication (German primary school grading system from 1 (very practiced/experienced) to 6 (not at all practiced/no experience)

Based on the information of the above-mentioned assessment of medication history, the *quality of pharmacotherapy* is assessed according to the FORTA principle [12], the PRISCUS list [13], and the Beers list [14]. In addition, *complexity of the medication regimen* is assessed according to the German version of the Medication Complexity Score (MRCI-D) [15] and *anticholinergic burden* is assessed according to the anticholinergic burden score for German prescribers (ACB-Score-G) [16]. The medication review is performed by a pharmacist (AM) and a geriatrician (HF).

Medication adherence Medication adherence is assessed via a face-to-face interview using the German version of the Medication Adherence Report Scale (MARS-D) [17]. This questionnaire asks for the frequency of non-adherent behavior using 5 items scored on a 5-point Likert scale (1 = always, 2 = often, 3 = sometimes, 4 = rarely, 5 = never). The total score ranges from 5 to 25, with higher scores indicating better adherence to the prescribed medication.

In addition to the MARS-D, the patients answer questions about factors possibly influencing their adherence behavior. These questions were created by the authors based on own ideas and observations, literature review, and expert surveys. Questions refer to general health, beliefs about taking the right amount of medication, taking helpful medications, not having too many changes in medication, tolerance/side effects of medication, actual/needed support regarding medication intake, failures regarding medication management as well as problems regarding vision, swallowing, recognizing medication, and application of different dosage forms.

Medication management skills In a face-to-face interview, medication management skills are assessed with a modified version of the medication management instrument for deficiencies in the elderly (MedMaIDE) [18]. The MedMaIDE was developed in the USA to assess deficiencies in medication management in community-dwelling older adults with non-medical staff. The MedMaIDE is based on subjective questionnaire data and direct observations of medication-taking behavior. It consists of 20 items covering 3 domains considered important for medication management: 1) what a person knows about the medication he/she is taking (knowledge; 8 items); 2) whether a person knows how to take his/her medication (administration; 6 items); and 3) whether a person knows how to get his/her medication from a doctor or pharmacy (procurement; 6 items). Critical items have been identified within each domain (5 for knowledge and administration each, and 3 for procurement), and are used in calculating the deficiency subscores for each domain and a total deficiency score. If a person is not able to answer an item/perform a task correctly for all prescribed medications, he/she gets a score of 1; thus, higher scores indicate higher deficiency in managing medication. For the ABLYMED study, the MedMaIDE was translated into German by a forward–backward translation procedure performed by a professional translation agency, and only the critical items are used.

Video-based evaluation of self-administration of medication A new method was developed to assess the ability of patients to self-administer medication in different dosage forms in their original packaging (A tablets, B eye-drops, C oral drops, D insulin pen, E patch, F inhaler). The application of each dosage form is explained via an instructional video. Patients perform the tests to assess their ability to self-administer medication in different dosage forms twice (except inhaler test) in a modified order (group 1: ABCDEFEDCBA, group 2: FEDCBAABCDE) to control for sequence effects. Patients' performance is video recorded, for each dosage form and each trial a separate video film is taken. The different dosage forms should be applied as follows:

A Tablets

On the table in front of the patient there are two packs of tablets (one including white tablets in an aluminum blister pack and one including blue tablets in a tablet tube), a pill organizer, and a pill cutter. The patient is asked to put one white tablet each for morning, noon, and evening and one blue tablet for the night into the pill organizer and close the organizer. The patient is then asked to open the pill organizer again, take out the blue tablet, divide it into two halves with the pill cutter, and put one half for the night back into the pill organizer.

B Eye-drops

On the table in front of the patient there is a one-dose ophtiole dispenser. The patient is asked to open the ophtiole dispenser.

C Oral drops

On the table in front of the patient there is a child-resistant dropper bottle and a teaspoon. The patient is asked to open the dropper bottle and drop 10 drops onto the teaspoon.

D Insulin pen

On the table in front of the patient there is an insulin pen. The patient is asked to dial in 12 units and inject it into a ball.

E Patch

On the table in front of the patient there is a packed patch. The patient is asked to unpack the patch, peel off the protective liner without touching the sticky part too much, and apply it to the skin of the arm.

F Inhaler

If the patient's medication already includes a metered-dose inhaler/dry-powder inhaler, the inhalation technique is evaluated according to the validated scoring system developed by Zambelli-Simões et al. [19]. Thereafter, the inspiratory flow rate is measured for each patient at different resistances using the In-Check Dial G16 (MPV Medical GmbH, Munich, Germany). For this purpose, the patient is asked to breathe in slowly and deeply through the mouthpiece at each resistance setting.

If the patients have difficulties during the self-administration of medication, the experimenter can provide verbal or practical assistance, which is documented.

In 30 patients the assessment is repeated after 5 days to assess test–retest reliability.

Based on the video recordings, 2 independent raters evaluate the patient's ability to self-administer different dosage forms of medication with a standardized assessment form. In a pilot phase, the form is presented to 15 different raters to evaluate the video recordings of 3 different patients. If the raters encounter problems leading to low interrater agreement, the form will be adapted. For each dosage form and each trial separately, the quality of the video is rated as good, moderate or unusable, with moderate indicating that for example the video starts too late or does not have an optimal focus, and unusable indicating that videos are missing or performance cannot be evaluated at all. Thereafter, each step of the medication administration is scored on a 5-point Likert scale (5 = not possible, meaning practical assistance needed or interruption; 4 = severe difficulties, meaning execution hardly possible or success of therapy at risk; 3 = moderate difficulties, meaning execution significantly slowed down; 2 = mild difficulties, meaning execution slightly slowed down; 1 = no difficulties, meaning correct and fluid execution).

The following steps of medication administration were defined:

For tablets: taking the white tablets out of the packaging, taking the blue tablet out of the packaging, cutting the blue tablet, putting all tablets correctly into the pill organizer

For eye-drops: opening the ophtiole dispenser

For oral drops: opening the dropper bottle, targeting at the teaspoon, correct number of drops on the teaspoon

For insulin pen: removing the cap from the pen, removing the cap from the needle, dialing in the right dose, injection

For patch: opening the packing, peeling off protective liner, sticking onto the arm

For inhaler: see Zambelli-Simões et al. [19]

Finally, a global impression of the ability to self-administer the respective dosage form is scored on a 5-point Likert scale (5 = very bad, 4 = bad, 3 = moderate, 2 = good, 1 = very good).

Motor function/functional state A hand dynamometer (Jamar™ hand dynamometer) is used to measure grip strength of the right and left hand. The maximum handgrip strength correlates well with total muscle mass. A hydraulic pinch gauge (Saehan Model SH 5005) is used to measure tip pinch strength of both hands. In tip pinch, the tip of the index finger and thumb hold the objects and the measure indicates direct strength of the 2 fingers.

To estimate everyday function of the hand and fingers, the patient is asked to open a bottle of water closed by a screw cap, which is rated as successful or not successful.

The grooved pegboard test (Lafayette Instrument®, Model 32,025, https://lafayetteevaluation.com/products/grooved-pegboard) is used to assess manual dexterity and complex visual-motor coordination. The patient is asked to put small pegs into 25 holes on a board as fast as possible. The grooved pegs must be inserted exactly and as soon as possible into appropriately shaped holes of the board. The test is executed with both hands separately, beginning with the dominant hand. For the right hand trial, pegs are placed from the patient's left to right, for the left-hand trial from right to left. The time the patient needs to perform each trial is recorded. A trial is interrupted after 300 s. In addition, the number of drops and the number of correctly placed pegs per trial is noted. The test is explained to the patient with the help of an instructional video.

As an indicator for appendicular skeletal muscle mass, we determine the circumference of the mid upper arm and the calve at the area of its largest extent [20].

Triceps skinfold thickness is an indicator of subcutaneous fat, which is a proxy for total body fat. Triceps

skinfold thickness is measured with a skinfold caliper (Fat Control Inc). With the subject's arm in a relaxed position, the skinfold is picked with thumb and index fingers at the middle of the back of upper arm.

History of falls is assessed in a face-to-face interview and categorized as 1 fall within the previous 12 months, 1 fall within the previous 3 months, or more than 1 fall within the previous 3 months.

The de Morton Mobility Index (DEMMI) [21] was developed to measure mobility in hospitalised older acute medical patients across a broad spectrum of mobility from bed bound to independent mobility. It consists of 15 mobility tasks which vary from easy (such as turning around while lying in bed) to demanding (such as placing the heel of one foot directly in front of the other with eyes closed for 10 s). The raw score is transformed to range from 0 to 100%, with lower scores indicating lower mobility.

The interview-based Katz index [22] assesses dependence in activities of daily living including bathing, dressing, going to the toilet, transferring, continence, and eating. It comprises 6 items, the total score ranges from 0 to 6, with lower scores indicating higher dependence.

The interview-based Barthel index [23] assesses dependence in activities of daily living similar to the Katz index, but in more domains, including help needed with eating, transfer (e.g. from bed to chair), grooming, bathing, toileting, walking, climbing stairs and dressing as well as presence of anal and urinary incontinence. It comprises 10 items, and the total score ranges from 0 to 100, with lower scores indicating higher dependence.

While the Barthel and the Katz index measure dependence in basic activities of daily living, the interview-based IADL scale [24] includes more complex activities of daily living. It comprises 8 items assessing the ability regarding telephone use, shopping, food preparation, housekeeping, laundry, mode of transportation, responsibility for own medications, and handling finances. The total score ranges from 0 to 8, with lower scores indicating higher dependence.

Nutritional status The Mini Nutritional Assessment Short Form (MNA-SF) [25] is used for the interview-based screening for undernutrition in geriatric practice. It consists of 6 items assessing decrease in food intake, weight loss and psychological stress/acute disease during the last 3 months and mobility, neuropsychological problems, and body mass index. The total score ranges from 0 to 14, scores < 11 indicate elevated risk for undernutrition.

Cognitive function The Timed Test of Money Counting [26] is a short test to assess manual dexterity and cognitive capacity. The patient is given a purse with separate pockets for coins and banknotes, which contains a predefined amount of money (9.80 Euros as a 5-Euro note, a 2-Euro coin, 2 1-Euro coins, a 50-cent coin and 3 10-cent coins) and is asked to take out all the money and count it. The time the patient needs to perform this task is measured. If the patient does not report the correct amount of money, the examiner gives the feedback that the answer is not correct and the patient is allowed to try again, with the number of attempts and the problems the patient has with this task being recorded. The time measurement is not interrupted while correcting patients. The Timed Test of Money Counting is interrupted after 3 incorrect answers or after 300 s, and in both cases a duration of 300 s is recorded. Values < 45 s indicate independence, 45–70 s increased risk for dependence, > 70 s increased care needs [26].

The Trail Making Test for older subjects (ZVT-G) [27] is the German version of the Trail Making Test A [28]. The ZVT-G was developed for subjects ≥ 55 years of age and is included in the Nürnberger Alters-Inventar [27]. The patient is asked to connect numbers from 1 to 30 in rising order with a pen. The time the patient needs to perform this task is measured. Mistakes shall be corrected immediately without interrupting time measurement. If the patient makes more than 3 mistakes, the test is repeated. If the patient again makes more than 3 mistakes or after a maximum time of 300 s, the test is interrupted, in both cases a duration of 300 s is recorded.

Drawing the interlocking pentagons taken from the Mini-mental state examination (MMSE) [29] is used to assess visual-spatial skills.

The Clock-drawing test [30] assesses higher-level cognitive abilities including visuospatial skills, integrative functions and abstract thinking. The patient is given a sheet of paper with a pre-drawn circle. The experimenter shows where the top of the page is and gives the instructions to put the numbers on the clock and set the time at 10 past 11. The score ranges from 1 to 6, with higher scores reflecting a greater number of errors and more impairment.

Time estimation is assessed with two tasks: First, the patient is asked to estimate how long one minute is with the following instruction: "Please give me a sign when you think one minute has passed, starting now." The time (in s) is measured until the patient gives the sign. Thereafter, the patient is asked to estimate his/her current length of hospital stay in days with the following instruction: "How long have you been in hospital?" It is noted whether the response is correct and, if not, how many days the response differs from the actual length of stay.

The interview part assessing factors possibly influencing medication adherence is framed by a task that addresses prospective memory, which is a version of the task used in the UK Biobank project [31] modified to increase difficulty. Prospective memory indicates the ability to carry out future intentions at a specific time or in response to a specific event. At the beginning of the specific interview part, patients receive the following instruction: "At the end of this interview part, we will show you colored symbols and ask you to touch the blue triangle. However, to test your memory, we want you to actually touch the orange square instead". The patients are shown a sheet with 3 different shapes (triangle, square, circle) presented in 3 different colors each (blue, orange, pink). Their first and final answer, the history of attempts, and whether a hint was given are recorded.

The six-item screener [32] is based on the MMSE [29] and comprises temporal orientation (current day of the week, month, year) and short term memory (ability to recall 3 newly learned words). A cut-off of ≥ 3 errors is applied to identify participants with cognitive impairment [32].

Personality traits Personality of the patients is assessed with the Big-Five-Inventory-10 (BFI-10) [33]. This questionnaire is based on the currently most popular model of human personality, the Big-Five model, which assumes 5 abstract personality dimensions (neuroticism, extraversion, openness, agreeableness, conscientiousness). Each of these dimensions is assessed with 2 items, which are scored on a 5-point Likert scale (1 = disagree strongly, 2 = disagree a little, 3 = neither agree nor disagree, 4 = agree a little, 5 = strongly agree). Scores are averaged per dimension and thus range from 1 to 5, with higher scores indicating higher expression of the personality trait.

The study is ongoing, patient recruitment has already started. Statistical analysis will take place in the second half of 2022, publication of the full results is scheduled for the first half of 2023.

Statistical analysis

Patients' characteristics regarding all variables assessed will be reported as mean ± standard deviation for continuous normally distributed variables, as median (Q1; Q3) for continuous variables which are not normally distributed, and as numbers (%, valid % when values are missing) for categorical variables.

For the video-based evaluation of self-administration of medication, at first 15 raters will rate a small subset of the patient sample to check whether the proposed standardized evaluation form is feasible, objective, and reliable. The agreement between the 15 raters on the ratings for each patient will be evaluated using Kendall's W for categorical data (single items) and intraclass correlation coefficient for continuous data (sum scores). If the agreement is sufficiently high (≥ 0.8), the total patient sample will be rated by 2 independent raters and agreement will be evaluated with Cohen's kappa for categorical data and intraclass correlation coefficient for continuous data. To assess test–retest reliability of the video-based evaluation, 30 patients will perform the assessment again after 5 days, and the 2 raters, who rated the total patient sample, will rate patient performance again. Retest reliability will be calculated using Spearman's Rho for continuous variables and Chi-square for categorical variables.

To evaluate which factors influence the ability to self-administer medication, correlation and regression analyses will be performed. For continuous scores describing the ability to self-administer medication, Spearman's Rho will be used for analyzing continuous and ordinal factors and Chi-square for analyzing nominal factors. Curve estimation procedure will be used to check whether a linear regression model fits the data in case of bivariate continuous associations and variables will be transformed if necessary. Uni- and multivariable linear regressions models including interaction terms will be calculated to identify which factors influence the ability to self-administer medication to which degree. If linear associations are not met even with data transformation, non-linear regressions will be performed. Missing data will be excluded from analysis listwise. All statistical analyses will be performed using SPSS 22 for Windows (IBM Corporation, Armonk, NY, USA). All statistical tests will be 2-tailed and p-values < 0.05 will be considered significant.

Discussion

The ABLYMED study aims to develop a feasible, objective, reliable, and valid tool to assess the ability of patients to handle their medication. Since especially older patients suffer from multimorbidity and have to take multiple medications, which often also have different dosage forms, it is important to be able to assess not only the ability to self-administer pills, but also oral drops, eyedrops, insulin pens, patches and inhalers, which are often included in the medication regimen of older patients. Up to now, such a tool, which is able to assess the ability to self-administer medication in different dosage forms, is lacking. However, this ability must be recognized and integrated into the medication regimen to ensure treatment success. If patients omit medication, use the wrong dose, or administer their medication in a wrong way, this can lead to over- or undertreatment, which might endanger patients' health and thus functional state and quality of life. On the one hand, assessment results allow

adjusting medication regimens to individual patients' abilities and needs to ensure independence and hence a better quality of life; on the other hand, insufficient abilities can be compensated for by inclusion of nursing services to secure correct medication administration and thus functional health and independence in other activities of daily living. Thus, the ABLYMED study will help to improve older patients' quality of life and allocate limited healthcare resources in a reasonable way. In future studies, the assessment tool developed in this study sample will be validated in independent patient samples using pill count and clinical parameters of disease control such as blood pressure, blood glucose, lung capacity, cognitive function etc. as comparative variables to evaluate convergent validity as an important part of construct validity.

Abbreviations

BFI-10: Big-Five-Inventory-10; IADL: Instrumental Activities of Daily Living; MedMaIDE: Medication Management Instrument for Deficiencies in the Elderly; MMSE: Mini-mental state examination; MNA-SF: Mini Nutritional Assessment Short Form; ZVT-G: Zahlen-Verbindungs-Test-G (trail making test for gerontopsychological research questions).

Acknowledgements

We thank all participants of the study.

Authors' contributions

AM, HF, and JG developed the research question and study design. RL critically commented on the study design and contributed to the self-administration evaluation procedure. AM and HF wrote the protocol for the ethics committee. AM and HF collect patient data. JG and RL analyze video recordings. JG will perform statistical analyses of data together with AM. JG and HF drafted the manuscript. AM, RL, SW and DMH critically revised the manuscript. All authors read and approved the final manuscript. All authors have agreed both to be personally accountable for their own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which they were not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

Funding

Open Access funding enabled and organized by Projekt DEAL. This study received funding from the Paul-Kuth Foundation, Wuppertal, Germany. The funder had no role in the design of the study and collection, management, analysis, and interpretation of data, writing the manuscript and decision to submit the manuscript for publication.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All participants who decided to participate in the study signed an informed consent form prior to their inclusion in the study. The study was approved by the ethics committee at the faculty of medicine of the Heinrich Heine University Düsseldorf (reference number 2021–1435).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author details

[1]Hospital Pharmacy, University Hospital Düsseldorf, Düsseldorf, Germany. [2]Institute of Systems Neuroscience, University Hospital Düsseldorf, Düsseldorf, Germany. [3]Institute of Neuroscience and Medicine (INM-7: Brain and Behaviour), Research Centre Jülich, Jülich, Germany. [4]Institute of General Practice, Centre for Health and Society (Chs), University Hospital Düsseldorf, Düsseldorf, Germany. [5]Department of Neurology and Center for Translational Neuro- and Behavioral Sciences (C-TNBS), University Hospital Essen, University Duisburg-Essen, Hufelandstr. 55, 45122 Essen, Germany. [6]Department of Orthopedics and Trauma Surgery, University Hospital Düsseldorf, Düsseldorf, Germany. [7]Faculty of Health, Department of Medicine, Geriatrics, University Witten-Herdecke, Witten, Germany.

Received: 1 April 2022 Accepted: 17 May 2022
Published online: 31 May 2022

References

1. Schäfer I, von Leitner E-C, Schön G, Koller D, Hansen H, Kolonko T, et al. Multimorbidity patterns in the elderly: a new approach of disease clustering identifies complex interrelations between chronic conditions. PLoS ONE. 2010;5:e15941. https://doi.org/10.1371/journal.pone.0015941.
2. Garfinkel D, Bilek A. Inappropriate medication use and polypharmacy in older people. BMJ. 2020;369:m2023. https://doi.org/10.1136/bmj.m2023.
3. Maher RL, Hanlon J, Hajjar ER. Clinical consequences of polypharmacy in elderly. Expert Opin Drug Saf. 2014;13:57–65. https://doi.org/10.1517/14740338.2013.827660.
4. Wauters M, Elseviers M, Vaes B, Degryse J, Dalleur O, Vander Stichele R, et al. Too many, too few, or too unsafe? Impact of inappropriate prescribing on mortality, and hospitalization in a cohort of community-dwelling oldest old. Br J Clin Pharmacol. 2016;82:1382–92. https://doi.org/10.1111/bcp.13055.
5. van Riet-Nales D, Donkerbroek L, Nicia A, Oussoren C, de Boer A, van den Bemt B. The development of a test battery to assess the hand-eye functions relevant in predicting easy and accurate tablet subdivision in older people: A pilot study. Br J Clin Pharmacol. 2020;86:1969–81. https://doi.org/10.1111/bcp.14201.
6. Ahn JH, Chung JH, Shin K-C, Choi EY, Jin HJ, Lee MS, et al. Critical Inhaler Handling Error Is an Independent Risk Factor for Frequent Exacerbations of Chronic Obstructive Pulmonary Disease: Interim Results of a Single Center Prospective Study. Int J Chron Obstruct Pulmon Dis. 2019;14:2767–75. https://doi.org/10.2147/COPD.S234774.
7. Lee HY, Song JH, Won H-K, Park Y, Chung KB, Lim H-J, et al. Comparing Inhaler Use Technique Based on Inhaler Type in Elderly Patients with Respiratory Disease. Tuberc Respir Dis (Seoul). 2021;84:46–54. https://doi.org/10.4046/trd.2020.0021.
8. Ruessel K, Luecke E, Schreiber J. Inhaler Devices in a Geriatric Patient Population: A Prospective Cross-Sectional Study on Patient Preferences. Patient Prefer Adherence. 2020;14:1811–22. https://doi.org/10.2147/PPA.S262057.
9. Nikolaus T, Kruse W, Bach M, Specht-Leible N, Oster P, Schlierf G. Elderly patients' problems with medication. An in-hospital and follow-up study. Eur J Clin Pharmacol. 1996;49:255–9. https://doi.org/10.1007/BF00226324.
10 UNESCO Institute for Statistics. International Standard Classification of Education: ISCED 2011. 2012. https://doi.org/10.15220/978-92-9189-123-8-en.
11. International Labour Office, Geneva, ILO. International Standard Classification of Occupations: ISCO-08. 2012.
12. Wehling M, Burkhardt H, Kuhn-Thiel A, Pazan F, Throm C, Weiss C, Frohnhofen H. VALFORTA: a randomised trial to validate the FORTA (Fit fOR The Aged) classification. Age Ageing. 2016;45:262–7. https://doi.org/10.1093/ageing/afv200.
13. Holt S, Schmiedl S, Thürmann PA. Potentially inappropriate medications in the elderly: the PRISCUS list. Dtsch Arztebl Int. 2010;107:543–51. https://doi.org/10.3238/arztebl.2010.0543.
14. Fick DM, Semla TP. 2012 American Geriatrics Society Beers Criteria: new year, new criteria, new perspective. J Am Geriatr Soc. 2012;60:614–5. https://doi.org/10.1111/j.1532-5415.2012.03922.x.
15. Stange D, Kriston L, Langebrake C, Cameron LK, Wollacott JD, Baehr M, Dartsch DC. Development and psychometric evaluation of the German

version of the Medication Regimen Complexity Index (MRCI-D). J Eval Clin Pract. 2012;18:515–22. https://doi.org/10.1111/j.1365-2753.2011.01636.x.
16. Kiesel EK, Hopf YM, Drey M. An anticholinergic burden score for German prescribers: score development. BMC Geriatr. 2018;18:239. https://doi.org/10.1186/s12877-018-0929-6.
17. Mahler C, Hermann K, Horne R, Ludt S, Haefeli WE, Szecsenyi J, Jank S. Assessing reported adherence to pharmacological treatment recommendations Translation and evaluation of the Medication Adherence Report Scale (MARS) in Germany. J Eval Clin Pract. 2010;16:574–9. https://doi.org/10.1111/j.1365-2753.2009.01169.x.
18. Orwig D, Brandt N, Gruber-Baldini AL. Medication management assessment for older adults in the community. Gerontologist. 2006;46:661–8. https://doi.org/10.1093/geront/46.5.661.
19. Zambelli-Simões L, Martins MC, Da Possari JCC, Carvalho GB, Coelho ACC, Cipriano SL, et al. Validation of scores of use of inhalation devices: valoration of errors. J Bras Pneumol. 2015;41:313–22. https://doi.org/10.1590/S1806-37132015000004435.
20. Hu F-J, Liu H, Liu X-L, Jia S-L, Hou L-S, Xia X, Dong B-R. Mid-Upper Arm Circumference as an Alternative Screening Instrument to Appendicular Skeletal Muscle Mass Index for Diagnosing Sarcopenia. Clin Interv Aging. 2021;16:1095–104. https://doi.org/10.2147/CIA.S311081.
21. de Morton NA, Davidson M, Keating JL. The de Morton Mobility Index (DEMMI): an essential health index for an ageing world. Health Qual Life Outcomes. 2008;6:63. https://doi.org/10.1186/1477-7525-6-63.
22 Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. STUDIES OF ILLNESS IN THE AGED THE INDEX OF ADL: A STANDARDIZED MEASURE OF BIOLOGICAL AND PSYCHOSOCIAL FUNCTION. JAMA. 1963;185:914–9. https://doi.org/10.1001/jama.1963.03060120024016.
23. Mahoney FI, Barthel DW. FUNCTIONAL EVALUATION: THE BARTHEL INDEX. Md State Med J. 1965;14:61–5.
24. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist. 1969;9:179–86.
25. Rubenstein LZ, Harker JO, Salvà A, Guigoz Y, Vellas B. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Biol Sci Med Sci. 2001;56:M366–72. https://doi.org/10.1093/gerona/56.6.m366.
26. Nikolaus T, Bach M, Oster P, Schlierf G. The Timed Test of Money Counting: a simple method of recognizing geriatric patients at risk for increased health care. Aging (Milano). 1995;7:179–83. https://doi.org/10.1007/BF03324310.
27 Oswald WD, Fleischmann UM. Nürnberger-Alters-Inventar: (NAI). 3rd ed. Göttingen: Hogrefe Verl. für Psychologie; 1995.
28. Reitan RM, Wolfson D. The halstead-reitan neuropsychological test battery: Theory and interpretation. 1985.
29 Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12:189–98. https://doi.org/10.1016/0022-3956(75)90026-6.
30. Shulman MF, Pushkar GD, Cohen CA, Zucchero CA. Clock-drawing and dementia in the community: A longitudinal study. Int J Geriat Psychiatry. 1993;8:487–96.
31. Cornelis MC, Wang Y, Holland T, Agarwal P, Weintraub S, Morris MC. Age and cognitive decline in the UK Biobank. PLoS ONE. 2019;14:e0213948. https://doi.org/10.1371/journal.pone.0213948.
32. Callahan CM, Unverzagt FW, Hui SL, Perkins AJ, Hendrie HC. Six-item screener to identify cognitive impairment among potential subjects for clinical research. Med Care. 2002;40:771–81. https://doi.org/10.1097/00005650-200209000-00007.
33. Rammstedt B, John OP. Measuring personality in one minute or less: A 10-item short version of the Big Five Inventory in English and German. J Res Pers. 2007;41:203–12.

Publisher's Note

3 Developing a novel tool to assess the ability to self-administer medication – A systematic evaluation of patients´ video recordings in the ABLYMED study, Luegering, A., Langner, R., Wilm, S., Doeppner, T.R., Hermann, D.M., Frohnhofen, H., Gronewold, J., Frontiers in Medicine, 10, (2023)

frontiers | Frontiers in Medicine

TYPE Methods
PUBLISHED 16 February 2023
DOI 10.3389/fmed.2023.1040528

OPEN ACCESS

EDITED BY
Mario Ulises Pérez-Zepeda,
Instituto Nacional de Geriatría,
Mexico

REVIEWED BY
Varalak Srinonprasert,
Mahidol University,
Thailand
Bert Bosche,
MediClin Klinik Reichshof,
Germany

*CORRESPONDENCE
Janine Gronewold
janine.gronewold@uk-essen.de

SPECIALTY SECTION
This article was submitted to Geriatric Medicine, a section of the journal Frontiers in Medicine

RECEIVED 11 September 2022
ACCEPTED 24 January 2023
PUBLISHED 16 February 2023

CITATION
Luegering A, Langner R, Wilm S, Doeppner TR, Hermann DM, Frohnhofen H and Gronewold J (2023) Developing a novel tool to assess the ability to self-administer medication – A systematic evaluation of patients' video recordings in the ABLYMED study. *Front. Med.* 10:1040528. doi: 10.3389/fmed.2023.1040528

Developing a novel tool to assess the ability to self-administer medication – A systematic evaluation of patients' video recordings in the ABLYMED study

Anneke Luegering[1], Robert Langner[2,3], Stefan Wilm[4], Thorsten R. Doeppner[5,6,7,8], Dirk M. Hermann[9], Helmut Frohnhofen[10,11] and Janine Gronewold[9]*

[1]Hospital Pharmacy, University Hospital Düsseldorf, Düsseldorf, Germany, [2]Institute of Systems Neuroscience, University Hospital Düsseldorf, Düsseldorf, Germany, [3]Institute of Neuroscience and Medicine (INM-7: Brain and Behaviour), Research Centre Jülich, Jülich, Germany, [4]Institute of General Practice, Centre for Health and Society (chs), University Hospital Düsseldorf, Düsseldorf, Germany, [5]Department of Neurology, University Hospital Giessen, Giessen, Germany, [6]Research Institute for Health Sciences and Technologies (SABITA), Istanbul Medipol University, Istanbul, Türkiye, [7]Department of Anatomy and Cell Biology, Medical University of Varna, Varna, Bulgaria, [8]Department of Neurology, University of Göttingen, Göttingen, Germany, [9]Department of Neurology and Center for Translational Neuro- and Behavioral Sciences (C-TNBS), University Hospital Essen, University Duisburg-Essen, Essen, Germany, [10]Department of Orthopedics and Trauma Surgery, University Hospital Düsseldorf, Düsseldorf, Germany, [11]Department of Medicine, Geriatrics, Faculty of Health, University Witten-Herdecke, Witten, Germany

Background: Older people often experience medication management problems due to multimorbidity, polypharmacy and medication complexity. There is often a large gap between patients' self-reported and actual abilities to handle the self-administration of their medication. Here we report on the development and evaluation of a new tool to assess the ability of non-demented hospitalized patients to self-administer medication in different dosage forms. To this end, we video-recorded the patients' medication management performance and implemented a novel assessment scheme, which was applied by several independent raters.

Methods: Sixty-seven in-patients ≥70 years of age and regularly taking ≥5 different drugs autonomously of the ABLYMED study agreed to the video recording of their medication management performance with five different dosage forms. All raters underwent a training and applied a standardized assessment form and written guide with rating rules for evaluation. In a pilot phase, video recordings of three patients were rated by 19 raters (15 medical students, two expert raters to determine a reference standard, and two main raters who later rated the total sample). In the rating phase, based on the ratings obtained from the two main raters, we determined interrater (assessed every section of 20 patients as agreement between the raters at one point of time) and intrarater (assessed as consistency within each rater across three points of time) agreement by intraclass correlation analysis.

Results: In the pilot phase we obtained an overall sufficient agreement pattern, with an adjustment of the rating rules for patches. In the rating phase we achieved satisfactory agreement between the two raters (interrater reliability) and across different points of time (intrarater reliability). For two dosage forms (eye-drops and pen), rater training needed to be repeated to reach satisfactory levels.

Discussion: Our novel rating procedure was found to be objective, valid and reproducible, given appropriate training of the raters. Our findings are an important part of a larger research project to implement a novel assessment for the ability to self-administer medication in different dosage forms. Further, they can support the

development of patient trainings to improve medication management and secure independent living.

Clinical Trial Registration: DRKS00025788, date of registration: 07/09/2021.

KEYWORDS

self administration, aged, medication management problems, self-reported ability, video recordings, rating procedure

Introduction

Adequate medication management is essential for a successful pharmacotherapy (1). Especially in older patients, impairments in physical and mental functions and increasing medication complexity make medication management challenging. This can lead to lower adherence, more medication errors and finally suboptimal treatment outcomes (1–3). Despite the high prevalence of problems with medication management in older people, these problems often remain unrecognized (4). With increasing age, comorbidity increases, and medication regimens become more complex, leading to higher workload in patients with mostly reduced capacity (5, 6). Medication regimen complexity is driven by the number of medications in different dosage forms, frequency of intake and required manipulations of medications. Examples for complex medication procedures are opening medication packages when sealed, releasing pills from a blister, cutting pills and opening child resistant bottles (4).

Therefore, in older adults, daily medication preparation is often time consuming, associated with coping strategies that differ from the instructions by the manufacturer, or with the inability to handle medication at all. Handling errors in daily medication preparation increase the risk of nonadherence (4, 7). Of note, such impairments are often not realized by patients and thus they do not report medication management problems: there is often a large gap between patients' self-reported and actual medication management skills (4).

Unfortunately, previous studies assessing medication management performance in older patients are scarce (8). To the best of our knowledge, most previous studies describe handling errors only of one selected dosage form such as inhalers, eye drops or pills. In addition, there is no instrument recommended for use in clinical practice which objectively measures medication self-management capacity (9). Furthermore, most findings were based on single person judgements or patients' self-reports (10–13). However, such methods bear the risk of bias. Nevertheless, eye-drop instillation has already been examined by a masked analysis of video recordings of patients self-instilling eye drops covering the aspects efficiency, safety and efficacy of eye-drop instillation, assessed by three raters (14).

For a comprehensive analysis of medication management, all common dosage forms should be evaluated, and in addition to patient's self-report, an objective, reliable, and ecologically valid quantitative assessment of performance based on behavioral observations in standardized test settings should be applied, involving multiple raters at multiple points in time.

The ABLYMED (8) study aims at developing a new tool to assess the ability to self-administer medication in non-demented hospitalized patients from the University Hospital Düsseldorf. The evaluation involves both subjective self-report measures and performance assessments provided by at least two raters. We used original packaging of medication that cover most medication formulations to create ecologically valid test scenarios.

One part of the ABLYMED study is a video-based evaluation of the self-administration of medication in different dosage forms. We made video recordings of each patient performing different tasks of medication management. Each study patient self-administered five different placebo dosage forms of medication in a video-instructed way. Each patient's self-administration performances, as captured by the video recordings, was than rated via systematic assessment procedure. Here we describe the development of the evaluation procedure used to reliably assess video recorded medication management performance in the ABLYMED study.

Since we live in an aging society and in 2030 seventy-one million people are expected to be over 65 years old, treatment of senior patients is getting more important, independently from the medical subject (15). Besides, physicians often overestimate their patients' cognitive and motor abilities needed for adequate self-administration of medication (16). Thus, our research is of high clinical and practical relevance.

Materials and methods

Setting and video evaluation procedure

The ABLYMED study recruited 100 non-demented patients from the University Hospital Duesseldorf ≥70 years of age regularly taking ≥5 different drugs autonomously. The median age was 79 years (74;84) and 50% were female. Of these patients, $n = 67$ agreed to the video recording of their medication management performance with placebo drugs. The study was approved by the ethics committee at the medical faculty of the Heinrich Heine University Düsseldorf (reference number 2021-1435). All patients gave written informed consent before entering the study.

The video recordings were made by AL (pharmacist) in the patient's rooms with a smart phone camera. To minimize intrusiveness, no further equipment was used. The video recordings showed patient's hands and arms, but not their faces and the videos are muted, for privacy protection. Patients performed the self-administration tasks in a sitting position. If patients were unable to perform steps of administration tasks, they received support by AL: verbal support could be given twice for each step of medication administration, if this did not help to complete the step, the video was interrupted, and practical assistance was given. Afterwards, the video recording started again, and the patient continued with the next step. If practical assistance was necessary, the rater evaluated this step of administration with "not possible" as described in the rating rules (see Supplementary Table S2). If there was no following video, all further administration steps were also not

possible. In this way, all steps of medication administration could be evaluated comprehensively. Verbal support was recognizable for the raters by ALs gestures on the video.

For each patient, five videos were recorded (five dosage forms [tablets, eye-drops, oral drops, insulin pen and patches]). Videos were evaluated by up to 19 raters using a standardized assessment form. The assessment form was developed by the two experts HF (internist, geriatrician) and AL based on viewing a few video recordings, literature review and following expert discussion including a statistician to reach consent. The quality of the assessment form was assessed by inter- and intrarater agreement. Interrater agreement was determined as the degree of agreement between different raters at one point of time. Intrarater agreement was determined as the degree of agreement (per rater) across three different points of time.

All raters got a training containing explanations to the instructional videos (see Supplementary Videos S1–S6), which were used to instruct the patients, and to the standardized assessment form (see Supplementary Table S1). Furthermore, the raters received a written guide with rating rules (see Supplementary Table S2). Thereafter, they evaluated the video recordings of the patients' medication management performance.

The assessment form contained a 5-point Likert scale for each step of the medication administration (5 = not possible, meaning practical assistance needed or interruption; 4 = severe difficulties, meaning execution hardly possible or success of therapy at risk; 3 = moderate difficulties, meaning execution significantly slowed down; 2 = mild difficulties, meaning execution slightly slowed down; 1 = no difficulties, meaning correct and fluid execution). In some cases, the assessment form contained the choice between correct or incorrect (1 = correct and 2 = incorrect).

The video raters were 15 random medical students (R1 - R15), JG (psychologist and epidemiologist), TD (neurologist), AL, and HF. The students voted anonymously during a lecture. JG and TD got access to the video recordings via a password-protected cloud solution and independently sent their evaluation results on the standardized assessment form via email. AL and HF evaluated the videos together and discussed to reach a consensus to set the reference standard.

Statistical analysis

For each dosage form, we summed up the scores for each administration step for each rater, leading to a continuous sum score, and analyzed the interrater agreement by intraclass correlation coefficient (ICC). For analyzing intrarater agreement, we analyzed agreements per rater between the sum score of the first evaluation, a second evaluation repeated after 2 weeks and a third evaluation after 4 weeks of one patient, using ICC as well (17). Missing data were imputed by the median (applies only to the evaluation of R1-R15). The dosage form-specific interrater agreement and intrarater agreements are presented as ICC with 95% confidence interval, based on consistency, 2-way mixed-effects model. Data were analyzed using SPSS 22 for Windows (IBM Corporation, Armonk, NY, United States).

Phases of the video evaluation procedure

The evaluation procedure was divided into two phases: a pilot phase and a rating phase.

Pilot phase

First, AL and HF selected videos of three patients that broadly covered the spectrum of no, moderate, and severe handling problems of each dosage form. These videos can be viewed in the supplementary (Supplementary Videos S7–S23). Each patient had five video sequences that showed the self-administration tasks of tablets, eye-drops, oral drops, a pen and a patch.

These videos were first rated by AL and HF who reached a consensus to set the reference standard. Next, 15 randomly selected medical students got a training containing explanations to the instructional videos, the standardized assessment form, and the written guide with rating rules. Thereafter, they rated patients´ medication management performance independently and blinded to the reference standard. Finally, JG and TD got the same training and evaluated the videos independently from each other and blinded to the former results.

To analyze the accuracy and precision of our standardized assessment form, we measured the agreements shown in Table 1 regarding the sum scores for each dosage form. Agreement with the reference standard was used to evaluate accuracy, that is how close a measurement is to the true or accepted value. Interrater agreement was used to evaluate precision, that is how close measurements of different raters of the performance of the same patients are to each other. A measurement system is considered valid if it is both accurate and precise, that is when measurements are all close to and tightly clustered around the true or accepted value (Figure 1).

In case of both satisfactory agreement of student raters as well as JG and TD with the reference standard (consensus of AL and HG), indicating accuracy, and agreement between the raters, indicating precision, the main evaluation phase was started. Satisfactory agreement was defined by ICC ≥0.5, representing at least moderate agreement (18). Otherwise, the assessment form was adapted, and the evaluation repeated until the agreement was satisfactory.

Rating phase

JG and TD rated all patient videos independently and blinded to the results of each other in sections of 20 patients. After each section, the interrater reliability was determined. If the agreement (JG vs. TD) was not satisfactory, the training was repeated, and the evaluation repeated until the agreement was satisfactory. We planned this procedure to keep the quality of the ratings consistently high. Besides, AL and HF determined a reference standard for one patient in each section by consensus. At the end of the rating of all patients videos, the agreement between JG and the reference standard and TD and the reference standard was assessed as an additional accuracy check.

Furthermore, JG and TD rated the video recordings of one patient in three points in time (t0, t1 after 2 weeks and t3 after 4 weeks) blinded to the previous ratings to show intrarater consistency over time.

TABLE 1 Measures of accuracy and precision in the pilot phase.

	Reference standard	Median R1-R15	Rater JG	Rater TD
Reference standard				
Median R1-R15	Accuracy			
Rater JG	Accuracy	Precision		
Rater TD	Accuracy	Precision	Precision	

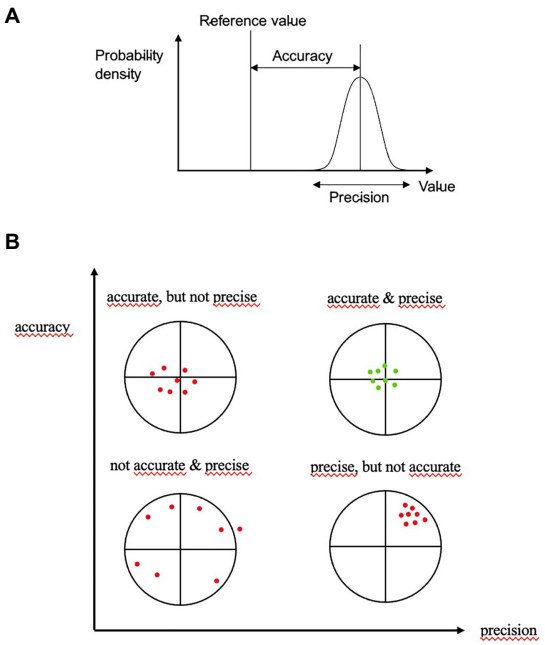

FIGURE 1
Accuracy is the proximity of assessments to the true value; precision is the degree to which repeated assessments under unchanged conditions show the same results. An ideal assessment should be accurate and precise (upper part Pekaje, creative common license wikimedia, https://commons.wikimedia.org/wiki/File:Accuracy_and_precision.svg, downloaded 25th July, 2022).

Results

Pilot phase

The rating results of the pilot phase are presented in Table 2. For R1-R15, 14 of 225 sum scores were imputed due to missing data. The video recordings of the three selected patients yielded a dosage form-specific satisfactory rater agreement for tablets, eye-drops, oral drops, and insulin pens. The patches showed satisfactory agreement except for three cases (rater JG vs. reference standard, median of R1-R15 vs. rater TD and rater JG vs. rater TD). Therefore, we added the rating rules for patch type two concerning the peeling off of the protective liner (Supplementary Table S2). In summary, we regarded the overall agreement pattern as sufficient to start the main rating phase.

Rating phase

Within two months, JG and TD rated all videos of 67 patients. The rating results for each section are presented in Table 3.

In the first section (patient-ID 1–20) there was satisfactory interrater agreement for tablets, oral drops, insulin pens and patches. For eye-drops, poor agreement was observed. Therefore, the rating rules for eye-drops application performance were adapted (evaluation was based on the number of grasping movements: one to two: no difficulties, three to four: mild difficulties, five to six: moderate difficulties, more than six: severe difficulties) (see Supplementary Table S2) and training for the dosage form eye-drops was repeated. Afterwards, JG and TD re-evaluated the eye-drops in this section again taking the new rating rules into account and achieved satisfactory interrater agreement.

In the second section (patient-ID 21–40) there was satisfactory interrater agreement for all dosage forms except for the insulin pen. As in the first section for eye-drops, rating rules for the insulin pen were adapted (unscrew the green cap: sever difficulties, injection: not enough back pressure so the pen moves in hand, or several tries to press down: moderate difficulties) (see Supplementary Table S2) and training was repeated. JG and TD re-evaluated the insulin pen in this section again taking the new rating rules into account and achieved satisfactory interrater agreement.

In all further sections (patient-ID 41–60, 61–80 and 81–100) there was satisfactory interrater agreement for all dosage forms.

The intrarater agreement as determined by rating the self-administration performance of one patient at three different points of time was excellent for both JG (1.00 [0.99–1.00]) and TD (0.97 [0.91–0.99]).

Table 4 (see also Supplementary Tables S3–S4) shows the agreement of JG and TD to the reference standard for one patient in each section. In all cases there was satisfactory agreement. In summary we could show satisfactory agreement between the two raters (interrater reliability), between each rater across different points of time (intrarater reliability) and between each rater and the reference standard (accuracy).

Besides, the raters also evaluated the video quality of each recording (good, limited, or not usable). In total, 79% of the video recordings were rated to have good quality, 17% to have limited quality, and 4% as being not usable.

Discussion

We report on the development of an evaluation procedure to objectively, reliably, and validly assess video recorded medication management performance including five different dosage forms in 67 older patients in the ABLYMED study. The pilot phase, during which 19 raters (of which two determined the reference standard by consensus) evaluated the video recorded medication management performance of three patients, confirmed the accuracy and precision of the standardized assessment form and rating rules. For the four dosage forms tablets, eye-drops, oral-drops and insulin pen, interrater agreement was satisfactory with an ICC between 0.54 and 1.00. Only the rating of the patches showed poor agreement for JG/reference standard, TD/median R1-R15 and JG/TD and led to the inclusion of an additional rating rule. In the rating phase, during which two raters evaluated the video recorded medication management performance of all 67 patients, interrater agreement (precision) was satisfactory with an ICC between 0.67 and 0.99, implying a range between moderate to excellent precision. In section 1 and 2 (patient-ID 1–20 and 21–40) additional rating rules for eye-drops and the insulin pen became necessary to reach satisfactory agreement. The agreement of the two raters with the reference standard (accuracy) at the end of the rating phase was satisfactory as well (ICC between 0.52–1.00). Furthermore, intrarater agreement over time at t0, t1 (after 2 weeks) and t2 (after 4 weeks) for JG (ICC = 1.00) and TD (ICC = 0.97) was excellent. To conclude, our results suggest that the evaluation procedure of the video recorded medication management performance for different dosage forms in older patients is valid and reproducible.

Insufficient medication management performance leads to impairments in the ability to engage in self-care and live independently

TABLE 2 Dosage form-specific interrater agreement in the pilot phase: ICC with 95% confidence intervals.

	Tablets	Eye-drops	Oral drops	Insulin pen	Patch
Median of R1-R15 versus reference standard	0.97 [−0.14–1.00]	1.00 [1.00–1.00]	0.99 [0.62–1.00]	1.00 [1.00–1.00]	0.57 [−15.71–0.99]
Rater JG versus reference standard	0.90 [−3.08–1.00]	0.92 [−2.00–1.00]	0.96 [−0.56–1.00]	0.99 [−2.83–1.00]	−2.00 [−116.00–0.92]
Rater TD versus reference standard	0.79 [−7.21–1.00]	0.89 [−3.33–1.00]	0.96 [−0.56–1.00]	0.96 [−24.91–1.00]	0.67 [−12.00–0.99]
R1-R15	0.99 [0.96–1.00]	0.99 [0.94–1.00]	1.00 [0.98–1.00]	0.98 [0.93–1.00]	0.70 [−0.28–0.99]
Median of R1-R15 versus rater JG	0.75 [−8.75–0.99]	0.92 [−2.00–1.00]	0.98 [0.03–1.00]	0.99 [0.72–1.00]	0.57 [−15.71–0.99]
Median of R1-R15 versus rater TD	0.54 [−17.05–0.99]	0.89 [−3.33–1.00]	0.98 [0.03–1.00]	0.96 [−0.44–1.00]	0.00 [−38.00–0.97]
Rater JG versus rater TD	0.95 [−0.86–1.00]	0.77 [−7.81–0.99]	1.00 [1.00–1.00]	0.98 [0.25–1.00]	0.00 [−38.00–0.97]

TABLE 3 Dosage form-specific rating results: ICC with 95% confidence intervals.

Dosage form-specific interrater agreement for patient 1–20					
	Tablets	Eye-drops	Oral drops	Insulin pen	Patch
Rater JG versus TD	0.83 [0.54–0.94]	−0.09 [−2.02–0.60]	0.75 [0.32–0.91]	0.89 [0.72–0.96]	0.83 [0.56–0.94]
Dosage form-specific interrater agreement for patient 1–20 after second evaluation of eye-drops					
	Tablets	**Eye-drops**	**Oral drops**	**Insulin pen**	**Patch**
Rater JG versus TD	0.83 [0.54–0.94]	0.79 [0.43–0.93]	0.75 [0.32–0.91]	0.89 [0.72–0.96]	0.83 [0.56–0.94]
Dosage form-specific interrater agreement for patient 21–40					
	Tablets	**Eye-drops**	**Oral drops**	**Insulin pen**	**Patch**
Rater JG versus TD	0.67 [−0.35–0.92]	0.95 [0.79–0.99]	0.89 [0.49–0.97]	0.28 [−2.58–0.86]	0.99 [0.95–1.00]
Dosage form-specific interrater agreement for patient 21–40 after second evaluation of the pen					
	Tablets	**Eye-drops**	**Oral drops**	**Insulin pen**	**Patch**
Rater JG versus TD	0.67 [−0.35–0.92]	0.95 [0.79–0.99]	0.89 [0.49–0.97]	0.87 [0.34–0.97]	0.99 [0.95–1.00]
Dosage form-specific interrater agreement for patient 41–60					
	Tablets	**Eye-drops**	**Oral drops**	**Insulin pen**	**Patch**
Rater JG versus TD	0.90 [0.68–0.97]	0.92 [0.73–0.98]	0.91 [0.71–0.97]	0.82 [0.28–0.96]	0.98 [0.93–0.99]
Dosage form-specific interrater agreement for patient 61–80					
	Tablets	**Eye-drops**	**Oral drops**	**Insulin pen**	**Patch**
Rater JG versus TD	0.97 [0.91–0.99]	0.87 [0.59–0.96]	0.78 [0.28–0.93]	0.97 [0.89–0.99]	0.97 [0.91–0.99]
Dosage form-specific interrater agreement for patient 81–100					
	Tablets	**Eye-drops**	**Oral drops**	**Insulin pen**	**Patch**
Rater JG versus TD	0.73 [−0.10–0.93]	0.76 [0.10–0.94]	0.99 [0.95–1.00]	0.98 [0.93–1.00]	0.98 [0.91–0.99]

TABLE 4 Dosage form-specific interrater agreement between JG/reference standard and TD/reference standard.

	Tablets	Eye-drops	Oral drops	Insulin pen	Patch
Rater JG versus reference standard	0.67 [−2.20–0.97]	1.00 [1.00–1.00]	1.00 [1.00–1.00]	0.80 [−0.97–0.98]	0.84 [−0.56–0.98]
Rater TD versus reference standard	0.52 [−3.62–0.95]	1.00 [1.00–1.00]	1.00 [1.00–1.00]	0.77 [−1.19–0.98]	0.92 [0.22–0.99]

(9). Thus, preserved medication performance skills are important for patients' quality of life. Besides, they are essential for a safe drug therapy. Older patients are at a higher risk for patient medication errors such as incorrect dosage, forgetting, mixing up medications, incorrect handling of inhalers or inappropriately storing drugs (19). The video recordings help to uncover patient's individual handling errors which influence medication management performance.

Prior studies using video recordings to measure patients' medication management performance are scarce. Park et al. used video recordings to examine self-instillation of artificial tears in 78 patients with glaucoma

or ocular hypertension. Three raters (medical students) evaluated the videos on the three criteria efficacy (whether an eye drop was instilled on the ocular surface), safety (whether the tip of the medication bottle made contact with the ocular surface or eyelids), and efficiency (number of eye drops expressed from the bottle). Park et al. reported good interrater reproducibility with a mean kappa level 0.64 for efficacy, 0.73 for safety, and 0.62 for efficiency. Measuring medication management performance using the criteria efficacy, safety, and efficiency is less detailed than our evaluation of each administration step. Furthermore, this study focused on eye-drops. In addition, our study comprised all common dosage forms to reach a comprehensive view of patients' medication management performance (14). Of note, there are some prior studies about assessment tools measuring medication management performance. One tool is called Drug Regimen Unassisted Grading Scale (DRUGS) which was developed based on 59 outpatients at the age of 70 years and older. These patients had to perform the four tasks identification, access, dosage, and timing with their own medication. The performance was evaluated by the DRUGS tool score ranging from 0% (when a patient can perform none of the tasks for none of their own medication) to 100% (when a patient can perform all four tasks for every drug of the own medication). The authors reported a statistically significant association between performance in the tasks of access, dosage, timing, and the Mini-Mental State Exam (MMSE) score (20). Another tool is called Medication Management Instrument for Deficiencies in the Elderly (MedMaIDE) which is based on a study with 50 patients at the age of 65 years and older, living in the community and being self-medicating. Participants had to answer 20 items about knowledge, how to take their medication, and procurement. Besides, validity was assessed by comparing the MedMaIDE score to pill count adherence. MedMaIDE is a valid and reliable instrument to assess medication management performance in older adults, but relies exclusively on patients' responses without external validation of handling skills (21). The assessment tool Medication Management Ability Assessment (MMAA) was developed based on 104 patients older than 45 years with schizophrenia and 33 normal comparison subjects, who had to perform a role-play task that simulated a fictious medication regime which was of similar complexity than those of older people. The total number of pills over that prescribed, total number of pills under that prescribed, and total number of correct responses were noted. Furthermore, adherence was measured by pharmacy claims data and cognitive status by MMSE. Patients made significantly more errors in the MMAA compared with controls and performance was significantly associated with prescription refill records and cognitive performance suggesting that adherence may improve with improving cognitive functions (22). The tools MMAA and DRUGS show a high correlation (Pearson correlation coefficient of 0.56) with each other in older individuals living in the community. Furthermore, the results of both tools correlated positively with cognitive function measured by MMSE (23).

Of note, contrary to our study, all the tools mentioned above only investigated single dosage forms but not all forms available. Furthermore, none of these instruments applied an objective, reliable, and ecologically valid quantitative assessment of medication management performance based on behavioral observations in standardized test settings as performed in the ABLYMED study. The methods applied in these studies to assess validity relied on adherence and cognition (16). In the ABLYMED study we assess adherence by Medication Adherence Report Scale (MARS), a tool already validated and widely used in clinical routine, and cognitive functions by six-item screener, Timed Test of Money Counting, Trail Making Test for older subjects (ZVT-G) and Clock-drawing test (8). Although prevention of patient's medication errors is not the main objective of our study, previous studies showed, that improving information about medication use reduces medication errors (24). Besides, patients sometimes revealed their home-grown strategies to deal with the daily medication. For example, patients reported to use scissors or knifes to open packaging or to divide tablets. To reduce patients' medication errors, methods like verbal instructions, tear-off calendars, apps and motivational interviews were examined so far (19). Pharmaceutical counseling on correct medication administration is not well established in all dosage forms. It is only common with inhalers or insulin pens (25, 26). Maybe pharmaceutical counseling on correct medication administration in all dosage forms can preserve medication performance skills. Furthermore, findings from the video recordings can indicate that a patient requires a different dosage form: When for example, a patient is not able to open a bottle of oral drops but is able to take tablets without any problems, the dosage form of tablets would be preferable if available. Of note, the ARMIN-Project (Arzneimittelinitiative Sachsen Thüringen) shows the importance of the interprofessional medication management program between community pharmacists and general practitioners to improve medication safety and effectiveness (27). The combination of individual counseling on correct medication administration and prescription of adequate medication preparations may reduce medication errors and preserve patients' independence.

Our study considers a population that excludes patients with cognitive impairments in order to create a tool, that is valid in persons who usually handle their medication by themselves. These independent patients are common in primary care practices. They may be at risk for medication-related problems, although the risk is less obvious in this group of patients. That is why our research has high relevance in an aging society.

Nevertheless, there are some limitations of our study to be considered. We determined a reference standard for the videos of the pilot phase and for video recordings of five patients in the rating phase by two raters (AL, HF). We used the reference standard as a gold standard to measure accuracy. This is the result of the best available method (28) as no other accepted gold standard is available. The MedMaIDE could be used as an established reference with demonstrated validity and reliability. However, the usefulness of this instrument for our purposes is limited because of some missing dosage forms (only tablets, patches, and insulin pen) and because the observations are done by one person only (21). Other instruments such as Medication Management Evaluation Instrument (MMEI), Medication Management Test (MMT) and Medication Assessment Instruments (MAI) are less suitable due to limitations in validity or the investigated population (9). Nevertheless, other instruments like MMAA and Medication Management Evaluation Instrument (MMEI) were validated by using at least one related construct like cognitive function (Cognitive Capacity Screening Exam, neuropsychological test battery) or medication adherence (self-reported, pill counting or pharmacy claims data) (9). Because there is no existing instrument to objectively evaluate medication management performance of different dosage forms, in future work within the ABLYMED study, we are going to use different external validation steps (association with grooved pegboard performance as an indicator of manual dexterity and complex visual-motor coordination, with Six-Item-Screener as an indicator of cognitive function, with self-reported adherence and with MedMaIDE). Another limitation concerns the non-standardized video

recording setting. As explained, we filmed the patients in their rooms with a smartphone camera. No further equipment or technical support was used to minimize intrusiveness and increase the ecological validity of the test setting. This came along with some limitations in video quality. In particular, there were some late onsets of the video recordings and suboptimal image sections. Late onset of the videos occurred when patients had no difficulties at all and managed the first administration steps quickly. We considered the presence of late onsets in our general rating rules, according to which missing steps are scored as no difficulties (see Supplementary Table S2). In total, 79% of the video recordings were rated to have good quality, 17% to have limited quality, and 4% as being not usable. Thus, we would argue that any negative impact of our non-standardized recording procedure is rather limited and outweighed by the ease of our procedure's integration into the geriatric hospital setting. Furthermore, only two raters evaluated all videos. Because of the high workload the limitation on two raters is ecologically valid and realistic. Unexpectedly, some problems with the different dosage forms of medications occurred. First, in some videos the bottle of the oral drops was blocked. Therefore, executing the task was complicated for the participants. This occurred in ten cases. Therefore, we decided to implement this into the rating rules: the raters should evaluate whether patients took action (e.g., shake the bottle, turn the bottle, see Supplementary Table S2). However, blocked bottles of oral drops also exist in real-life settings with non-placebo drugs, increasing the ecological validity of our task. Despite previous testing we could not avoid this. Second, we had to change our patches from a product with subdivided protective liner to a product with continuous protective liner. The reason was a stop in production during data collection. Critical steps of patch application are opening the packaging and removing the protective foil (29). While the packaging and the protective liner differed between the two products and may have biased the absolute ratings, the inter- and intrarater agreement was not affected negatively. Of note, the comparison of different patches and their handling may also be an exciting topic for further research as it is already performed for different inhalers (27, 30). Regarding the different dosage forms of the medications, some aspects need to be discussed. In our study we only assessed opening a one-dose ophtiole dispenser of eye-drops. Due to data privacy, we were not allowed to film the eye-drop instillation. A study in patients with glaucoma showed, that especially placing the drops in both eyes and maintaining the bottle's sterility during application are often improper (31). Thus, our performance task in the self-administration of eye-drops may have been too easy and may not cover critical steps of eye drop administration. Finally, we did not access inhaler use in our assessment battery, because this topic is well investigated (27, 32). Additionally, the number of patients in need of inhalers was too low to achieve reliable results.

Conclusion

Using a typical older, non-demented patient population with polypharmacy and independent medication management, the video recordings of medication administration performance and their systematic evaluation yielded important results for the ABLYMED study. The satisfactory interrater and intrarater agreement of the ratings showed a valid and reproducible evaluation procedure of the video recordings. The rating results represent patients' objective ability to self-administer medication. Due to the existing gap between patients' self-reported ability to self-administer medication and their observable skills, reliable and valid measurement of actual medication management performance, as presented, is essential. One further step is the identification of factors influencing the ability to self-administer medication. This topic will also be analyzed in the ABLYMED study. Our results will be applicable to patients in a comparable health condition, that means patients without cognitive impairment and without any need of daily care. Such patients can be identified easily since they usually visit their family doctor independently and without help. Our method of constructing the assessment form to evaluate the performance of patients while self-administering different dosage forms of medication can function as a guide also for other patient populations since the assessment form can be adapted to their individual characteristics and problems. Factors influencing the ability to self-administer medication should be included in geriatric assessment to avoid medication errors and secure patients independent living.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

The studies involving human participants were reviewed and approved by Heinrich Heine Universität Düsseldorf. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

AL, HF, SW, and JG developed the research question and the rating procedure. AL and HF collected patient data and determined the reference standard. JG and TD analyzed video recordings. JG performed statistical analyses of data together with AL. AL, JG, and HF drafted the manuscript. TD, RL, SW, and DH critically revised the manuscript. AL, RL, SW, TD, DH, HF, and JG agreed both to be personally accountable for their own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which they were not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature. All authors contributed to the article and approved the submitted version.

Funding

This study received funding from the Paul-Kuth Foundation, Wuppertal, Germany. The funder had no role in the design of the study and collection, management, analysis, and interpretation of data, writing the manuscript and decision to submit the manuscript for publication.

Acknowledgments

We thank all participants of the study for their time and energy. We thank Dana Meier for the review and text correction. We thank the medical students for their time and energy performing the ratings in the pilot phase.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer BB declared a past co-authorship with the author(s) TD, DH to the handling editor.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmed.2023.1040528/full#supplementary-material

SUPPLEMENTARY VIDEOS S1-S23
https://figshare.com/articles/media/Video_S1-S23_mov/21383736

References

1. Beckman, AG, Parker, MG, and Thorslund, M. Can elderly people take their medicine? *Patient Educ Couns*. (2005) 59:186–91. doi: 10.1016/j.pec.2004.11.005

2. Gellad, WF, Grenard, JL, and Marcum, ZA. A systematic review of barriers to medication adherence in the elderly: looking beyond cost and regimen complexity. *Am J Geriatr Pharmacother*. (2011) 9:11–23. doi: 10.1016/j.amjopharm.2011.02.004

3. Maher, RL, Hanlon, J, and Hajjar, ER. Clinical consequences of polypharmacy in elderly. *Expert Opin Drug Saf*. (2014) 13:57–65. doi: 10.1517/14740338.2013.827660

4. Schenk, A, Eckardt-Felmberg, R, Steinhagen-Thiessen, E, and Stegemann, S. Patient behaviour in medication management: findings from a patient usability study that may impact clinical outcomes. *Br J Clin Pharmacol*. (2020) 86:1958–68. doi: 10.1111/bcp.13946

5. Shippee, ND, Shah, ND, May, CR, Mair, FS, and Montori, VM. Cumulative complexity: a functional, patient-centered model of patient complexity can improve research and practice. *J Clin Epidemiol*. (2012) 65:1041–51. doi: 10.1016/j.jclinepi.2012.05.005

6. Gnjidic, D, Husband, A, and Todd, A. Challenges and innovations of delivering medicines to older adults. *Adv Drug Deliv Rev*. (2018) 135:97–105. doi: 10.1016/j.addr.2018.08.003

7. Notenboom, K, Beers, E, van Riet-Nales, DA, Egberts, TC, Leufkens, HG, Jansen, PA, et al. Practical problems with medication use that older people experience: a qualitative study. *J Am Geriatr Soc*. (2014) 62:2339–44. doi: 10.1111/jgs.13126

8. Maiworm, A, Langner, R, Wilm, S, Hermann, DM, Frohnhofen, H, and Gronewold, J. Developing a novel tool to assess the ability to self-administer medication in non-demented in-hospital patients: ABLYMED study protocol. *BMC Geriatr*. (2022) 22:466. doi: 10.1186/s12877-022-03147-8

9. Badawoud, AM, Salgado, TM, Lu, J, Parsons, P, Peron, EP, and Slattum, PW. Measuring medication self-management capacity: a scoping review of available instruments. *Drugs Aging*. (2020) 37:483–501. doi: 10.1007/s40266-020-00764-z

10. Ahn, JH, Chung, JH, Shin, K-C, Choi, EY, Jin, HJ, Lee, MS, et al. Critical inhaler handling error is an independent risk factor for frequent exacerbations of chronic obstructive pulmonary disease: interim results of a single center prospective study. *Int J Chron Obstruct Pulmon Dis*. (2019) 14:2767–75. doi: 10.2147/COPD.S234774

11. Lee, HY, Song, JH, Won, H-K, Park, Y, Chung, KB, Lim, H-J, et al. Comparing inhaler use technique based on inhaler type in elderly patients with respiratory disease. *Tuberc. Respir. Dis.* (2021) 84:46–54. doi: 10.4046/trd.2020.0021

12. Ruessel, K, Luecke, E, and Schreiber, J. Inhaler devices in a geriatric patient population: a prospective cross-sectional study on patient preferences. *Patient Prefer Adherence*. (2020) 14:1811–22. doi: 10.2147/PPA.S262057

13. Nikolaus, T, Kruse, W, Bach, M, Specht-Leible, N, Oster, P, and Schlierf, G. Elderly patients' problems with medication. An in-hospital and follow-up study. *Eur J Clin Pharmacol*. (1996) 49:255–9. doi: 10.1007/BF00226324

14. Park, MS, Patel, MM, Sarezky, D, Rojas, C, Choo, C, Choi, M, et al. Inter-rater agreement in the assessment of video recordings of eye drop instillation by glaucoma patients. *PLoS One*. (2016) 11:e0145764. doi: 10.1371/journal.pone.0145764

15. Lavan, AH, Gallagher, PF, and O'Mahony, D. Methods to reduce prescribing errors in elderly patients with multimorbidity. *Clin Interv Aging*. (2016) 11:857–66. doi: 10.2147/CIA.S80280

16. Elliott, RA, and Marriott, JL. Standardised assessment of patients' capacity to manage medications: a systematic review of published instruments. *BMC Geriatr*. (2009) 9:27. doi: 10.1186/1471-2318-9-27

17. Shoukri, MM. Agreement, measurement of In: P Armitage and T Colton, editors. *Encyclopedia of Biostatistics*. Chichester, UK: John Wiley & Sons, Ltd (2005)

18. Koo, TK, and Li, MY. A guideline of selecting and reporting Intraclass correlation coefficients for reliability research. *J Chiropr Med*. (2016) 15:155–63. doi: 10.1016/j.jcm.2016.02.012

19. Mira, JJ, Lorenzo, S, Guilabert, M, Navarro, I, and Pérez-Jover, V. A systematic review of patient medication error on self-administering medication at home. *Expert Opin Drug Saf*. (2015) 14:815–38. doi: 10.1517/14740338.2015.1026326

20. Edelberg, HK, Shallenberger, E, and Wei, JY. Medication management capacity in highly functioning community-living older adults: detection of early deficits. *J Am Geriatr Soc*. (1999) 47:592–6. doi: 10.1111/j.1532-5415.1999.tb02574.x

21. Orwig, D, Brandt, N, and Gruber-Baldini, AL. Medication management assessment for older adults in the community. *The Gerontologist*. (2006) 46:661–8. doi: 10.1093/geront/46.5.661

22. Patterson, TL, Lacro, J, McKibbin, CL, Moscona, S, Hughs, T, and Jeste, DV. Medication management ability assessment: results from a performance-based measure in older outpatients with schizophrenia. *J Clin Psychopharmacol*. (2002) 22:11–9. doi: 10.1097/00004714-200202000-00003

23. Hutchison, LC, Jones, SK, West, DS, and Wei, JY. Assessment of medication management by community-living elderly persons with two standardized assessment tools: a cross-sectional study. *Am J Geriatr Pharmacother*. (2006) 4:144–53. doi: 10.1016/j.amjopharm.2006.06.009

24. Mira, JJ, Martínez-Jimeno, L, Orozco-Beltrán, D, Iglesias-Alonso, F, Lorenzo, S, Nuño, R, et al. What older complex chronic patients need to know about their everyday medication for safe drug use. *Expert Opin Drug Saf*. (2014) 13:1–9. doi: 10.1517/14740338.2014.916272

25. Hämmerlein, A, Müller, U, and Schulz, M. Versorgungsmanagement für menschen mit asthma--einbindung der apotheker. *Z. Evid. Fortbild. Qual. Gesundheits.* (2010) 104:92–8. doi: 10.1016/j.zefq.2009.07.007

26. Frid, AH, Hirsch, LJ, Menchior, AR, Morel, DR, and Strauss, KW. Worldwide injection technique questionnaire study: injecting complications and the role of the professional. *Mayo Clin Proc*. (2016) 91:1224–30. doi: 10.1016/j.mayocp.2016.06.012

27. Lavorini, F, Magnan, A, Dubus, JC, Voshaar, T, Corbetta, L, Broeders, M, et al. Effect of incorrect use of dry powder inhalers on management of patients with asthma and COPD. *Respir Med*. (2008) 102:593–604. doi: 10.1016/j.rmed.2007.11.003

28. Rutjes, AW, Reitsma, JB, Coomarasamy, A, Khan, KS, and Bossuyt, PM. Evaluation of diagnostic tests when there is no gold standard. A review of methods. *Health Technol. Assess.* (2007) 11:iii, ix–51. doi: 10.3310/hta11500

29. Lampert, A, Kessler, J, Washington-Dorando, P, Bardenheuer, HJ, Bocek Eknes, EM, Krisam, J, et al. Patient experiences with handling of analgesic transdermal patches and challenges in correct drug administration: a pilot study on patient education. *J Patient Saf*. (2018) 14:e97–e101. doi: 10.1097/PTS.0000000000000538

30. Sanchis, J, Corrigan, C, Levy, ML, and Viejo, JL. Inhaler devices - from theory to practice. *Respir Med*. (2013) 107:495–502. doi: 10.1016/j.rmed.2012.12.007

31. Brown, MM, Brown, GC, and Spaeth, GL. Improper topical self-administration of ocular medication among patients with glaucoma. *Can. J. Ophthalmol.* (1984) 19:2–5.

32. Incalzi, RA, Scarlata, S, Pennazza, G, Santonico, M, and Pedone, C. Chronic obstructive pulmonary disease in the elderly. *Eur J Intern Med*. (2014) 25:320–8. doi: 10.1016/j.ejim.2013.10.001

4 Diskussion

Ausgehend von dem Spannungsfeld zwischen unerkannten Medikationsmanagementdefiziten bei älteren Patienten und Bedeutsamkeit der sachgerechten Arzneimittelanwendung für den Therapieerfolg entstand das Studienprotokoll der ABLYMED-Pilotstudie. Das Protokoll beschreibt die Entwicklung eines Assessmentinstruments zur Erfassung der Fähigkeiten zur eigenverantwortlichen Arzneimittelanwendung durch ältere Patienten anhand von 100 Studienteilnehmern. Die Datenerhebung umfasst dabei ein Interview, ein geriatrisches Assessment sowie die videobasierte Aufzeichnung der Arzneimittelhandhabung der Studienteilnehmer. Insgesamt konnten bei der Durchführung der ABLYMED-Studie Videos von 67 Patienten aufgenommen werden, die ihre Fähigkeiten im Umgang mit fünf verschiedenen Placebo-Arzneimitteldarreichungsformen zeigten. Zur systematischen Beurteilung der gefilmten Leistungen der Patienten wurde ein Ratingverfahren unter Anwendung eines Bewertungsbogens und Bewertungsregeln entwickelt. Alle Videos wurden mit einer zufriedenstellenden Interrater- und Intraraterreliabilität von zwei Ratern bewertet. Das Ergebnis ist ein valides und reproduzierbares Bewertungsverfahren der Videoaufnahmen. In der Literatur sind einige Instrumente beschrieben, die die Fähigkeiten von Patienten im Management ihrer Medikation überprüfen sollen. Die Überprüfung findet dabei entweder anhand der eigenen Medikation oder anhand einer simulierten Medikation statt. Die bestehenden Instrumente haben verschiedener Limitationen und keinen Einzug in das geriatrische Assessment gefunden (15, 20). Daher sind weitere Forschungsprojekte wie unser ABLYMED Projekt notwendig. Ausgewählte Bewertungsinstrumente werden im Folgenden diskutiert, um die Limitationen darzustellen. Das Bewertungsinstrument MMAA (Medication Management Ability Assessment) wurde an einem Kollektiv von Patienten ab 45 Jahren mit Schizophrenie entwickelt und ist nicht auf unser Patientenkollektiv übertragbar (23). Das Bewertungsinstrument MedMaIDE (Medication Management Instrument for Deficiencies in the Elderly) beruht auf einer Studie mit 50 Patienten im Alter von 65 Jahren und älter, die ihre Medikation selbstständig managten. Die Teilnehmer mussten 20 Fragen zum Wissen, zur Einnahme ihrer Medikamente und zur Beschaffung beantworten. Das Instrument stützt sich ausschließlich auf die Antworten der Patienten, eine externe Validierung erfolgte anhand der *Pill count* Adhärenz, nicht aber anhand der direkten Bewertung der Handhabungsfähigkeiten. Zur Erhebung der *Pill count* Adhärenz wurden die Tabletten der Patienten zu einem

Bezugszeitpunkt und 30 Tage später gezählt und der Verbrauch in Relation zum geplanten Verbrauch aufgrund der ärztlichen Anordnung gesetzt (24). Das Bewertungsinstrument DRUGS (Drug Regimen Unassisted Grading Scale) basiert auf einer Studie mit 95 zu Hause lebenden Patienten im Alter von 70 Jahren und älter. Die Teilnehmer demonstrierten ihre praktischen Fähigkeiten anhand der ihnen verordneten Medikation. Die Leistung wurde mit dem DRUGS-Tool-Score bewertet, der ein Maximum von einhundert Prozent annehmen kann. Die Patienten, die in einer Befragung angaben, ihre Medikation selbst managen zu können, hatten einen mittleren Score von 95%. Die Patienten, die nach eigenen Angaben Hilfe im Medikamentenmanagement benötigen, hatten einen Score von 86%. Nicht unerwartet berichteten die Autoren über einen statistisch signifikanten Zusammenhang zwischen eingeschränkten kognitiven Fähigkeiten und den Aufgaben Öffnen, Dosierung und Zeitplan (25). Den erwartbaren Zusammenhang zwischen kognitiver Leistung und Fähigkeiten zum eigenständigen Medikamentenmanagement konnten auch schon andere Studien beobachten. So zeigt eine Untersuchung an 55 aufgrund von Herzinsuffizienz hospitalisierten Patienten ab 65 Jahren, dass Patienten mit kognitiven Einschränkungen (erfasst durch Mini-Cog) öfter Aufschriften auf Tablettenpackungen nicht lesen können und unfähig sind, einen kindersicheren Verschluss zu öffnen (26). Unsere Forschung unterscheidet sich im untersuchten Patientenkollektiv. Wir betrachten unabhängig lebende Patienten ohne Demenzdiagnose, bei denen Defizite im Medikamentenselbstmanagement nicht offensichtlich sind. Unsere Einschlusskriterien (≥ 70 Jahre, ≥ 5 Medikamente, eigenständiges Medikamentenmanagement) bilden den typischen Hausarztpatienten ab. Eine Untersuchung aus Portugal erforschte ein ähnliches Patientenkollektiv (Polymedikation und ≥ 65 Jahre). Das Kollektiv der genannten Studie war im Mittel 76 Jahre alt, nimmt durchschnittlich sieben Medikamente ein und war zu 63% weiblich. Die meisten Studienteilnehmer lebten in einer Familie und die ATC Gruppen Verdauungstrakt und Stoffwechsel, Herz-Kreislauf-System und Nervensystem waren in den Medikationen am meisten vertreten (27). Die Patienten der ABLYMED-Studie waren im Mittel 79 Jahre alt, wendeten durchschnittlich neun Medikamente an, wobei Arzneimittel für das kardiovaskuläre System vorherrschten, und waren zu 50% weiblich. Über die Hälfte der Studienteilnehmer lebte in einer Familie. Der Vergleich der Patientenkollektive zeigt, dass die Patienten der ABLYMED-Studie durchaus repräsentativ sind, auch wenn sie nur aus zwei Düsseldorfer Kliniken rekrutiert wurden. In der portugiesischen Studie wurden die Adhärenz und Risikofaktoren für

Medikationsfehler anhand eines Fragebogens erhoben. Die Nonadhärenz betraf 47,7% der Patienten. Relevante Faktoren für die Nichteinhaltung der Therapievereinbarung waren Vergesslichkeit (38,8 %), Schwierigkeiten bei der Verwaltung der Medikamente (14,3 %), Bedenken hinsichtlich der Nebenwirkungen (10,7 %) und der Preis der Medikamente (9,2 %) (27). Einen weiteren Faktor für Nonadhärenz kann die Komplexität der Medikation darstellen. Die HIOPP-6-Arbeitsgruppe (Hausärztliche Initiative zur Optimierung der Patientensicherheit bei Polypharmazie) beschäftigte sich mit dem Einfluss der Erfassung und Reduktion der Medikamentenkomplexität auf die Adhärenz. Ein elektronisches Tool analysierte dabei Komplexitätsfaktoren der Medikation von 139 Patienten, die mehr als fünf Medikamente dauerhaft anwendeten. Zusätzlich bewerteten die Patienten die analysierten Faktoren in einem Interview selbst. Bei den meisten Medikationen (94%) konnten Komplexitätsfaktoren identifiziert werden, wobei weniger als 15% der Faktoren nach eigener Einschätzung tatsächlich für die Patienten relevant waren (28, 29). Die ABLYMED-Studie zeichnet sich dadurch aus, dass neben der Befragung durch einen Fragebogen auch die tatsächlichen Fähigkeiten der Patienten im Umgang mit Medikamenten aufgezeichnet werden. Die Autoren Schenk et al haben in einer Studie mit dem Titel „Patient behaviour in medication management: Findings from a patient usability study that may impact clinical outcomes“ herausgefunden, dass die berichteten Fähigkeiten der Patienten im Umgang mit Medikamenten nicht verlässlich sind. Diese Erkenntnis machten die Forscher an 20 Patienten, die das Management der eigenen Medikation zeigten und ein Interview durchliefen. Auch hier wurden Videosequenzen der Patienten aufgezeichnet, während sie ihre Medikamente vorbereiteten. Die Auswertung der Videos unterschied sich von unserem Verfahren, da in dieser Studie lediglich qualitativ Probleme bei der Medikamentenvorbereitung herausgearbeitet wurden (13). Auf Grundlage dieser Studie leitet sich die Notwendigkeit eines Vergleiches der berichteten und tatsächlichen Fähigkeiten ab. Eine Studie zur Selbstverabreichung von Augentropfen verwendete ein ähnliches Bewertungsverfahren von Videoaufnahmen wie es in der ABLYMED-Studie verwendet wurde. Die Forscher untersuchten die Applikation von künstlichen Tränen anhand von 78 Patienten mit Glaukom oder okulärer Hypertension mit Hilfe von Videoaufzeichnungen. Drei Bewerter bewerteten die Videos anhand der drei Kriterien Wirksamkeit (Bewertung, ob Augentropfen die Augenoberfläche trifft), Sicherheit (Bewertung, ob Spitze der Tropfflasche das Auge berührt) und Effizienz (Anzahl der Tropfen). Die Autoren Park et al. berichteten über eine gute Interrater-Reproduzierbarkeit für alle drei Kategorien (30).

Die ABLYMED-Studie bewertet die Leistungen im Medikamentenmanagement detaillierter, indem jeder einzelnen Verabreichungsschritte mit einer Fünf-Punkt-Likert Skala bewertet wird. Außerdem umfasste die ABLYMED-Studie neben Augentropfen die Darreichungsformen Tabletten, Tropfen, Pen und Pflaster. So konnten wir ein umfassendes Bild der Medikationsmanagementleistung der Patienten erhalten.

Ein Assessmentinstrument zur Überprüfung der Medikamentenselbstmanagementfähigkeiten von Patienten sollte valide und reliabel sein (15, 20). Die Validität unterteilt sich in Inhaltsvalidität und Konstruktvalidität. Die Autoren Elliott et al. definieren Inhaltsvalidität, wenn folgende Kompetenzbereiche bewertet werden: 1) Identifizierung von Medikamenten (z. B. durch Lesen des Etiketts oder Erkennen der Verpackung), 2) Zugang zu Medikamenten aus der Verpackung, 3) Verstehen und Erklären oder Demonstrieren von Medikamentenanweisungen, 4) Abrufen von Informationen und 5) Verabreichung von Medikamenten (20). Diese Kompetenzen werden durch die Demonstration der fünf Darreichungsformen in der ABLYMED-Studie abgedeckt. Um Konstruktvalidität zu zeigen, wurden bei der ABLYMED-Studie die Kognition, die Adhärenz und der funktionale Status erhoben. Bei der ABLYMED-Studie handelte es sich im eine Pilotforschung mit einer explorativen Fragestellung. Basierend auf den Erkenntnissen der ABLYMED-Studie werden weitere Studien an unabhängigen Patientenkollektiven zur Validierung eines Assessmentinstruments für den klinischen Alltag notwendig. Diese künftigen Studien sollen einerseits einen deutlich geringeren Assessmentumfang haben. Das bedeutet, dass nur Faktoren untersucht werden, die laut den Ergebnissen der ABLYMED-Studie einen Zusammenhang mit dem Medikamentenmanagementfähigkeiten haben könnten. Außerdem soll die Fallzahl in zukünftigen Studien vorab berechnet werden, um statistisch signifikante Ergebnisse erzielen zu können. Es sollten Adhärenzkriterien wie *Pill-Counting* oder klinische Parameter der Krankheitskontrolle wie Blutdruck, Blutzucker, Lungenkapazität usw. als Validierungsvariablen verwendet werden.

5 Literatur- und Quellenverzeichnis

1. Garin N, Koyanagi A, Chatterji S, et al.: Global Multimorbidity Patterns: A Cross-Sectional, Population-Based, Multi-Country Study. J Gerontol A Biol Sci Med Sci 2016; 71(2): 205–14.
2. Puth M-T, Weckbecker K, Schmid M, Münster E: Prevalence of multimorbidity in Germany: impact of age and educational level in a cross-sectional study on 19,294 adults. BMC Public Health 2017; 17(1): 826.
3. Gnjidic D, Husband A, Todd A: Challenges and innovations of delivering medicines to older adults. Adv Drug Deliv Rev 2018; 135: 97–105.
4. Wehling M, Burkhardt H, Kuhn-Thiel A, et al.: VALFORTA: a randomised trial to validate the FORTA (Fit fOR The Aged) classification. Age Ageing 2016; 45(2): 262–7.
5. Maher RL, Hanlon J, Hajjar ER: Clinical consequences of polypharmacy in elderly. Expert Opin Drug Saf 2014; 13(1): 57–65.
6. Jansen J, Naganathan V, Carter SM, et al.: Too much medicine in older people? Deprescribing through shared decision making. BMJ 2016; 353: i2893.
7. Stange D, Kriston L, Langebrake C, et al.: Development and psychometric evaluation of the German version of the Medication Regimen Complexity Index (MRCI-D). J Eval Clin Pract 2012; 18(3): 515–22.
8. Beckman AGK, Parker MG, Thorslund M: Can elderly people take their medicine? Patient Educ Couns 2005; 59(2): 186–91.
9. van Riet-Nales D, Donkerbroek L, Nicia A, Oussoren C, Boer A de, van den Bemt B: The development of a test battery to assess the hand-eye functions relevant in predicting easy and accurate tablet subdivision in older people: A pilot study. Br J Clin Pharmacol 2020; 86(10): 1969–81.
10. Notenboom K, Beers E, van Riet-Nales DA, et al.: Practical problems with medication use that older people experience: a qualitative study. J Am Geriatr Soc 2014; 62(12): 2339–44.
11. Kouladjian L, Gnjidic D, Chen TF, Mangoni AA, Hilmer SN: Drug Burden Index in older adults: theoretical and practical issues. Clin Interv Aging 2014; 9: 1503–15.
12. Elliott RA, Marriott JL: Review of Instruments used in Clinical Practice to Assess Patients' Ability to Manage Medications. Journal of Pharmacy Practice and Research 2010; 40(1): 36–42.
13. Schenk A, Eckardt-Felmberg R, Steinhagen-Thiessen E, Stegemann S: Patient behaviour in medication management: Findings from a patient usability study that may impact clinical outcomes. Br J Clin Pharmacol 2020; 86(10): 1958–68.
14. Applegate WB, Blass JP, Williams TF: Instruments for the functional assessment of older patients. N Engl J Med 1990; 322(17): 1207–14.
15. Badawoud AM, Salgado TM, Lu J, Parsons P, Peron EP, Slattum PW: Measuring Medication Self-Management Capacity: A Scoping Review of Available Instruments. Drugs Aging 2020; 37(7): 483–501.
16. Christopher C, Kc B, Shrestha S, et al.: Medication use problems among older adults at a primary care: A narrative of literature review. Aging Med (Milton) 2022; 5(2): 126–37.
17. Hughes CM: Medication non-adherence in the elderly: how big is the problem? Drugs Aging 2004; 21(12): 793–811.
18. Gellad WF, Grenard JL, Marcum ZA: A systematic review of barriers to medication adherence in the elderly: looking beyond cost and regimen complexity. Am J Geriatr Pharmacother 2011; 9(1): 11–23.

19. Elliott RA: Problems with Medication Use in the Elderly: An Australian Perspective. Journal of Pharmacy Practice and Research 2006; 36(1): 58–66.
20. Elliott RA, Marriott JL: Standardised assessment of patients' capacity to manage medications: a systematic review of published instruments. BMC Geriatr 2009; 9: 27.
21. Maiworm A, Langner R, Wilm S, Hermann DM, Frohnhofen H, Gronewold J: Developing a novel tool to assess the ability to self-administer medication in non-demented in-hospital patients: ABLYMED study protocol. BMC Geriatr 2022; 22(1): 466.
22. Luegering A, Langner R, Wilm S, et al.: Developing a novel tool to assess the ability to self-administer medication – A systematic evaluation of patients' video recordings in the ABLYMED study. Front. Med. 2023; 10.
23. Patterson TL, Lacro J, McKibbin CL, Moscona S, Hughs T, Jeste DV: Medication management ability assessment: results from a performance-based measure in older outpatients with schizophrenia. J Clin Psychopharmacol 2002; 22(1): 11–9.
24. Orwig D, Brandt N, Gruber-Baldini AL: Medication management assessment for older adults in the community. Gerontologist 2006; 46(5): 661–8.
25. Edelberg HK, Shallenberger E, Wei JY: Medication management capacity in highly functioning community-living older adults: detection of early deficits. J Am Geriatr Soc 1999; 47(5): 592–6.
26. Howell EH, Senapati A, Hsich E, Gorodeski EZ: Medication self-management skills and cognitive impairment in older adults hospitalized for heart failure: A cross-sectional study. SAGE Open Med 2017; 5: 2050312117700301.
27. Gomes D, Placido AI, Mó R, et al.: Daily Medication Management and Adherence in the Polymedicated Elderly: A Cross-Sectional Study in Portugal. Int J Env Res Pub He 2019; 17(1).
28. Wurmbach VS, Schmidt SJ, Lampert A, et al.: Correction to: Prevalence and patient-rated relevance of complexity factors in medication regimens of community dwelling patients with polypharmacy. Eur J Clin Pharmacol 2022; 78(8): 1363.
29. Wurmbach VS, Schmidt SJ, Lampert A, et al.: HIOPP-6 - a pilot study on the evaluation of an electronic tool to assess and reduce the complexity of drug treatment considering patients' views. BMC Prim Care 2022; 23(1): 164.
30. Park MS, Patel MM, Sarezky D, et al.: Inter-Rater Agreement in the Assessment of Video Recordings of Eye Drop Instillation by Glaucoma Patients. PLoS One 2016; 11(1): e0145764.

Danksagung

Ich danke Prof. Dr. med. Helmut Frohnhofen für die Idee zum Thema und die hervorragende Betreuung und Unterstützung während des gesamten Projektes. Ich danke Frau Dr. rer. nat. Janine Gronewold für die exzellente Unterstützung besonders bei der Verfassung der Publikationen und Univ.-Prof. Dr. med. Stefan Wilm für die offizielle Betreuung meiner Arbeit. Außerdem danke ich allen weiteren Koautoren für die konstruktive Kritik und meiner Chefin Frau Dr. rer. nat. Christina Westhoff für die Möglichkeit zur Umsetzung meines Promotionsvorhabens.

Ich möchte mich für die finanzielle Unterstützung bei der Paul-Kuth-Stiftung bedanken.

Privat danke ich meiner Familie und meinem Mann für die Unterstützung und Befürwortung meines Promotionsvorhabens.