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Targeting complexity of geriatric emergency department visitors: Comprehensiveness in a high-paced and efficiency-focused medical setting

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Widmung

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Abbreviations

APOP *Acutely Presenting Older Patient*

CFS *Clinical Frailty Scale*

CGA *comprehensive geriatric assessment*

COVID-19 *Coronavirus Disease 2019*

ED *emergency department*

EQ5D-5L *European Quality of Life-5 Dimensions*

GEDI *Geriatric Emergency Department Intervention*

GVV *Geriatrischer Versorgungsverbund*

HRQOL *health-related quality of life*

INKA *Interdisziplinäre Notfall- und Kurzliegeraufnahmestation*

ISAR *Identification of Seniors at Risk*

LOS *lengh of stay*

MPI *Multidimensional Prognostic Index*

NRW *North Rhine-Westphalia*

QI *quality indicators*

QOL *quality of life*

Sars-Cov-2 *Severe Acute Respiratory Syndrome-Corona Virus 2*

WHO *World Health Organization*

1. Deutsche Zusammenfassung

Die Notaufnahme ist weltweit eine der wichtigsten Zugänge zum Gesundheitssystem und ein Knotenpunkt zwischen ambulanter und stationärer Versorgung.[1] Viele Notaufnahmen in Deutschland beobachten einen Anstieg der Fallzahlen in den letzten Jahren bis hin zu Überfüllungen.[2-4] Zusätzlich wird eine Zunahme des Anteils älterer Menschen erwartet, welche eine hohe klinische Komplexität besitzen und vermehrten medizinischen und pflegerischen Aufwand benötigen.[5] Verstärkt durch den demographischen Wandel kann es in den nächsten Jahrzenten zu einer signifikanten Verschiebung der Altersstruktur im deutschen Gesundheitssystem kommen, wodurch vor allem die Notaufnahmen als intersektorale Knotenpunkte besonders betroffen sein können.[6]

Nach Gruneir et al. sind ältere Menschen eine besonders vulnerable Gruppe mit einem im Vergleich zu jüngeren Altersgruppen erhöhten Risiko für klinische Komplikationen.[7] Sie erreichen die Notaufnahme häufig mit einer hohen klinischen Dringlichkeit, haben längere Liegezeiten und werden häufiger hospitalisiert. Die hohe Prävalenz an atypischen Symptomen, Multimorbidität, Polypharmazie, neuropsychiatrischen und kognitiven Einschränkungen erschweren Anamnese, Diagnostik und Therapie in der Notaufnahme.[8] Mit ihrer klinischen Komplexität, speziellen Bedürfnissen und einem hohem Versorgungsaufwand passen sie schlecht in dieses hektische und effizienz-basierte Setting. Jedoch ist das Alter kein alleiniges Kriterium für ein erhöhtes Risiko für klinische Komplikationen. Hierzu gehört nach der häufigsten Definition auch eine gleichzeitig bestehende „geriatrietypische“ Multimorbidität, sowie eine erhöhte klinische Vulnerabilität aufgrund von chronischen Erkrankungen oder dem Risiko eines Autonomieverlustes im Alltag.[9] Davon sind jedoch nicht alle Menschen im Alter gleichermaßen betroffen.

Der Alterungsprozess vollzieht sich individuell unterschiedlich und wird durch eine Vielzahl von komplexen, mehrschichtigen Altersprozessen verursacht, welche stark von Genetik, Lebensverläufen und soziokulturellen Hintergründen beeinflusst werden.[10] Eine ungleiche Degeneration von molekularen, zellulären und physiologischen Organsystemen beeinflusst mit steigendem Lebensalter zunehmend, individuell unterschiedlich und in ihrer klinischen Ausprägung dynamisch die homöostatischen Systeme des Körpers.[10,11]

Gebrechlichkeit (Frailty) kann als pathologische Manifestation dieser Alterungsprozesse angesehen werden.[10,12,13] Sie zeichnet sich durch eine dynamisch erhöhte Vulnerabilität gegenüber niedrig-gradigen intrinsischen und extrinsischen Stressoren und eine verschlechterte klinischen Prognose aus.[10,14] Erste Konzepte definieren Gebrechlichkeit als Phänotyp oder Kontinuum, während ein neuer Ansatz ein vielschichtiges und multidimensionales Konstrukt beschreibt, welches den Eigenschaften des allgemeinen Alterungsprozesses ähnelt.[12] Weitere Faktoren, welche die erhöhte klinische Komplexität

ausmachen, sind geriatrische Syndrome. Sie zeigen sich in einer limitierten Anzahl klinischer Bilder, wie beispielsweise Delir, Stürze, Immobilität, Inkontinenz und Mangelernährung, welche jedoch Endpunkte unterschiedlicher und individueller physiologischer Prozesse sein können und meistens organübergreifende Auslöser haben.[15] Die Diagnostik und Therapie geriatrischer Syndrome ist besonders in der Notaufnahme aufwändig, da diese durch ihre komplexen Ursachen nicht in organzentrierte Krankheitsmodelle passen.[16] Auch sozioökonomische Einflüsse wie Armut, Bildungsstand, Vernachlässigung und Isolation führen zu einer erhöhen klinischen Komplexität und Gebrechlichkeit, welche in einer Notaufnahme nur schwer evaluiert und angesprochen werden können.[17-19]

Bei der geriatrischen Versorgung in der Notaufnahme besteht die Herausforderung, neben der Identifikation von lebensbedrohlichen Krankheiten der oben genannten klinischen Komplexität gerecht zu werden. Eine Notwendigkeit ist hierbei ein effektives Screening von Risikopersonen, welche von umfangreicheren und zeitaufwendigeren Assessments profitieren könnten. Die in vielen Notaufnahmen übliche und weit verbreitete Klassifikation durch Triage Systeme kommt bei älteren Menschen an ihre Grenzen.[20-23] Um diese Lücke zu schließen, entstanden in den letzten Jahren eine Vielzahl an geriatrischen Screening-Instrumenten, um Gebrechlichkeit und klinische Vulnerabilität zu identifizieren.[24,25] Diese zeigten jedoch in Metaanalysen eine eingeschränkte Effektivität im Kontext einer Notaufnahme.[26,27] Der Identification of Seniors at Risk (ISAR) Score ist einer der am häufigsten genutzten geriatrischen Screening Instrumente in Deutschland und wird von mehreren Fachgesellschaften empfohlen.[28,29] Metaanalysen konnten zeigen, dass der ISAR Score im Vergleich zu anderen Screening Instrumenten eine hohe Sensitivität, jedoch auch eine niedrige Spezifität besitzt und nur mäßig eine schlechtes Behandlungsergebnis prognostizieren kann.[30-32] Der Multidimensionale Prognostische Index (MPI) wurde schon in zahlreichen Settings erprobt und könnte eine Alternative für das Setting einer Notaufnahme sein.[24,33] Entwickelt wurde dieses Instrument auf der Basis eines umfangreichen Geriatrischen Assessments (comprehensive geriatric assessment, CGA).[34] Das CGA ist ein multidimensionales und interdisziplinäres Assessment, welches standardisierte diagnostische Verfahren nutzt, den Schwerpunkt jedoch auf personenbezogene Faktoren wie Lebensqualität, Prognose und Ressourcen setzt, um einen individuellen und holistischen Therapieplan zu entwickeln.[35] Der MPI kann auf dieser Grundlage mehrere Dimensionen der Gesundheit abdecken und in der Prognoseberechnung der klinischen Komplexität in der Altersmedizin gerecht werden.[36]

Eine wichtige Dimension von Gesundheit ist die Lebensqualität, welche in diesem Kontext als gesundheitsbezogene Lebensqualität bezeichnet wird.[37] Sie spielt eine wichtige Rolle in der Behandlung von chronischen Erkrankungen und ist deshalb auch bei patientenbezogenen Behandlungskonzepten in der Altersmedizin sehr relevant.[38,39] Studien konnten zeigen, dass

die Lebensqualität von älteren Menschen stark von ihrem Gesundheitszustand abhängt.[39-42] Besonders geriatrische Syndrome wie der Verlust von Alltagsfunktionen,[43-45] kognitive Einschränkungen,[46] Instabilität,[47] Inkontinenz,[48] Schmerzen,[49] Fehlernährung,[50] und soziale Isolation[51] sind mit einer verringerten gesundheitsbezogenen Lebensqualität assoziiert.

Die dieser Dissertationsschrift zugrundeliegende Publikation von Rarek et al. konnte zeigen, dass der MPI als multidimensionales Prognoseinstrument auch mit der gesundheitsbezogenen Lebensqualität bei Aufnahme und bis zu 6 Monaten später assoziiert ist.[52] Dies erweitert die Multidimensionalität dieses Instrumentes um eine weitere patientenzentrierte Ebene. Eine verstärkte Aufmerksamkeit auf Zusammenhänge zwischen patientenbezogenen Outcome-Faktoren und klinischer Prognose könnte dabei helfen, den holistischen Ansatz von geriatrischen Assessments und Zuteilungsentscheidungen in der Notaufnahme zu verbessern.

Wie kann ein CGA oder Anteile davon in die Abläufe einer Notaufnahme integriert werden, um die Identifizierung und das Management von älteren Risikogruppen zu verbessern? Viele unterschiedliche Konzepte wurden in den letzten Jahren in den USA erprobt.[53] Evidenzbasierte Leitlinien empfehlen zum einen die geriatrische Weiterbildung des Personals und eine strukturelle Anpassung von Protokollen und Prozeduren, um den Bedürfnissen älterer Menschen gerecht zu werden.[54,55] Die Studienlage über die beste Strategie zur Implementation eines CGA in die Routineabläufe einer Notaufnahme ist jedoch uneindeutig und die Evidenz aufgrund unterschiedlicher Herangehensweisen und Settings unzureichend.[27,56]

Es existieren bereits erste Konzepte, wie die geriatrische Behandlung auch in deutschen Notaufnahmen verbessert werden kann. Eine Maßnahme zur strukturellen Verbesserung der geriatrischen Versorgung in Deutschland ist die Implementierung eines „Geriatrischen Versorgungsverbundes“ aus spezialisierten geriatrischen Stationen oder Krankenhäusern und zuteilende Strukturen wie Notaufnahmen und allgemeinmedizinischen Praxen.[57,58] Eine wichtige Voraussetzung ist die Identifizierung von einem geriatrischem Versorgungbedarf zu einem frühen Zeitpunkt in der klinischen Behandlung, idealerweise in der Notaufnahme. Hierfür wird in Deutschland bisher nur der ISAR Score empfohlen,[28,59] welcher jedoch bezüglich seiner klinischen Effizienz im Kontext einer Notaufnahme umstritten ist.[26,31,32,60,61] Weitere Screening Werkzeuge, welche entweder in Kombination oder als Alternative genutzt werden können, werden aktuell evaluiert. Zu nennen wären diesbezüglich der MPI oder der in Deutschland entwickelte „Geriatrie Check“.[62,63] Strukturelle Konzepte wie die „Interdisziplinäre Notfall- und Kurzaufnahmestation“ in Hamburg,[64] oder das „Acutely Presenting Older Patient Screening Programm“ in den Niederlanden,[65] sind an die amerikanischen Empfehlungen angelehnt und können Beispiele für die zukünftige geriatrische Notfallversorgung in Deutschland sein. Die Anpassung von Notaufnahmen an die Komplexität und die Bedürfnisse

einer alternden Gesellschaft wird für das Gesundheitssystem eine große Herausforderung darstellen.

Der weltweite Ausbruch der Coronavirus Disease 2019 (COVID-19) Pandemie bedrohte die Gesundheitssysteme zahlreicher Nationen und zum Zeitpunkt der Veröffentlichung dieser Arbeit ist noch kein Ende absehbar.[66] Viele Aspekte und Herausforderungen der geriatrischen Versorgung können mithilfe der neusten Forschungsergebnisse über die COVID-19 Pandemie dargestellt werden. Ältere Menschen sind aufgrund von Multimorbidität und Gebrechlichkeit[67,68] in einem hohen Maße von einem schweren Krankheitsverlauf sowie einer höheren Mortalität betroffen.[69-73]. Durch den Hintergrund von Pandemiebedingter Ressourcenknappheit von Behandlungsplätzen bekommt ein effektives Risiko-Screening von Personen in der Notaufnahme mit und ohne COVID-19 eine stärkere Bedeutung. Die „Clinical Frailty Scale“ wurde als Instrument zu einem frühen Zeitpunkt von europäischen Fachgesellschaften empfohlen.[74-76] Neuste Studien zeigen auch für den MPI eine effektive Prognoseberechnung im Kontext einer COVID-19 Erkrankung.[77] Unabhängig von den genutzten Instrumenten sollte ein Risiko-Screening zu einem frühen Zeitpunkt erfolgen, idealerweise schon in der Notaufnahme.[74] Deren zentrale Rolle in der Zuteilung wurde durch die COVID-19 Pandemie zusätzlich verstärkt.
Notaufnahmen in Deutschland zeigten im Jahr 2020 eine gute Anpassung an die Anforderungen der Pandemie.[78] Interessanterweise zeigte sich ein allgemeiner Rückgang der Fallzahlen in Notaufnahmen mit sowohl traumatischen als auch atraumatischen Diagnosen, wie beispielsweise Herzinfarkte und Schlaganfälle.[79,80] Die Angst vor einer COVID-19 Infektion, sowie eingeschränkter Kontakt zu Angehörigen könnte viele Menschen mit milden und mittelschweren Symptomen von einer Vorstellung abgehalten haben.[79,81] Dies sollte in Hinblick auf die Versorgung chronischer Erkrankungen mit Sorge betrachtet werden. Durch eine fehlende Therapie könnten diese aggravieren und die Prävalenz von Multimorbidität, Gebrechlichkeit und Pflegebedürftigkeit in naher Zukunft erhöhen.

Die COVID-19 Pandemie zeigte auch einen negativen Einfluss auf die gesundheitsbezogene Lebensqualität, beispielsweise aufgrund von Angst vor einer Infektion, dem Verlust von Angehörigen, Einsamkeit bedingt durch Isolierungsmaßnahmen und Zukunftsängsten.[82,83] Insgesamt zeigen erste Studien, dass ältere Menschen im Durchschnitt jedoch weniger von einer Reduktion der gesundheitsbezogenen Lebensqualität betroffen zu sein scheinen als Jüngere.[84,85] Einen Einfluss auf die gesundheitsbezogene Lebensqualität könnte auch die Entwicklung von post-COVID-19 Symptomen haben.[86,87] Da schwere Verläufe von COVID-19 das Risiko für Spätfolgen erhöhen, könnten ältere und vulnerable Menschen stärker von chronischen Symptomen betroffen sein.[67,71,88] Erste Studien zeigen, dass post-COVID-19 Symptome mit einer signifikanten Reduktion der gesundheitsbezogenen Lebensqualität

assoziiert sind.[89,90] Dies zeigt, dass die Pandemie auch langfristige Folgen für die Lebensqualität älterer Menschen haben kann.

Zusammengefasst stellt die Pandemie eine große Herausforderung für die aktuelle und zukünftige Gesundheitsversorgung dar, insbesondere von älteren und vulnerablen Menschen. Wenn man Gebrechlichkeit als Endpunkt multifaktorieller Degeneration von Organsystemen beschreibt, dann könnte eine Infektion mit COVID-19 als Beschleuniger des Alterungsprozesses wirken und die Prävalenz dessen erhöhen.[12] Dies könnte auch einen starken Einfluss auf den demographischen Wandel haben. Dessen Implikationen für das Gesundheitssystem liegen nicht nur an der reinen Anzahl älterer Menschen, sondern vor allem an der Prävalenz von Multimorbidität, Gebrechlichkeit und Pflegebedürftigkeit.

Die Notaufnahme befindet sich als Knotenpunkt in der Gesundheitsversorgung an der Front der aktuellen und zukünftigen Herausforderungen des Gesundheitssystems. Die effektive Identifikation von Gebrechlichkeit und Vulnerabilität, die strukturelle Umwandlung zu Geriatrie-freundlichen Notaufnahmen und ein verbesserter Informationsaustausch von ambulanten und stationären Einrichtungen sind im Angesicht des demographischen Wandels wichtige Ansätze, um eine adäquate geriatrische Versorgung zu gewährleisten. Die Reduktion von Hospitalisierung und Aufrechterhaltung der Autonomie im Lebensalltag könnten nicht nur das klinische Outcome, sondern auch die gesundheitsbezogene Lebensqualität verbessern. Die dieser Dissertationsschrift zugrundeliegende Publikation konnte darstellen, dass der MPI im Setting einer Notaufnahme eingesetzt werden kann, um die Komplexität und die Prognose von älteren Menschen anzubilden.[52] Die Assoziationen mit der gesundheitsbezogenen Lebensqualität könnte die Aufmerksamkeit bezüglich patientenbezogener Outcome Faktoren in der geriatrischen Versorgung zusätzlich stärken. Diese könnten im besonderen Maße von Therapieansätzen profitieren, welche die Funktionalität, Symptomreduktion und eine Verbesserung der Lebensqualität ansprechen. Schlussendlich könnte dies den Ansatz für holistische und patientenbezogene Zuteilungs- und Behandlungskonzepte in den zukünftigen Notaufnahmen stärken.

2. Summary

The emergency department (ED) is one of the most important access points to medical care worldwide and a central link between out- and inpatient care.[1] The demographic development is predicted to change the age distribution of patients in the German health system over the next few decades which could strongly affect the ED as a multidisciplinary centre of the health system.[4,6] Many EDs in Germany have already observed an increase in the number of older and clinically complex patients that bind more resources and personnel capacities.[91] Geriatric patients in the ED are a particularly vulnerable group with an increased risk of clinical complications compared to younger age groups.[7] The higher prevalence of frailty, atypical symptoms, multimorbidity, polypharmacy, neuropsychiatric and cognitive impairments impede fast diagnosis and therapy.[8]

The integration of an elaborate and time-consuming assessment of older patients in an otherwise fast-paced and efficiency-driven environment is a major challenge of present-day and future EDs. Therefore, an effective screening for older patients who would benefit from further evaluation will be paramount. Common standardized triage systems of EDs[20-23] or existing screening instruments like the Identification of Seniors at Risk (ISAR) score[29] show major difficulties in effectively identifying vulnerable older patients.[30-32,60,61] The Multidimensional Prognostic Index (MPI),[33] which is based on a comprehensive geriatric assessment (CGA),[34] has already been tested in numerous settings and might be an alternative to grasp the complexity of older ED patients.[24,36]

An important but rarely evaluated clinical outcome parameter is health-related quality of life (HRQOL).[37] It is a central component of patient-related treatment concepts and plays a crucial role in the care for geriatric patients.[38,39] Existing literature shows a strong influence of the health status on HRQOL of older people.[39-42] The results of the study by Rarek et al., on which this thesis is based upon, were able to show that the HRQOL of geriatric ED patients is significantly associated with clinical prognosis at ED admission and up to 6 months after.[52] Attention to the association between patient-related outcome factors such as HRQOL and objective clinical prognosis can improve a holistic approach for allocation decisions in future concepts of geriatric ED care.

Various innovative concepts for the improvement of detection and management of geriatric and patients in the ED have been tested and evaluated in the USA in recent years.[27,53,56] The initial experience about advantages and disadvantages of approaches that were tested can help to create adapted concepts for the German health care system. First responses to the increasing number of geriatric patients already exist in Germany and range from new screening tools[62,63] to specialized ED units[64] and an improved linking of different health care providers.[59] Adapting EDs to the complexities and needs of geriatric patients will be a major challenge in an aging society.

The global outbreak of the Coronavirus Disease 2019 (COVID-19) pandemic has threatened the health systems of numerous nations and at the time of this publication, the end is still unforeseeable.[66] Many aspects and challenges of the complexity in geriatric patients in clinical practice have been illustrated by the impact of the pandemic on geriatric care. Older, multimorbid and frail patients are particularly affected by this disease due to an increased risk of a severe course of disease and higher mortality.[69-73] The need to effectively identify vulnerable patients in the ED with a poor clinical prognosis has become more important due to the pandemic-related scarcity of resources. In addition, it has been observed that the COVID-19 pandemic had a negative impact on HRQOL[89,90] of older people and the treatment of chronic illnesses.[79,80] Given that geriatric patients have a higher risk for the development of chronic remnants of COVID-19, the pandemic could have unforeseeable influence on future health of the aging society.[67,71,88]

In the face of demographic changes, present and future challenges for health systems, effective identification and management of frail and vulnerable patients in the ED and structural changes to obtain geriatric-friendly EDs are important steps to guarantee adequate geriatric care and improve the clinical outcome as well as HRQOL.

3. Introduction

3.1 The Emergency Department

3.1.1. Structure in Germany

Worldwide, the ED is a major access point of patients to medical care beside primary care providers.[1] It is one of three pillars of emergency care in Germany in addition to the ambulance service and the "Kassenärztlicher Bereitschaftsdienst", a standby duty often carried out by medical practitioners in private practice.[2] As a link between inpatient and outpatient care, the ED has a key role in the emergency service, ambulatory treatment and transition to hospital care.[92-94] Until the millennial change, emergency care in Germany was dominated by preclinical care and structures.[95] The implementation of interdisciplinary and independent EDs in Germany has therefore been a recent development in comparison to Anglo-Saxon and Scandinavian health care systems.[96] Without the distinct speciality of an emergency medicine physician, the "Zentrale Notaufnahme (central emergency ward)" in Germany turned into an important link for the treatment and allocation of in- and outpatients with acute medical conditions. [92,93] It is usually organizationally and spatially independent from the hospital with a distinct directorship and offers interdisciplinary medical care by assigned physicians from major specialties like internal medicine and surgery and the possibility of consultations from other departments.[95] Official data on the number and variety of structures of EDs in Germany is lacking, but it has been estimated that 70% of hospitals offered emergency service via a central emergency wards in 2010.[97]

3.1.2. General Data on ED visitors

Valid and comprehensive data on medical care and the demographic attributes of German ED visitors is limited as well. Due to decentralized care structures and non-uniform accounting systems, providing a precise and up-to-date overview is difficult. [3,98] A report by Stillfried and colleagues quantified the numbers of cases in German EDs by 17 million in 2015, with half of them being admitted to stationary care.[99] This number is, however, criticized for being inaccurate and too small by neglecting self-pay patients and multiple visits in an accounting period. [100,101] Nonetheless, many studies indicate an increment of inpatients and ED visitors over the last years. [2-4] This increment also seems to be higher than the European average.[102] Several potential reasons for this development have been hypothesized, including a lack of knowledge in patients about alternative emergency services, reduced capacities of primary care providers and a quicker and broader range of diagnostic procedures available 24 hours a day in a hospital that might motivate patients to choose the ED.[2,103]

A consequence of this development is the overcrowding of EDs in Germany.[103] The simultaneous treatment of patients in life-and-death situations and patients with minor urgency

intensifies the workload and impedes decision-making of physicians in the ED. Given that working in the ED is part of the specialist training, assistant physicians often have little clinical experience and the presence of trained supervisors is not always a matter of course.[104,105] This aggravates the pressure on timely and accurate diagnostic protocols, decision-making and treatment algorithms in the ED for patients in general, but particularly for a vulnerable and multimorbid group that is projected to increase drastically over the next decades: older patients.

3.2 Demographic development

Exceptional progression in medicine and the average increase of wealth over the last century have led to extended longevity and declining fertility rates.[106] This is prognosed to lead to a demographic shift. The amount of people worldwide aged 80 and older are predicted to triple from today until 2050. [107] This development could lead to an increment of older patients with a rising challenge for healthcare systems.

3.2.1. Data for Germany

The “Statistical Offices of the Federation and the Länder” published a booklet on the impact of the demographic change on inpatient treatment for the next decades in Germany.[5] The authors calculated an increase of 34.5% of people aged 60 and above until 2030. The amount of people older than 60 in the population will increase from approximately 25% in 2009 to 37% in 2030 and 40% in 2050. The age group of 80 to 90 years will eventually increase by 34,8% (2030) and 116,2% (2050) and the group of older than 90 years by 211% (2030) and 386% (2050). These increasing groups will likely affect the future inpatient structure of hospitals. Already, nearly 50% of all inpatients in the year 2015 were older than 60 years and this number is predicted by the department to rise up to 60% until 2030.[5,108] Furthermore, the authors estimated an increase of inpatients in German hospitals of 8% in total till 2030.[5]

3.2.2. International perspective

Many countries in the EU share the same demographical development. The amount of people in the EU aged 65 or above in relation to those aged 15 to 64 will increase from nearly 30% today to 50% by 2060.[109] Van den Heede et al. developed a projection model to estimate the impact of ageing on hospital capacity for the next decades in Belgium.[6] They predicted an increase of the demand on hospital beds for geriatric patients and a shift of the hospital structure towards more geriatric and chronic care units. A model of accelerated ageing estimated a 50% increase of inpatient stays till 2025 with the peak of this development being predicted from 2030 onwards. The authors anticipated a shortening of the length of stay (LOS) as an economic response to this development. However, a higher turnover of inpatients might be at the expense of older patients who are at higher risk of prolonged hospital stay.[110] An increment of hospital cases and decrement of the length of stay has already been observed in

Germany. The number of inpatients in hospitals increased about 13.6% and the average LOS decreased from 8.7 to 7.5 days from 2005 to 2013.[111]

Schulz and colleagues anticipated that patients aged 70 and older would be responsible for around 50% of all hospital days in Germany in 2050, calling for a reorganisation of hospital landscapes.[112] This trend will meet a progressing shortage of healthcare workers in Germany, leading to a gap in medical and care treatment.[113] Another predicted trend of decreasing primary care providers could reduce the options for outpatient care, thereby aggravating the pressure on stationary healthcare systems even more.[114]

The expected higher demand on hospital beds and decrement of primary care provider in Germany could lead to an increment of older patients in the ED and might become a challenge for future EDs.

3.3 Older patients in the ED

3.3.1. Characteristics

Older patients tend to be a more vulnerable group than younger persons. A systematic literature review by Gruneir et al. summarized characteristics of older ED patients.[7] They tend to arrive two to four times more often by ambulance and present with more clinical acute conditions. One third to half of all older ED patients ends up being hospitalized. Their LOS in the ED is 19-58% longer than that of younger patients, pooling resources and personnel time.

3.3.2. Clinical appearance

Furthermore, the older patients' reasons for seeking an ED are different from other age groups. While younger patients tend to present surgical complaints or accidents, older patients often seek the ED with complex medical complaints that are not always obvious and easy to overlook for nurses and physicians.[7] Samaras et al. summarized the most common conditions of older patients in the ED and illustrated that those often occur with atypical disease presentation and a multicausal aetiology.[8] Functional decline, frailty and polypharmacy often add complexity to diagnostic assessments and treatment strategies. The authors pointed out that additionally, common neuropsychiatric disorders like delirium, dementia and depression could likewise affect the ED presentation negatively. Cognitive and sensorial impairments like sight loss or reduced hearing capacity can impede the communication and anamnesis, particularly if relatives or caregivers are absent.[115,116] Despite their importance in clinical outcomes, those syndromes are often undetected or, if assessed, not documented.[117] A systematic meta-analysis has shown that dominant risk factors for prolonged LOS, mortality and discharge destination are mainly geriatric syndromes that represent the functional capacity and cognitive status instead of routinely collected information like age, gender or diagnosis.[118]

3.3.3. Risk for adverse events

The complexity of conditions often results in a broad usage of diagnostic procedures, leading to diagnoses that tend to be less accurate compared to those of younger patients.[117,119] This can lead to unrecognized health issues, suboptimal treatment and medication upon discharge and eventually, a return to the ED.[117,120] Every fourth older ED visitor seems to return to the ED or is hospitalized within three months, while the mortality averages out to 10%.[119] Furthermore, older patients are at risk of developing increasing functional dependence three months after an ED visit.[119] These findings support the evidence that older emergency patients should be considered as high-risk patients in unprepared EDs.[8,119,121,122] But a high age alone should not be acknowledged as high-risk per se. The heterogeneity of ageing caused by genetics, individual life-courses and social and cultural backgrounds can lead to a broad variety of clinical appearances and prognoses.[123] The detection of vulnerable geriatric patients is therefore a major challenge of today´s and future EDs.

3.3.4. Age distribution in German EDs

There is only limited data on the age distribution of the patients in German EDs. The workgroup "Der ältere Patient in der Notfallmedizin" of the "Deutsche Gesellschaft für Interdisziplinäre Notfall- und Akutmedizin (DGINA)" carried out a non-representative survey on their members regarding geriatric care and age distribution between 2010 and 2013 in 30 EDs nationwide.[91] The median percentage of patients aged 70 and more was 30%. A single-centred study on 14 EDs in Munich numbered the percentage of patents aged 65 years and above with 26.7%.[124]

The influence of the demographic development on the characteristics of ED patients has been observed in the last years. Groening et al. identified an unbalanced increment in the number of patients classified by their age.[91] The biggest growth in absolute numbers was observed in patients aged 70 to 79, followed by the age group of 30 to 39. The age groups of 80 to 89 and 90+ had a smaller increment in absolute numbers, but the 90+ group had the highest percentage growth by 21%; followed by the age group of 30 to 39 (20.4%). However, the age group of 90+ was perceived to be the one with the highest increment in absolute numbers by the ED physicians who responded to the survey. The authors attributed this to a stronger perception of this group in clinical day life because of a higher effort of care.

An observed increment of the demands on ambulant emergency care speaks in favour of this growth in the number of older patients with emergency care demands. A study by Veser et al. for the federal state of Bavaria evaluated that 33% of all emergency ambulance usages in 2012 were caused by people aged 75 years and above.[125] They furthermore predicted an increase of ambulance usages by 21% from 2012 to 2032.

This change in the age distribution of ED visitors does not happen exclusively in Germany. An international analysis of Berchet et al. evaluated that patients older than 65 represented about 20% of all ED visitors in 2012 in Australia, Canada and England, about 38% in Switzerland

and nearly 50% in the US.[102] Studies in the US and Switzerland likewise observed an increase of ED visits influenced by the demographic development.[1,126]

3.4 Clinical complexity of geriatric patients

3.4.1. Definition of the geriatric patient

The “Deutsche Gesellschaft für Geriatrie” and “Deutsche Gesellschaft für Gerontologie und Geriatrie“, in cooperation with the “Bundesarbeitsgemeinschaft Geriatrischer Einrichtungen“ defined a geriatric patient as someone who presents with higher age and a geriatric-typical multimorbidity (≥ 70 years) or elevated vulnerability (≥ 80 years) caused by the risk of chronification or loss of autonomy.[9] According to the authors, the attention should hereby focus on the multimorbidity and complexity rather than age alone. Onder and Vetrano describe multimorbidity as the “co-occurrence of several diseases in the same person regardless of main clinic entity”.[127] The concurrence of various chronic diseases and the related prescription of multiple medications does not only influence clinical symptoms and treatment options but impedes clinical assessment especially in the ED where time and personnel resources are strained. Next to age, the second aspect in this definition of a geriatric patient is an increased vulnerability towards adverse clinical outcomes like a chronic manifestation or loss of autonomy. There are several reasons for geriatric patients being more vulnerable than other patient groups.[127] Many of these factors are associated with complex physiological changes that are associated with the ageing process. They overlap one another, influence themself and are not easy to distinguish in clinical context.

3.4.2. Complexity of biological ageing processes

Ageing is a complex biological phenomenon affecting an individual on various levels: molecular, cellular, physiological and psycho-social.[10] It is to a lesser extent a biological programmed finiteness, but rather the accumulation of time-dependent cellular damage resulting in a decline of physiological functionality due to a limited capacity in preservation and protection against intrinsic and extrinsic stressors.[128] A model of biological ageing by López-Otín and colleagues describes the biological hallmarks of ageing from microscopic to macroscopic changes.[11] Various extrinsic and intrinsic physical (e.g. ultraviolet and gamma radiation), chemical (e.g. oxygen-free radicals) and biological (e.g. viruses and bacteria) agents lead to damage of the deoxyribonucleic acid, mitochondrial mutations, telomere loss, epigenetic alteration and defective proteostasis.[11,129] These deteriorations accumulate over time and eventually overexert downstream protecting mechanisms like mitochondrial functioning, nutrient sensing for metabolic regulation and cellular senescence controlling cell cycles.[11] The failure of these systems accumulates the damage on cellular level, causing disturbed intercellular communication and stem cell proliferation which ultimately affects tissue homeostasis and macroscopic functionality.

This development does not affect all cells in an organ evenly, which leads to the coexisting of damaged and functional, undamaged cells.[10] At first, the organ system continues to function but experiences a progressive reduction of physiological capacity and resilience. Fulop and colleagues called this a "*mosaic*" progression resulting into dynamic and heterogeneous manifestations.[10] The complexity of an individual's ageing process can be assigned on a continuum between two poles of "successful" and "pathologic" ageing, depending on the reserve capacity and resilience of physiological systems. Individual factors like genetic variability, accumulated diseases, environment, lifestyle and nutrition might have an important influence on the assignment on this scale. Frailty might be considered as a clinically apparent and pathological manifestation of a normal ageing process.[10,12,13]

3.4.3. Frailty

Frailty describes a state of vulnerability caused by a life-long cumulated decline of various physiological systems leading to reduced resistance towards low-power extrinsic stressors.[14] It is a multidimensional concept with dynamic states and an extreme consequence of normal ageing.[13] Frailty is furthermore associated with multiple adverse outcomes like fall,[130] hospitalization,[131] institutionalization to long term care,[132] cognitive impairment,[133,134] affective disorders,[135] and reduced life expectancy.[136]

3.4.4. Concepts of frailty

There is no global consensus or standardised measurement for frailty and research is based on different concepts and a variety of assessment tools with a wide range of applicability.[137] The most widely used frailty definitions and instruments can be classified into two different approaches:

The first one is based on the frailty phenotype by Fried and colleagues.[138] It is the classification of frailty as a phenotype by certain pre-defined clinical signs or symptoms (for example 3 out of 5) like exhaustion, low activity, weakness, gait speed or unintentional weight loss.[13] This definition of frailty by Fried and colleagues conceptualise frailty as a decline of energetic capabilities and resilience against physiological stressors that manifest in those clinical conditions.[12] This concept has been largely evaluated in clinical and research context, but it is criticized for a lack of the representation of other health dimensions like cognition. In addition, the threshold for some criteria were based on distributions in patients with mainly cardiovascular diseases.[12]

The second approach is the accumulation of various age-related health deficits like symptoms, diseases, disabilities and abnormal clinical tests into an index score measuring frailty as a continuum.[13] This stochastic approach by Rockwood and Mitnitski led to the development of the Frailty index.[139] Although this concept incorporates multiple factors of various organ systems that are a sensitive predictor of adverse outcomes in combination, it treats those

deficits equally which narrows an individual treatment approach and omits the concept of specific biological mechanisms causing frailty.[12] Both approaches of frailty assessment are well validated for different settings and populations and have set the foundation for various frailty instruments.[137]

3.4.5. Frailty as a multidimensional model

A recent approach to frailty as a multi-layered or multidimensional model by Ferrucci et al. adopted the narrative of the aforementioned biological and physiological ageing mechanisms.[12] It describes frailty as a construct with three overlaying dimensions, which can be epitomised by the layers of an onion. The core and first layer contain the biological basis and represents the mechanisms that are hypothesized as the primary causes of frailty. It includes all the aforementioned biomolecular mechanisms that might drive both the ageing and frailty process. The intermediate layer is called “area of biomarkers” and represents descriptive pathophysiological mechanisms of frailty like weakness, energy imbalance, hormone deficit, inflammation, and neurodegeneration. These might be the first manifestations of frailty on a physiological level and represent the reduced reserve and resilience of organ systems with superficially absent clinical signs. The outermost and visible layer includes apparent clinical symptoms of frailty like multimorbidity, functional decline, reduced mobility, cognitive impairment and other geriatric syndromes. According to this model, the clinical manifestations of frailty share no monocausal aetiology but emerge as the common endpoint of declined and dysfunctional processes of the inner layers. Single processes in the core and intermediate layer on their own have low impact on the outer layer, but once a disbalance in multiple systems arises, they become clinically apparent. The model does not emphasise particular processes or biomarkers as being primarily responsible for frailty, but instead describes it as the endpoint of various processes that are closely intertwined and whose clinical manifestations are strongly dependent on individual predispositions, life-style decisions and life-long influences. It is suitable to connect existing theoretical aetiologies of ageing and frailty and can help the understanding of the complexity that lies dormant beneath frailty. A multidimensional approach to the definition of frailty that incorporates the multilayered physiological backgrounds of ageing could speak in favor of acknowledging the significance and complexity of its aetiology.[12]

3.4.6. Prevalence of frailty

Estimating the global prevalence of frailty is difficult due to the differences in definitions and measurement tools. A systematic review on the prevalence of frailty in community dwelling older adults of high-income countries found a pooled average of 10%.[140]. However, the reported range spanned between 4 and 59%, which was explained by the large differences of concepts and measurement techniques. A meta-analysis of the prevalence of frailty in China demonstrated a similar result of 10%[141] and a survey of the World Health Organization (WHO)

showed a higher prevalence in emerging countries like Mexico (30%), Ghana (38%) and India (57%) compared to western societies.[142]

Despite the uncertainty about the prevalence, common patterns of affected patients do exist. Frailty is more often present in women, explained by the longer expected lifespan of women and their lower amount of lean body mass and muscle capacity.[140] Furthermore, ethnic and racial minorities and people with low educational level are affected more often.[19,143] The burden of frailty impacts both the societal level with increased health-care costs[13,144] and the individual level with a higher rate of health care admissions, social deprivation and reduced quality of life (QOL).[145-147]

3.4.7. Clinical presentation of complexity and frailty

But what exactly constitutes the clinical complexity of an older patient with a highly aged or (pre-)frail condition in the setting of an ED? Especially processes in systems with widespread influence like the immunologic-, endocrinal-, metabolic- and vascular-system have massive influence on physiological processes, morbidity and mortality.

“Inflammageing”, an age associated, deregulated, low-grade, chronic and systemic inflammation caused by accumulated imbalances of protective and harming factors drives impairment and pathogenesis in multiple organ systems.[148,149] It induces a catabolic state increasing the risk for vascular diseases, sarcopenia, anaemia, insulin resistance, osteoporosis, reduced neurogenesis and frailty.[149]

Oxidative stress caused by ageing processes, chronic inflammation and lifestyle habits can lead to the development of a metabolic syndrome and insulin resistance, which themselves contribute to the aforementioned ageing processes and are driving factors for diabetes, heart- and vascular diseases.[150-152] A decline in growth hormones, dysregulated inflammation, microvascular changes, lifestyle habits and cellular ageing mechanisms disturb the homeostasis of the skeletal muscle leading to a catabolic metabolism and the development of sarcopenia, which is one of the cornerstones of the phenotype-based definition of frailty.[153] The loss of muscle strength contributes majorly to the decline in functional abilities, falls, fractures, impaired QOL and mortality.[153-155] Ageing processes in the endothelium of blood cells like the reduction of nitrous oxide availability, increment of oxidative stress and the deposition of metabolic products lead to endothelial dysfunction, which impairs the response of blood vessels to haemodynamic changes and damages end-organ capillary in heart, kidney and brain.[156,157] Changes in the flexibility of blood vessels and age-related impairments of the autonomic nervous system amplify conditions with pathological blood pressure like hypertension,[158] or orthostatic hypotension,[159] thus increasing the risk for coronary heart disease, heart failure, cognitive impairment, falls, and death.[160,161]

Cognitive decline is likewise affected by multi-layered processes like genetics, micromolecular ageing processes, inflammation, cardiovascular and metabolic diseases and lifestyle habits.[162]

Like ageing and frailty, it can be conceptualised as a continuum from non-pathologic impairments, “hidden” deficits with superficial inconspicuousness like mild cognitive impairment, to diseases like dementia.[162-165] The clinical manifestation and influence on orientation, communication, anamnestic and therapeutic processes could be dynamic, apparently or inconspicuously.[123] Social-economic aspects like poverty, educational level, neglect and isolation can furthermore influence the aforementioned bio-physiological processes, frailty, preventive and therapeutic potentialities.[17-19]

3.4.8. Geriatric syndromes

The complexity of the ageing process can lead to the development of clinical conditions that do not fit into distinct disease categories: geriatric syndromes.[16] They depict symptoms or a complexity of symptoms that have a high prevalence in older patients but are not exclusively present in higher age groups.[127] Common examples are frailty, delirium, cognitive impairment, fall and instability, incontinence, malnutrition and immobility. Inouye and colleagues described the clinical characteristics of geriatric syndromes: While common clinical syndromes develop from a pattern of symptoms with a single pathogenic pathway, geriatric syndromes emerge from multiple and complex underlying factors that influence each other in their development.[16] The dysfunction of multiple and distant organ systems can result in clinical signs that are not necessarily unambiguous and are therefore more difficult to diagnose. Diagnostic strategies of geriatric syndromes can be burdensome and costly, while treatment options do not necessarily require a detailed clarification of the underlying cause.[16]

Research shows that geriatric syndromes seem to be very frequent in geriatric patients in all care settings.[166] The median number of geriatric syndromes at hospital admission is estimated at 5-6 and nearly every geriatric patient tends to present with at least one.[167-169] They are important risk factors for many adverse health outcomes: hospital LOS,[170,171] discharge delay,[170,172] (re-)hospitalization,[173,174] institutionalization,[172,175] functional decline,[176-178] decrease in QOL[179-181] and mortality.[167] Their impact on these outcomes seem to be greater than age, comorbidity and illness severity.[170] Despite their importance for the patient´s prognosis, there is little knowledge on the assessment and treatment of geriatric syndromes in healthcare providers outside of the geriatric setting.[16]

Geriatric syndromes and frailty are common clinical presentations that arise from the multi-layered complexity of processes that accompany an asymptomatic or pathologic ageing process. Many processes share common pathways and influence each other. This complex multidimensionality of a highly aged or (pre-)frail patient contrasts the still prevalent organ-centred approach in many clinical settings. Patients with a great variety of complaints and needs might be often reduced to a main symptom or main organ illness in the ED due to a lack of time and possibilities to assess the complexity that accompanies an older person. This simplification might be an eligible strategy for ED caretakers who must decide quickly about

the appropriate clinical pathway for a specific patient, but it might “frame” the patient with influence on the subsequent care. This patient could be transferred to a specialized department that offers the best medical care for the organ system affected by the main diagnosis, but which might fail to unveil and address the factors that often drive frailty and lead to hospital (re-) admission if a geriatric co-treatment is overlooked. The screening for frail and vulnerable patients that might profit from further geriatric evaluation is therefore an important need for clinical decision-makers, especially in the high-paced and efficiency-driven setting of the ED.

3.5 Screening for vulnerability in the ED

3.5.1. Triage

A common key element to classify ED patients according to their clinical urgency is the triage. It is commonly assessed by nurses after the patient’s arrival to the ED using a short instrument for early allocation decisions and to establish the clinical priority.[182] The aforementioned rising number of ED visitors and patients with low-urgent complaints has intensified the relevance of effective triage to prevent treatment delay in possible life endangering conditions. However, the most used triage systems like the Manchester Triage System and The Emergency Severity Index show a risk of decreased sensitivity for geriatric patients, which might be explained by the patient’s complexity and the presentation with atypical or nonspecific symptoms.[20-23] There is a need for in-depth screening instruments of geriatric patients that are well-adapted to the setting of an ED.

3.5.2. Frailty screening in the ED

Despite an increase in the development of various frailty instruments over the last decades, the transition from the identification of frailty into clinical practice routine in the special setting of an ED is still limited.[24,25] A large meta-analysis on 34 studies by Carpenter et al. validated seven screening instruments for prognostic accuracy in the ED, with five frailty instruments among them. The authors reported insufficient prognostic accuracy in every examined tool regarding the distinction of high-risk and low-risk geriatric patients.[26] A review by Preston and colleagues on the identification and management strategies of frailty in the ED found scarce and not particularly robust evidence for ED approaches targeting frailty.[27] Existing studies regarding frailty instruments were heterogenous with varying definitions of frailty and ages as inclusion criteria. Only few screening instruments have been validated in a wide range of settings and most of them in the US. Tools were designed for different goals, either the identification or the support in management decision, which impedes comparability. The authors did not recommend a universal tool due to a limited applicability from one health care system (in their case the United Kingdom) to another regarding outcomes like hospital admission and ED readmissions. This might impede the research on screening instruments and the transition of knowledge from one health care system to another. Hence, health care

providers have to find instruments that fit into the specific conditions and characteristics of their system.

3.5.3. The ISAR score

The “Gesellschaften Bundesverband Geriatrie” and “Deutsche Gesellschaft für Gerontologie und Geriatrie” recommended the implementation of the ISAR score as a screening instrument in German EDs in 2012.[28,29] Today, it has become a gold standard for the screening of vulnerable older patients in the German ED.[62] This short and easy-to-conduct questionnaire is based on 6 yes/no questions regarding prior dependency, hospitalization, visual impairment and memory complaints as well as the intake of six or more medications. The presence of two or more items has been shown to predict adverse outcomes like functional decline, institutionalization and death after an ED visit.[29] In the setting of a German ED, the ISAR score predicted death of any cause, recurrent ED visit, hospitalization and institutionalization.[183] However, studies in other countries observed an insufficient predictive ability.[61,184] Warnier and colleagues compared 16 frailty indices conducted at hospital admission and reported that the ISAR score had one of the highest sensitivities but low specificity.[30] Another meta-analysis was conducted by Galvin et al., attributing modest predictive ability for adverse outcomes like unplanned ED readmission, hospitalization and death six months after an ED visit to the ISAR score.[31] Again, the ISAR score showed high sensitivity (> 0.81), yet low specificity (0.26 – 0.38). The authors recommended the usage of a negative ISAR score (< 2 items) to support the decision to discharge low-risk patients from the ED.

A comparison of the ISAR score and two other screening instruments repeated this metric of high sensitivity and low specificity and showed a high false-positive rate of 33%.[32] An evaluation of other adverse outcomes like a decrement on the Barthel Index (BI), the living condition or the German care level showed similar metrics.[62] Additionally, the authors reported that the ISAR score classified 80% of the study population (146 patients older than 70 in the ED of Ulm University Hospital) as geriatric patients, which reflects its low specificity. This pattern was also observed in other studies.[60,185] Although the ISAR score has been shown to identify patients who benefitted from closer geriatric assessment, the low specificity may present a problem in ED routine.[186-188]

3.5.4. Comprehensive Geriatric Assessment

A success story in assessing and keeping track of the complexity of geriatric patients has been the CGA. It is a method to assess a substantial overview of a geriatric patient including medical, psycho-behavioural, social and functional capacity.[35] The emphasis is hereby placed on an interdisciplinary and multidimensional evaluation using standardized instruments with the goal to develop a coordinated and patient-centred short and long term treatment plan.[35] Developed by Warren and colleagues in the 1930s, the CGA has evolved into a cornerstone of geriatric

medicine and the gold standard for the assessment of geriatric patients.[34] It has been demonstrated to improve several health outcomes like mortality, disability and cognitive function of geriatric patients in multiple settings.[189]

Ellis et al. conducted a meta-analysis on the effectiveness of a CGA for older hospital inpatients who were admitted via the ED in comparison to general acute care.[190] Those who received a CGA and were treated in geriatric wards were more likely to survive and live in their own home after twelve months and had a better cognitive status. This was concomitant with no increased costs of care. Subgroup analysis showed that this effect was primarily carried by CGA wards in comparison to CGA consultation teams.

Although CGAs have been successfully implemented in inpatient care, there is insufficient knowledge on the effective implementation of CGAs in the setting of an ED to date.[56,189]

3.5.5. The Multidimensional Prognostic Index

The MPI was developed as an extension of a CGA by Pilotto and colleagues as a prognostic instrument for mortality of hospitalized older patients.[33] It has been established as a common instrument for the assessment of frailty and clinical prognosis in in- and outpatient care.[24,36] The MPI calculates an index with a mathematic algorithm including information from 53 items of eight different domains and instruments that are validated and in clinical usage for CGAs. Functional status is assessed by Katz's Activities of Daily Living[191] and the Lawton's Instrumental Activities of Daily Living,[192] multimorbidity by the Cumulative Illness Rating Scale,[193] cognitive status by the Short Portable Mental Status Questionnaire,[194] mobility and pressure ulcer risk by the Exton-Smith Scale[195] and in addition, social living conditions and the number of prescribes drugs are evaluated. Initially, the MPI was developed by using the Mini Nutritional Assessment for nutritional status,[196] but it was afterwards validated with the shorter Mini Nutritional Assessment Short Form.[197,198]

The MPI transforms the conventional cut-off points from each of those instruments to a single risk score ranging between 0 (lower-risk) and 1 (higher-risk).[33] This score can additionally be divided into three risk groups to support patient classification: low risk MPI-1 (0-0.33), moderate risk MPI-2 (0.34-0.66) and high risk MPI-3 (0.67-1). As a comprehensive tool, the MPI needs more time for administration than simpler screening instruments.[30] It can be completed in 25 to 30min, while the modified version using the Mini Nutritional Assessment Short Form can be conducted in 20 minutes with a comparable degree of accuracy.[30,197] Another modification was made for the self-administrational use as a frailty instrument of community dwelling adult people.[199]

3.5.6. Clinical associations and usage of the MPI

The MPI has been shown to effectively predict hospital mortality, hospital length of stay, institutionalization, rehospitalization, the usage of home care service and mortality one year

after discharge.[200-202] It is furthermore sensitive to the change of health and functional status during a hospital stay even in non-geriatric settings and can be used as a monitor especially in prolonged hospital stays.[203,204] Associations of the MPI index with the use of health care resources in the German health care system after discharge were likewise observed.[205] To date, there are only few studies that have evaluated the MPI in primary care. A study for community dwelling older patients in Germany found an association of higher MPI scores with more adverse outcomes and a higher usage of primary care.[206] A study in Italy observed its usefulness for the identification of older people who are qualified for public disability benefits.[207] The prognostic value of the MPI has been demonstrated in various diseases common in older patients like pneumonia,[208] Clostridium difficile infections,[209] heart and respiratory failure,[210,211] acute intestinal bleeding,[212] chronic kidney disease[213] and dental health.[214] Furthermore, the MPI showed potential for the screening and treatment monitoring of depression in older patients.[215,216]

Its great potential for supporting clinical decision-making in geriatric patients was shown in the European multi-study research project MPI_AGE.[217] In addition, the MPI has been successfully used in evaluating the risk-benefit ratio in the pharmacotherapy of dementia,[218] atrial fibrillation[219] and the usage of statins on diabetes mellitus[220] and coronary heart disease.[221] Furthermore, it has shown to be useful in the selection of older patients who would benefit from invasive treatment options like transcatheter aortic valve implantation[222,223] and enteral tube feeding.[224] Regarding cancer treatment, Sbrana and colleagues found the MPI to be effective in estimating the survival rate of older patients with cancer immunotherapy,[225] while Pata and colleagues evaluated it as a useful tool for the outcome prediction of colorectal surgery.[226]

In comparison with other clinical frailty and prognosis instruments, the MPI demonstrated prominent performance abilities. In a comparison with three other frailty instruments, it showed the highest discriminative ability for predicting mortality of hospitalized older patients after one month and one year.[227] A large systematic review of different prognostic indices on hospital inpatients by Yourman et al. provided evidence that the MPI was a well calibrated instrument with good discriminative ability and performance for one month and one year.[228] It was furthermore the only prognostic instrument which was based on a CGA. Warnier and colleagues compared the MPI with 16 screening instruments for frailty on older patients admitted to the hospital.[30] The MPI showed excellent predictive validity with one of the highest values for sensitivity, the highest specificity for mortality (Area under the curve: 0.71-0.83) and the largest body of evidence regarding the included studies.

3.5.7. The MPI as a geriatric instrument

Taken together, the MPI can be conducted as a multifunctional instrument on different patient groups, medical specialities, and clinical settings. This overall efficiency and adaptability to different settings is rooted in the concept of a CGA. Due to its broad range of items in different

dimensions of health, the MPI also includes the detection of geriatric symptoms.[229] Each instrument included in the MPI algorithm is in itself a field-tested tool to identify frequent geriatric syndromes like functional decline, cognitive impairment and immobility. These syndromes have a large impact on the patient's clinical presentation, pathway in health care and living conditions.[171,172,181] Early identification and treatment can substantially affect the patient's prognosis by reducing functional decline, hospitalization, ambulatory health care utilization and mortality.[167,170,172,173,176,178] An assessment by the MPI might support clinical decision-making of older patients by estimating overall prognosis and revealing geriatric syndromes. Hospitalized older patients could thereby profit from an early assessment that influences the clinical pathway to the appropriate and sustainable treatment.

3.6 Health-related quality of life

3.6.1. Concepts of (health-related) quality of life

The effectiveness of therapeutic strategies is often measured by clinical outcome parameters like illness severity, hospitalization and the utilization of health care. QOL is a relatively young outcome parameter for medical interventions that has gained importance over the last decades.[230] Despite a rapid development of different measurements and the worldwide implementation into medical and health research, the concept and assessment of QOL is being debated to this date with no consensus definition.[231] The WHO defines QOL as "*an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns*".[232] QOL is a complex, multidimensional and dynamic concept with many interacting layers: objective and subjective aspects with dimensions on societal and individual levels.[43] Embedding this concept into medical and health research has resulted in a narrower concept of HRQOL.[37]

In the existing literature, HRQOL is not well defined and most definitions insufficiently distinguish HRQOL from health or QOL.[233] Karimi and Brazier identified four common definitions that are used in the literature. The first definition is based on the subjective evaluation of a person's physical, mental, social and functional wellbeing.[234] The second definition narrows the concept of QOL down to those factors that arise from the perception of health by excluding non-health domains like economic and political circumstances.[235] However, the authors noted that both definitions are difficult to distinguish from the perception of health itself.

A third concept is defined by aspects of QOL that are influenced by health and diseases.[236] According to the authors, the problem of this definition seems to be that it hardly differentiates between QOL and HRQOL, as health could affect many non-health related aspects of QOL like income and social life. The last definition for HRQOL focuses on the value that people assign to their health state's influence on wellbeing.[237] However, as the authors noted, non-

health factors are often considered by participants when evaluating their health states in HRQOL research, which makes this definition dependent on the participant's internalized QOL definition. This shows the existing problem of the conceptualisation of HRQOL and its overlap with health and QOL. Karimi and Brazier suggested to differentiate between the measures of health status and measures of QOL and use the concept of HRQOL to either measure the utility that is associated with health status or the way health status affects QOL.

In general, taking the patient's perception into consideration has gained importance in the evaluation of interventions - especially in long lasting illnesses like in palliative care and geriatric medicine.[38,238] The concept of an intervention with the main goal of total disease remission and the return to a "healthy" state fails in the setting of reduced life expectancy or in the face of severe complexity induced by multimorbidity and frailty with little influence on the underlying diseases. Considering HRQOL in clinical decision-making in older patients provides the opportunity of adding another important dimension of comprehensiveness.

3.6.2. Influence of age on QOL and HRQOL

There is an ongoing debate on the influence of age on wellbeing and QOL. Some researchers proposed a U-shaped association of age and wellbeing through the lifetime with the lowest state of wellbeing in between the individuals' thirties and fifties and an increase with advanced age.[239,240] Gwosdz and colleagues analysed longitudinal data on life satisfaction of older people in Germany and found a similar shape.[241] However, after a correction for cohort effects like the second world war, the results showed a consistent life satisfaction over the lifespan. A review by Ulloa and colleagues about subjective wellbeing and age found similar results but also evidence supporting the U-shape model that implies an increase with advancing age.[242]

The hypothesis behind higher or constant subjective wellbeing with increasing age is the socioemotional selectivity theory. It describes a change in the evaluation of everyday situations and actions in the presence of approaching death towards more awareness of positivity.[243] In this context, the satisfaction paradox of older people is mentioned often. It describes the reportedly high level of subjective life satisfaction with higher age in objectively bad living conditions.[244] However, there is an ongoing debate on the influence of cohort effects on this observation and whether wellbeing generally increases or decreases with age.[245,246] A review on wellbeing and ageing by Steptoe and colleagues described a U-shaped model for high-income anglophone countries, but linear models for other societies like eastern Europe and sub-Saharan states.[38] This shows the great influence of socioeconomic, cultural and historical background on the impact of ageing on QOL and the challenges of QOL research.

3.6.3. Influence of health on QOL and HRQOL

Despite the controversial debate if a “pure” influence of age on wellbeing exists, researchers claim a strong influence of health on wellbeing in higher age. The linear association of age and wellbeing for the German population presented by Gwosdz and colleagues was present till the age of 85.[241] Older age groups experienced a decrease in wellbeing. This observation of differences in the “young-old” and the ”old-old” is supported by other studies as well.[45,245-247] The decrement of wellbeing in the “old-old” is attributed to a perception of worse health. This is not only explained by the higher frequency of illnesses with advancing age, but by an increase of functional impairments and chronic geriatric syndromes that prevent functional autonomy and social participation.[38,44,45] Good functional capacity as well as feelings of independence, usefulness and social participation are highly important factors for QOL in old age.[43,44] This can be shown by a higher value that older people attribute to health and functional autonomy in comparison to younger age groups.[39,40] A great amount of literature shows the strong negative impact of geriatric syndromes on QOL and HRQOL,[41,42] frailty,[145,248] subjective and objective cognitive impairment,[46,249,250] incontinence,[48] pain,[49] malnutrition,[50] fall[47] and social isolation.[51] The effort to preserve functional autonomy and to treat geriatric syndromes should be vital for public health systems to increase HRQOL and provide opportunities for successful ageing.[38,251]

3.6.4. HRQOL in the ED

Research on HRQOL in geriatric patients during an episode of emergency illness is hard to conduct due to time constraints in the ED and the severity of clinical conditions. Consequently, there is sparse literature on HRQOL of older patients during an episode of actual illness visiting an ED. The non-availability of HRQOL ratings prior to ED admission impedes valid results additionally.[252] Chin and colleagues measured HRQOL in older patients during an ED visit asking for current and retrospective perceptions.[253] The self-perceived HRQOL seemed to decrease during the time of the illness and tended to recover after treatment. Interestingly, HRQOL did not recover to baseline levels and patients who reported functional limitations at baseline and received insufficient help in everyday activities were less likely to fully recover to previous HRQOL levels. In contrast, Hall and colleagues observed different results in their study.[254] They conducted a randomised controlled trial to evaluate a transition to home intervention consisting of follow-up monitoring, coaching and counselling by trained health care coaches after the ED visit for older patients. HRQOL was highest for both the intervention and control group receiving usual care at the time of the ED visit and decreased in the days after the encounter. This result was explained by the reassurance and advice regarding the illness episode that participants received as part of the ED visit. The authors hypothesized that the decrement following discharge could have been explained by the return to a setting with limited access to advice and reassurance. Both studies recruited participants during their ED visit, but

they used different measurements of HRQOL. This illustrates the need for further research on HRQOL in the ED and a refined definition of this concept. A qualitative study by Dresden and colleagues on geriatric ED patients evaluated their perception of HRQOL during an ED visit retrospectively.[255] The patients reported concerns about returning to their previous functional status of activity and independence. Stress and anxiety were noted in the presence of uncertainty about recovery and the risk of reduced HRQOL after the episode of illness. Furthermore, patients recognized the influence of physical health on mental health and vice versa and showed a desire for a holistic view on their problems. However, they recognized that an ED had limited capacity to care for those needs. These findings emphasise the importance of functional independence in old age and the impact on HRQOL.

3.6.5. The Euopean Quality of life-5 Dimensions

A well-established value-based instrument in HRQOL research is the European Quality of life-5 Dimensions (EQ5D-5L) by the EuroQOL group.[256] It is available in 138 languages and widely used in HRQOL research and quality of care monitoring.[257] Due to its universally applicable wording, it is useful for research on heterogenic patient groups and non-disease-specific analyses like older patients.[258] It has demonstrated its validity in geriatric populations and geriatric-related diseases.[41,258,259] Furthermore, it showed the best combination of feasibility, reliability and validity compared to other HRQOL instruments for the usage on patients with dementia according to a recent meta-regression analysis.[260] This speaks in favour of the usage of this instrument in the ED, where older patients with cognitive impairment are common.[261]

3.6.6. Hypothesis and aim

When catering to the needs of geriatric patients, the ED's main challenge is to balance the duty of acute emergency service and the pivotal, but more complex and time-consuming role that it can play in the identification and appropriate allocation of patients that would profit from a holistic perspective on their condition. The observational longitudinal study "Influence of the Multidimensional Prognostic Index (MPI) on the Hospitalisation of Older Patients admitted to the Emergency department – The MPI-HOPE study", registered at the German Clinical Trials Register (DRKS00012694) aimed at evaluating the geriatric population (≥75 years) of the central emergency ward of the metropolitan University Hospital Cologne. Overall, the central emergency ward consists of fourteen beds and a separated observation unit with 10 beds. The observation unit is used for patients of all ages who are admitted in the evening hours or at night and who require a longer time period for diagnostic procedures, reassessments and allocation decisions. While the MPI has been introduced previously on an associated ward of the internal department with an emphasis on geriatric care, the MPI-HOPE study aimed at assessing the feasibility and validity directly in the ED. Primary outcome parameters were hospitalization, LOS, rehospitalization, institutionalization, and mortality. Another important

goal was the evaluation of HRQOL using the EQ5D-5L at recruitment time and in follow-up interviews after discharge. HRQOL is an important dimension of health in geriatric patients, but often poorly recognized and evaluated in the setting of an ED. It contributes to the complexity of geriatric patients and should be regarded as an important outcome parameter for allocation decisions. In the first phase of the study, from October 2017 to January 2018, 215 patients were recruited and received follow-up interviews after 3 and 6 months. The results of this phase were presented on three scientific congresses with one poster presentation and two oral presentations and additionally published in Aging Clinical and Experimental Research in November 2020 (s. Chapter 7 Preliminary publication of results). “The prognostic signature of health-related quality of life in older patients admitted to the emergency department: a 6-month follow-up study” aimed at evaluating the frailty of geriatric ED patients and its relationship to HRQOL at recruitment time and 6 months after discharge.[52] We hypothesized that bad clinical prognosis and frailty as measured by the MPI is associated with reduced HRQOL in an ED setting. The association with self-perceived HRQOL would add another important dimension of health to the multidimensional CGA-based frailty instrument and therefore strengthen the approach of a holistic assessment and evaluation of geriatric ED patients.

4. Published original work

4.1 Rarek MP, Meyer AM, Pickert L, Pilotto A, Benzing T, Burst V, Polidori MC (2020) The prognostic signature of health-related quality of life in older patients admitted to the emergency demartment: a 6-month follow-up study. Aging Clin Exp Res

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ORIGINAL ARTICLE

The prognostic signature of health-related quality of life in older patients admitted to the emergency department: a 6-month follow-up study

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Abstract

Background The management of older and multimorbid patients with complex care requires a personalised and comprehensive approach. The main diagnosis is often registered as the cause of hospitalisation, yet poor health-related quality of life (HRQoL) as well as multimorbidity may represent the underlying cause and markedly influence prognosis.

Aims To analyse the association of HRQoL and clinical prognosis over time as assessed by a Comprehensive Geriatric Assessment (CGA)-based Multidimensional Prognostic Index (MPI) in older patients admitted to the emergency department (ED).

Methods We used data from the prospective MPI–HOPE (Influence of the MPI on the Hospitalisation of Older Patients admitted to the Emergency department) study. Data from 165 patients (≥ 75 years) admitted to the ED of the University Hospital of Cologne, Germany, between Oct 2017 and Jan 2018 were included. Clinical prognosis was calculated by the MPI and HRQoL by the EQ5D-5L. Follow-up interviews assessed HRQoL up to 6 months after discharge.

Results Most patients were multimorbid and presented with several geriatric syndromes. At admission, HRQoL was highest in patients with the best clinical prognosis. The MPI showed a negative correlation with the EQ-Index at admission ($r_s(86) = -0.50$, $p < 0.0001$) and follow-up assessments after 3 and 6 months ($r_s(86) = -0.55$ and $r_s(86) = -0.47$, $p < 0.0001$).

Discussion Our results suggest that patients' self-perceived HRQoL in the ED is related to functional health status and clinical prognosis.

Conclusion The MPI as a multidimensional snapshot provides information on clinical health indicators and informs about subjective HRQoL, thereby helping in identifying patients who would benefit from a specific treatment within the frame of a patient-centered, value-based care strategy geriatric treatment.

Keywords Geriatric assessment · Prognosis · Health-related quality of life · Emergency department · Clinical decision-making

Volker Burst and Maria Cristina Polidori are equal supervisors.

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Introduction

One of the biggest challenges for worldwide healthcare systems is the ongoing demographic change, with the increase in older patients with complex care needs requiring personnel and economic resources [1]. Older patients in the emergency department (ED) tend to present with typically multifactorial conditions. These are often related to underlining frailty in domains beyond the physical. Multifactoriality and frailty in multiple domains often do escape organ medicine-related usual care, particularly in settings like EDs where high-performance actions are in high demand [2, 3]. Psychiatric, social and functional deficits may accompany patients' trajectories, influencing post-ED management and outcomes [4–6]. One way to fill the gap between management needs in advanced age and optimal care efficiency is the use of the Comprehensive Geriatric Assessment (CGA) [7, 8]. This, however, poses important organisational issues [9] and to date the CGA is largely underused in EDs, including those in Germany [5]. Furthermore, the effectiveness of recommended screening instruments for older patients in the ED like the Identification of Seniors at Risk Score (ISAR) is currently under debate [4, 5]. As a consequence of the traditional "one cause-one disease-one treatment" approach [10, 11], the main diagnosis of older adults is therefore still often registered as the cause of hospitalisation.

Health-related quality of life (HRQoL) [12] measured by the European Quality of life-5 Dimensions (EQ5D) by the EuroQol group [13] is well established in geriatric populations and shows good interaction and discriminative ability of geriatric conditions [14, 15]. Considering HRQoL could strengthen the personalised approach recognising both health and well-being.

The present study was designed to evaluate the long-term relationship between multidimensional health measured by means of a CGA-based prognosis evaluation and HRQoL measured by the EQ5D in older patients admitted to the ED of a large German metropolitan hospital.

Patients and methods

Study design and participants

The observational longitudinal study "Influence of the Multidimensional Prognostic Index (MPI) on the Hospitalisation of Older Patients admitted to the Emergency department—The MPI_HOPE study", registered at the German Clinical Trials Register (DRKS00012694) complies with the ethical rules for human experimentation that are stated in the Declaration of Helsinki (1983). The study was approved by the Ethical Committee of the University Hospital of Cologne, Germany. Inclusion criteria were age 75 years and older, willingness/ability to consent and admission during the quartile between 18 October 2017 and 17 January 2018. Patients aged less than 75 years, visited outside the above cited time window and those unwilling/unable to consent were excluded from the study. All patients or proxy respondents gave written informed consent to participate after a personal conversation with the study doctor and adequate time for questions and decision-making.

Of the 1071 older patients admitted during the recruitment window, an average of 2–3 patients per recruitment day formally agreed to participate. Out of 215 consecutive participants who signed the informed consent, 165 with complete datasets were included in the present analysis.

Assessment

After giving informed consent, patients underwent a CGA-based calculation of the MPI [16–19], chosen for its clinimetric properties and its correlation to several key performance indicators [20, 21]. HRQoL was measured by the German 5-level EQ5D version. The first part provides a questionnaire addressing five dimensions (mobility, self-care, usual activities, pain/discomfort and anxiety/depression) that are rated on a Likert scale for this particular day (1 = no problems, 2 = slight problems, 3 = moderate problems, 4 = severe problems and 5 = extreme problems/unable to do). The dimensions can be analysed separately or combined into an index, using population-based preference weights. This study used the German value set from Ludwig et al. [22], which allows for the calculation of an index score that ranges from − 0.66 over 0 (death) to 1 (full health). Negative index values are rated as a health state being worse than death. The second part consists of a visual analogue scale (VAS), giving the interviewees the opportunity to estimate their current overall health status that day on a scale from 0 to 100 (0 = worst and 100 = best imaginable health).

The MPI combines information of eight different domains from widely used assessments: daily dependence by Katz's Activities of Daily Living (ADL) [23], the Lawton's Instrumental Activities of Daily Living (IADL) [24], comorbidities by the Cumulative Illness Rating Scale (CIRS) [25], pressure ulcer risk by the Exton-Smith Scale (ESS) [26], nutrition by the Mini Nutritional Assessment Short Form (MNA-SF) [27], cognition by the Short Portable Mental Status Questionnaire (SPMSQ) [28] and additional information on social living conditions and number of prescribed drugs. The summarised

MPI ranges from 0 indicating the lowest risk of mortality to 1 indicating the highest risk. It can additionally be classified into three risk groups: low risk MPI-1 (0–0.33), moderate risk MPI-2 (0.34–0.66) and high risk MPI-3 (0.67–1). For the assessment and definition of geriatric syndromes, liberal criteria were applied to reflect common clinical conditions in geriatric patients in line with previous literature [29, 30]

Follow-up

In follow-up interviews via phone three and six months after recruitment, the EQ5D was applied to measure changes in HRQoL. Additionally, information about the length of the initial hospital stay (LHS) after the ED visit was obtained.

Registration, participant consent and ethics

Statistical analysis

In the present analysis, we included $n = 165$ patients with complete assessments of both MPI and EQ5D-5L assessment at recruitment. Patients with incomplete HRQoL follow-up assessment were excluded from the follow-up analysis. Lost to follow-up was defined as participants who died during the follow-up, refused to continue participation or were not contactable via phone. A study patient flow chart is shown in Fig. 1.

All statistical analyses were performed with SPSS Statistics 25.0 (IBM Corp., Armonk, NY) for Windows. General characteristics are expressed using absolute numbers and relative frequencies for description of categorial variables. The Kolmogorov–Smirnov test was used to test for normal distribution and indicated that all variables used in this analysis were non-normally distributed. Therefore, the median (Mdn) and interquartile range (IQR) were reported for ordinal and continuous variables. We tested for differences between MPI risk groups and compared characteristics of patients who were lost to follow-up with those who remained in the study using nonparametric methods. Pairwise comparisons were carried out using Bonferroni-corrected post hoc tests.

To analyse the differences in HRQoL ratings over the study observation time (Admission, FU1 after three months, FU2 after 6 months), the Friedman test was carried out. Partial Spearman correlations were calculated to analyse the relationship between the MPI score on admission and EQ-Index score as well as the VAS score at different time points. To further analyse the association, linear regression analyses were carried out using the MPI score as the predictor for EQ-Index score and VAS score after adjusting for age and sex at admission, FU1 and FU2. To create an integer scale, the MPI score was multiplied by 10. In addition, the relationship between the geriatric syndromes assessed at admission with HRQoL was analysed. The analyses were adjusted for sex and age. We corrected for multiple testing using Bonferroni correction.

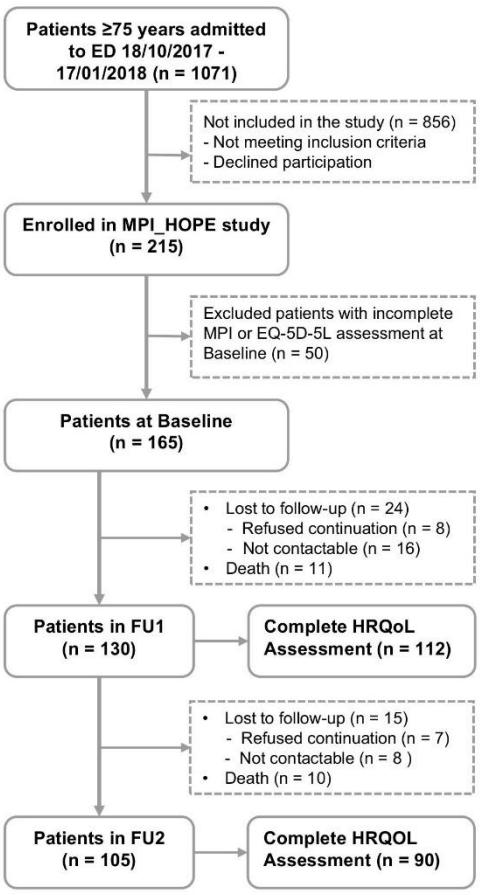

Fig. 1 Study flow chart. Out of $n = 215$ patients who were enrolled in the MPI_HOPE study, a subsample of $n = 165$ patients with complete MPI and HRQoL assessment was used for analysis at baseline. The flow chart illustrates the number of patients included in the analysis at the three different time points and provides information about the number and reasons for exclusions

Table 1 Characteristics of the study sample

	Total ($n=165$)	MPI-1 $n=84$ (50.9%)	MPI-2 $n=70$ (42.4%)	MPI-3 $n=11$ (6.7%)	H value/X^2 value
Sex (male), n (%)	98 (59.4)	59 (70.2)$^{\#}$	33 (47.1)*	6 (54.5)	8.56, $p<0.05$
Age, median (IQR)	80 (77.5–84)	80 (77.3–83)	80.5 (77–85)	84 (78–87)	1.39, $p=0.25$
Number of diagnoses, median (IQR)	8 (5–11)	6 (4–9)**	9 (6–12)$^{\#\#}$	10 (4–12)	6.65, $p<0.01$
Number of geriatric syndromes, median (IQR)	4 (3–5)	3 (2–4)$^{\#\#\#}$	4.5 (4–6)***	6.5 (5–7)***$^{\#}$	38.93, $p<0.001$
Length of stay (days), median (IQR)	4 (1–11.5)	5 (1–11)	3 (1–11)	26 (3–33.8)	5.34, $p=0.07$
Discharged home after ED visit, n (%)	23 (13.9)	12 (14.3)	11 (15.7)	0 (0)	1.97, $p=0.37$
Main diagnosis at the ED, n (%)[a]					
Heart disease	56 (33.9)	27 (32.1)	27 (38.6)	2 (18.2)	2.01, $p=0.37$
Neurologic disease	23 (13.9)	14 (16.7)	7 (10)	2 (18.2)	1.6, $p=0.45$
Musculoskeletal disease	22 (13.3)	11 (13.1)	7 (10)	4 (36.4)	5.2, $p=0.057$
Vascular/blood/lymphatic disease	21 (12.7)	13 (15.5	7 (10)	1 (9.1)	1.17, $p=0.56$
Respiratory disease	12 (7.3)	5 (6)	6 (8.6)	1 (9.1)	0.45, $p=0.80$
Intestinal disease	17 (10.3)	10 (11.9)	7 (10)	0 (0)	1.5, $p=0.47$
Kidney disease	7 (4.2)	3 (3.6)	4 (5.7)	0 (0)	0.95, $p=0.62$
Genitourinary disease	5 (3)	2 (2.4)	3 (4.3)	1 (9.1)	0.84, $p=0.66$
Endocrinological/metabolic disease	2 (1.2)	0 (0)	2 (2.9)	0 (0)	2.75, $p=0.25$
Other	22 (13.3)	12 (14.3)	9 (12.9)	1 (9.1)	0.25, $p=0.89$
≥ 2 main diagnosis, n (%)	27 (16.4)	14 (16.7)	12 (17.1)	1 (9.1)	0.47, $p=0.79$

[a]Multiple diagnoses possible per patient

Bonferroni-adjusted post hoc p values in comparison with MPI-1: *$p<0.016$, **$p<0.003$, ***$p<0.0003$ and to MPI-2 $^{\#}p<0.016$, $^{\#\#}p<0.003$, $^{\#\#\#}p<0.0003$

Results

Characteristic of study population

The demographic and clinical characteristics of the sample at admission and categorised by MPI groups are described in Table 1.

Eighty-four patients were classified into the low-risk (MPI-1), 70 into the moderate-risk (MPI-2) and 11 into the high-risk group (MPI-3). The majority of patients was male (59.4%) and only MPI-2 group had significantly fewer male than female patients in comparison with the MPI-1 group ($p=0.016$). The median age was 80 (IQR = 77.5–84) years, the MPI risk groups did not differ significantly in age. The mean number of diagnoses was 8 (IQR = 5–11); the number of diagnoses was significantly associated with the MPI group ($p<0.01$). The number of geriatric syndromes at admission (Mdn = 4, IQR = 3–5) was significantly associated with the MPI group ($p<0.001$). The most frequent geriatric syndromes were sensorial impairment (81.7%), polypharmacy (77.6%) and fluid or electrolyte imbalance (37.2%).

The length of hospital stay after ED admission was Mdn = 4 days (IRQ = 4–11.5), the MPI groups did not differ significantly in the number of in-hospital days ($p=0.07$). In total, 13.9% of the patients were discharged home.

The most frequent main diagnoses given at the ED concerned diseases of the heart (33.9%), followed by neurological (13.9%) and musculoskeletal (13.3%) disorders.

Follow-up results

When comparing admission characteristics of the subjects who were lost to follow-up with those who underwent all FU assessments, the former displayed a significantly higher MPI (Mdn = 0.38, IQR = 0.31–0.5 vs. Mdn = 0.31, IQR = 0.25–0.38; $U=4527.50$, $p<0.001$) and older age (Mdn = 81 years, IQR = 78–86 years vs. Mdn = 79.5 years, IQR = 77–82.3 years; $U=4094.50$, $p<0.05$) than the latter group.

HRQoL analysis

The EQ-Index and the VAS score were non-normally distributed according to Kolmogorov–Smirnov test. Therefore, a nonparametric Friedman test was carried out to analyse the progression over time and revealed that both

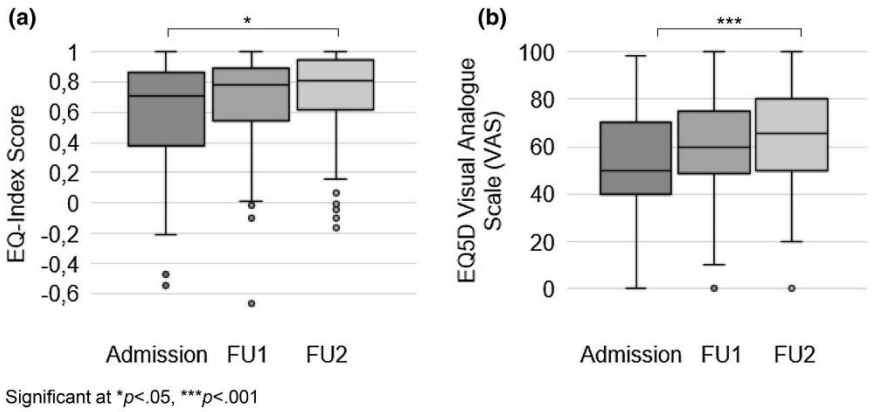

Fig. 2 Boxplot of the self-reported HRQoL as reported on EQ5D Index (**a**) and visual analogue scale (VAS) (**b**) over the course of the study visits (admission, FU1 after 3 months, FU2 after 6 months), showing the median. Whiskers extend 1.5 times the interquartile range from the 25th and 75th percentiles, and outliers are represented by dots. Higher scores on EQ5D Index and VAS indicate higher self-reported HRQoL. Patients reported significantly higher HRQoL at FU2 compared to admission on the EQ-Index and the VAS

scores differed between the measurement time points (EQ-Index: $\chi^2(2) = 6.96$, $p < 0.05$; VAS score: $\chi^2(2) = 14.37$, $p < 0.001$). Post hoc testing indicated that the VAS score after 6 months (FU2) was significantly higher compared to admission ($p = 0.001$), but not to FU1 after 3 months; there was no significant difference between admission and FU1. The results were similar for the EQ-Index at 6 months compared to admission ($p < 0.05$). The results are presented in Fig. 2. The number of geriatric syndromes correlated negatively with the EQ-Index [$r_s(149) = -0.35$, $p < 001$] and the VAS [$r_s(149) = -0.17$, $p < 0.05$] at admission. However, the correlation between the number of geriatric syndromes and the VAS missed significance level after Bonferroni correction.

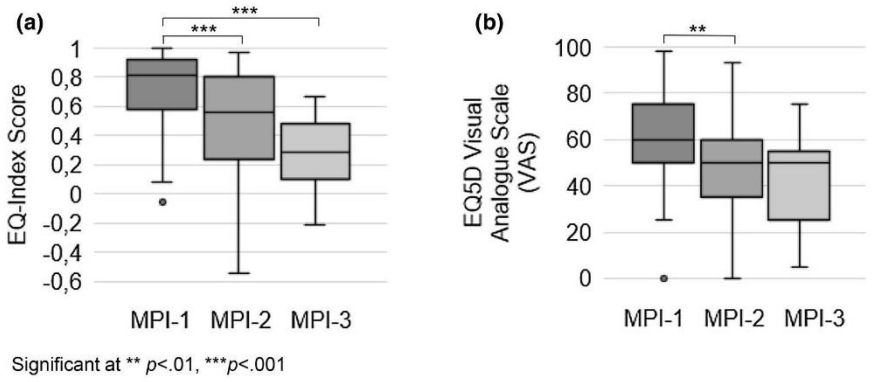

Fig. 3 Boxplot of the self-reported HRQoL as reported on the EQ-Index (**a**) and visual analogue scale (VAS) (**b**) for each MPI risk group, showing the median. Whiskers extend 1.5 times the interquartile range from the 25th and 75th percentiles, and outliers are represented by dots. Higher scores on EQ5D Index and visual analogue scale indicate higher self-reported HRQoL. **a** Patients in low-risk group MPI-1 reported significantly higher HRQoL on the EQ-Index compared to patients in the moderate-risk (MPI-2) and high-risk (MPI-3) groups. **b** Patients in MPI-1 group reported significantly higher HRQoL on the VAS compared to patients in MPI-2

Associations of HRQoL and MPI

The Kruskal–Wallis test used to assess differences in HRQoL at admission between MPI risk groups revealed that groups differed significantly in self-reported HRQoL as reported on the VAS ($H = 13.17$, $p = 0.001$) and measured with the EQ-Index ($H = 34.45$, $p < 0.001$). Dunn–Bonferroni post hoc tests showed that self-reported HRQoL was lower in the MPI-2 group compared to the MPI-1 group ($p < 0.01$). There was a trend for a lower self-reported HRQoL in the MPI-3 group compared to the MPI-1 group; however, this difference did not reach statistical significance after correcting for multiple testing ($p = 0.073$). For the EQ-Index, the measured HRQoL was higher in MPI-1 in comparison with both the MPI-2 ($p < 0.001$) and MPI-3 group ($p < 0.001$). The results are plotted in Fig. 3.

Partial Spearman correlation analysis revealed that the MPI showed a moderate to strong negative correlation with the VAS as well as with the EQ-Index at admission and both FU visits. As expected, the HRQoL measures correlated highly with each other. The results are presented in Table 2. Linear regression analyses indicated that the MPI was associated with the EQ-Index and VAS at all three time points. At admission, a decimal point increase on the MPI implied a decrease of 0.09 points on the EQ-Index ($p < 0.0001$). For the VAS, an increase of one decimal unit on the MPI at admission corresponded to a decrease of 3.83 points on the VAS ($p = 0001$). Detailed results for FU1 and FU2 are shown in Table 3.

Table 3 Results of simple linear regression analyses using the MPI score as a predictor for the EQ-Index and VAS at admission, after 3 months (FU1) and 6 months (FU2) adjusted for sex and age

Time point	Independent variable	β	95% CI	p value
Admission	EQ-Index	− 0.09	[− 0.11; − 0.06]	< 0.001
	VAS	− 3.83	[− 5.76; − 1.90]	< 0.001
FU1	EQ-Index	− 0.08	[− 0.11; − 0.04]	< 0.001
	VAS	− 5.34	[− 8.03; − 2.65]	< 0.001
FU2	EQ-Index	− 0.08	[− 0.12; − 0.04]	< 0.001
	VAS	− 5.42	[− 8.35; − 2.49]	< 0.001

Discussion

The main result of the present study is that HRQoL as assessed by the EQ5D was significantly associated with clinical prognosis in older multimorbid patients admitted to the ED. Clinical prognosis, as indicated by the MPI, had a moderate to strong correlation with HRQoL at assessment and up to 6 months later. The results of linear regression analyses support this association at all three time points adjusted for age and sex. Patients with a poor health status as indicated by the MPI group classification tended to report lower general and specific HRQoL indicated by the EQ-Index and VAS than patients with a better MPI score. These results indicate that clinical prognosis assessed by the MPI is related to the patients' self-perceived HRQoL at admission to the ED and after hospital discharge.

In line with our findings, a recent meta-analysis by Kojima et al. [31] on community-dwelling older people emphasized a negative association of a multidimensional frailty status and multiple HRQoL questionnaires. Furthermore, low self-rated HRQoL measured by the EQ5D at hospital admission has been linked to increased mortality and functional decline after discharge [32]. Consistent with other studies examining the HRQoL after an episode of emergency illness, we observed a significant increment from baseline to follow-up indicated by the EQ-Index and VAS [33, 34].

While the main diagnosis was often registered as the reason for admission to the ED, most patients presented a background of multimorbidity, with a median of four geriatric syndromes and eight different diagnoses. In addition, we found that the number of geriatric syndromes correlated negatively with HRQoL as indicated by the EQ-Index, although the observed association was weak and the correlation with the VAS missed significance level after Bonferroni correction.

Table 2 Spearman correlation coefficients between MPI and HRQoL indicators at admission and follow-up at 3 months (FU1) and 6 months (FU2) adjusted for sex and age

		1	2	3	4	5	6	7
1	MPI							
2	EQ-Index	− 0.50***						
3	VAS	− 0.40***	0.40***					
4	EQ-Index (FU1)	− 0.55***	0.48***	0.38**				
5	VAS (FU1)	− 0.45***	0.50***	0.50***	0.71***			
6	EQ-Index (FU2)	−0.47***	0.52***	0.44***	0.67***	0.58***		
7	VAS (FU2)	− 0.37**	0.39**	0.35**	0.58***	0.65***	0.64***	

Bonferroni-adjusted post hoc p value: **$p < 0.00016$, ***$p < 0.000016$

Underlying multimorbidity as well as geriatric syndromes and related impact on quality of life might be important determinants of patients' trajectories and might substantially add to the traditional organ-centred approach [30, 35–37]. Following disease-specific care can conflict with patients' values and preferences and might even lead to harm [37–39]. Reasons for this clinical practice are mostly unclear responsibilities and lack of geriatric training [40]. Therefore, to improve prognosis and strengthen therapeutic adherence, a more complex and elaborated approach than one-disease-one-treatment is recommended [41]. Only a structured CGA can enable coordinated, integrated care planning for the treatment and long-term follow-up care of older people [42], more so if accompanied by the assessment of patients' perspective [43]. Our findings provide further insight into the relationship between HRQoL and clinical prognosis due to multimorbidity as indicated by the MPI score.

There are limitations to our study. The study sample was relatively small, and patients with worse clinical status may have been more likely to reject participation in the study. In addition, we only used data from patients with complete MPI and EQ5D questionnaires. Patients who were unable to complete the assessment likely had worse health or cognitive status. Taken together, this may have introduced selection bias and could be an explanation for the low number of participants in MPI-3 compared to MPI-1 and MPI-2. The low number of high-risk patients may also have impacted statistical power to detect differences between the MPI groups.

Furthermore, while HRQoL was measured at admission and on two follow-up time points, the design of the study did not enable us to collect information on HRQoL before admission to the ED. Therefore, we cannot compare HRQoL before and after the ED visits, which limits the interpretation of the progression of HRQoL over time. Being in a stressful environment such as the ED with an acute medical condition could likely bias HRQoL ratings [33]. However, we found the strongest correlation of the MPI with HRQoL at 3 months after ED visit, where we can assume a decreased influence of the initial ED visit. Looking at the components of both indices, the correlation might be explained by similar targets like mobility, self-care and daily activities. Nevertheless, both questionnaires aim to address a different purpose: whereas the MPI is applied to constitute an objective multidimensional assessment of the patients' overall clinical status, the EQ5D is intended to evaluate the patients' self-perceived rating of their health. The relationship between both scales shows that the MPI assessment mirrors the patients' subjective evaluation of their health status.

Assessing and addressing HRQoL elaborately is rarely feasible in clinical practice due to time and resource constraints, especially in the ED. However, given that our data suggests that HRQoL is related to clinical prognosis, patients would likely benefit from additional assessment of HRQoL-related factors to support a holistic treatment that considers both health and well-being in the management of geriatric care. The MPI's ability to address HRQoL is limited, but our study shows that the MPI as a multidimensional snapshot of the patient can nevertheless provide insight into the patients self-perceived health status. A trained person could assess the full MPI in 20–30 min. This qualifies this prognostic instrument as a substitute for a CGA-like assessment at an early stage of treatment. Further studies are needed to evaluate the feasibility and effectiveness of the MPI in the clinical setting of an ED. This kind of multidimensional examination might improve personalised treatment of the older multimorbid acutely ill person through tailored intervention. Anticipating geriatric needs and fostering prevention could aid the management of multimorbidity, avoid hospitalisation and institutionalisation, improve self-reliance and ultimately, quality of life.

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Author contributions MPR, VB and MCP conceived and designed the clinical trial. VB provided resources. MPR. LP performed the experiments. MPR analysed the data. MPR wrote the paper. MRP, AMM and MCP were involved in the conception of the manuscript. AMM, LP, AP, TB, VB and MCP contributed to critical revisions.

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Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Statement of human and animal rights The study was registered at the German Clinical Trials Register (DRKS00012694) and complies with the ethical rules for human experimentation that are stated in the Declaration of Helsinki (1983). It was approved by the Ethical Committee of the University Hospital of Cologne, Germany.

Informed consent Written informed consent was obtained from all individual participants or proxy respondent included in the study.

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5. Discussion

To our knowledge, this study is the first to evaluate the clinical prognosis of older patients measured by the MPI and its relationship with self-rated HRQOL. In addition, it characterizes older patients in a German interdisciplinary ED. The presented correlation of the MPI with HRQOL adds to existing literature and provides evidence that clinical prognosis is closely connected to HRQOL measured at hospital admission and up to six months after. This indicates that applying such a multidimensional and CGA-based prognostic instrument in the ED can add valuable information to broaden the scope of clinical prognosis.

Although HRQOL has become an important quality indicator for research on treatment strategies and care processes, it is seldomly recognized in clinical practice and much less in the setting of an ED. HRQOL is an important aspect of the wellbeing of older patients and has many associations with important outcome parameters, for example various adverse clinical outcomes that affect health care systems economically. A recent meta-analysis by Phyo and colleagues analysed 42 studies that used different QOL tools in a total of 1.200.000 community dwelling participants aged predominantly above 65 years. They found that higher levels of QOL were associated with a lower risk of mortality.[262] Cavrini and colleagues conducted a longitudinal study over a timespan of up to eight years on nearly 10.000 community dwelling older without severe health problems and found a significant association of low HRQOL and short term hospital admission,[263] as well as long term hospital admission and mortality.[264] Other prospective studies on community dwelling geriatric patients showed that low HRQOL was a risk factor for adverse clinical outcomes like falls, hospital and ED admissions, nursing home placement and death.[265,266] In line with our results, low self-rated HRQOL assessed by the EQ5D-5L of older inpatients surveyed at hospital admission or discharge was furthermore linked with important outcome parameters of geriatric patients like increased risk for a higher initial LOS, functional decline after discharge and mortality and institutionalization after 6 months.[267-269] Nevertheless, QOL is seldom considered in daily acute medical care due to the lack of time and capacity and therefore, its lower priority in the ED is certainly understandable, but it should be considered as an important factor of health in older patients and a starting point for patient-centred and holistic allocation decisions and interventions.[270] With regard to the increasing relevance of geriatric patients in the ED and the accompanying challenges, a change of perspective incorporating a comprehensive understanding of geriatric medical conditions and well-being is necessary to improve care and do justice to the complexity of older patients.

5.1 Targeting Complexity – The American Setting

The MPI-HOPE study, focussed on geriatric patients in a German multidisciplinary ED. Geriatric emergency patient are high-risk patients that pose a challenge for today's

EDs.[121,122,188] This challenge will likely increase over the next decades. Taken together with observations from other studies, it appears that German EDs might be ill-prepared to cater to the clinical complexity of older patients and therefore risk higher rates of rehospitalisation and functional decline.[112,119,121,122] Changes to the infrastructure, personnel and clinical protocols of an ED are necessary to be able to implement a comprehensive assessment of geriatric patients and adapt the ED to the complexity of this patient group. Many Western countries experience comparable demographical developments, likewise increasing the relevance of geriatric patients in acute care. The following chapter presents potential strategies to react to this development using the example of the USA and evaluate potential implications for the organisation of German EDs.

5.1.1. Demographic development in the USA

The USA faces similar problems regarding the demographic development and change of ED clientele like Germany. The US Census Bureau estimated that in 2060, nearly a quarter of the population will be 65 years and older.[271] Further projections show an increasing burden on the healthcare system with an increment of hospital admissions and hospital LOS about 20% faster than the population growth.[271,272] Pallin and colleagues examined the projected influence of the demographic development on ED visits till 2050 and recommended to expand ED services 10% faster than population growth or alternatively to optimise emergency care efficiency to keep pace with the ageing society.[273]

5.1.2. Geriatric emergency department interventions

A concept to handle the rising number of older patients with frailty is the development of Geriatric Emergency Departments Interventions (GEDI).[175] The American College of Emergency Physicians, the American Geriatrics Society, the Emergency Nurses Association and the Society for Academic Emergency Medicine developed an evidence-based guideline on how to modify ED structures, procedures, staffing, equipment, protocols and how to improve treatment, transition of care and QOL of older ED patients.[54] The guidelines recommend two basic approaches to improve geriatric care outcomes in the ED.[55] One is the education of ED staff within existing ED routines and the implementation and adaptation of special policies, procedures and protocols for the needs of geriatric patients. This consists of the implementation of staff coordinators, policies for screenings of vulnerable individuals, the management of common geriatric syndromes and follow-up and transition to care strategies. The second approach is the combination of the first one with infrastructural changes and a geriatric-friendly ED redesign for hospitals that can afford such measures. Those include a separation of high-traffic ED cases, noise reduction, changeable and individual lightning settings, anti-pressure stretcher mattresses, large looking clocks and appropriate sanitary

facilities.[55] Those recommendations have led to the development of various GEDI in the last years. Some, but not all of them use a CGA as a central cornerstone.

5.1.3. Innovative models for geriatric care in the ED

Southerland and colleagues described four different examples of innovative models from EDs in the US that incorporated geriatric care into their clinical routine.[53]

The first model is the implementation of a spatially divided geriatric unit within the ED. These units are designed to support the needs of older patients and provide support rails, adequate lightning, pressure-reducing mattresses and sky or ceiling windows.[175] This segregation from the noisy and frantic environment of an ED might help to prevent delirium and avoid the impression of older patients "blocking" a bed when they require a longer stay. Patients who could benefit from this unit should be selected by screening instruments early at arrival at the ED. A dedicated multidimensional team consisting of geriatric physicians and nurses, physical therapists, case managers, social workers, palliative consultants and pharmacists could bring concentrated expertise to the complex needs of these older ED visitors.[53] However, this concept might be hard to obtain by smaller hospitals with a lower patient flow and inadequate structural possibilities. Other barriers are the assignment of geriatric specialists to the unit, which might be expensive and that the unit might not be fully functionable at night and weekend times due to lack of capacities.[53]

The second approach is the embedding of geriatric professionals, structural changes and assessments into an existing ED routine, which might be easier and cheaper to obtain for hospitals with restricted space. The number of specialists could be variable according to the needs, ranging from one geriatric nurse to a team with an additional physician and other health specialists. Concomitant assessment of older patients within the ED routine could either increase the ED LOS because it could take longer time to conduct additional geriatric assessments[274] or decrease it because of the advice from experienced geriatric practitioners.[275]

The third model designed for EDs with less geriatric patient flow or lower financial opportunities is the implementation of a geriatric champion. This could be a physician or nurse with expertise in geriatric care who is responsible for staff education and the implementation of geriatric protocols. The champion does not carry out CGAs but evaluates patients and suggests either a hospital admission or a succeeding outpatient follow-up assessment if necessary. The ED could provide some assessment parts, like pharmaceutical evaluation or medical diagnostic, but outsources the remaining assessments to other health care providers. Southerland et al. note that this model requires good communication and coordination with community health care providers and can be particularly challenging on days with busy ED routine or when outpatient services are limited.[53]

5.1.4. Geriatric observation units

The fourth common model of GEDIs described by Southerland and colleagues is the geriatric-focused observation unit.[53] General observation units in the ED have the purpose to provide surveillance or inpatient care lasting between 6 to 48 hours for conditions that extend the capacity of an ED but do not justify a costly hospital admission.[276] These units are common in the emergency care in the USA[277] and have demonstrated to decrease ED crowding, diagnostic uncertainty, resource utilization and LOS whilst improving clinical outcomes and patient satisfaction.[276,278,279] General observation units play an important role in the care of geriatric ED patients. Thirty percent of patients in general observation units in the US are older than 65 and their admission is mostly used for the diagnosis and treatment of clinical conditions with general symptoms and unclear emergence like syncope, fever, tachycardia and vomiting.[280] Furthermore, general observation units have demonstrated to avoid hospital admissions.[280]

5.1.5. Benefits and limitations of geriatric observation units

The idea of creating an observation unit fitted to the structural necessities of geriatric patients with access to a multidisciplinary CGA and treatment protocols outside of the ED setting could lead to a great benefit for geriatric patients.[281] This model could provide time for the assessment and evaluation of this population, which is often time consuming and challenging to embed in normal ED routine. The assessment time for admitted geriatric patients who have a bed for a short time can be flexible and patients who visit the ED at night-time can wait for a comprehensive evaluation till the next morning. In addition, the contact and medical history from relatives can be conducted properly, which tends to be problematic in cognitively impaired patients. This could prevent unnecessary hospital admissions in cases of unclear diagnoses or discharges with incomplete assessments.[280] The CGA could be outsourced to the hospital's geriatric service which evades the need of a constant presence of geriatric professionals in the ED.[53]

Finally, this setting could improve the organisation and transition to community-based care services.[53] Benefits of the implementation of a CGA-based evaluation in a geriatric observation unit in different health care systems have been observed, such as reduced hospital admission and ED readmission rates and functional decline after ED discharge.[53] A pilot study by Southerland and colleagues demonstrated good feasibility of a multidisciplinary assessment in an ED observation unit within 24 hours without affecting the ED length of stay or hospital admission rate.[281]

Again, this model could be harder to implement in smaller hospitals than cannot provide adequate structures or consultant services for geriatric patients. Another limitation is the lack of a standardized and well-validated screening instrument to identify geriatric patients who would benefit the most, which could lead to inefficient allocations.[24,282]

5.1.6. Evaluation of geriatric observation units

A recent review by Heeren and colleagues on sixteen studies evaluated the emergent research on geriatric observation units.[283] The difficulties of embedding a multidimensional CGA in this setting was shown by the low number of CGAs that covered medical, functional, cognitive and social dimensions. Although all studies showed interdisciplinary processes, half of the presented units did not provide at least one geriatric practitioner, such as a specialised nurse or a physician. Heeren and colleagues ascribed the absence of a geriatric professional staff to an international shortage of those professions or limited billing abilities for geriatric interventions in the ED. The admission criteria for the observation unit were very heterogeneous and hardly any study used a validated geriatric screening instrument. Nearly all units lacked a dedicated space for assessment conduction or protocols to guide clinical care which have been proven essential to general observation units.[276] Although general observation units are common for EDs in the US, the implementation of a geriatric friendly environment and efficient assessment possibilities is still challenging.

5.1.7. Evaluation of CGA-based intervention concepts

Several EDs have applied one or more of the above-mentioned models to implement a CGA into their ED routine. Preston and colleagues conducted a systematic review of CGA-based interventions in EDs regarding their efficiency in reduction of adverse outcomes.[56] The evidence was inconsistent because of a high heterogeneity in study designs, inclusion criteria, outcome measurements and reported results. This highlights the high variety of interventions and difficulties in comparability. Discharge interventions based on CGA improved the linkage between the ED and community services, but meta-analyses showed limited evidence for effectiveness[284,285] and one review displayed a tendency of increased ED readmissions in the short term.[286] The authors of this review ascribed the increased rate of readmission to the possibility of patients returning to complete the treatment of an acute condition or an increased awareness in patients and relatives for previously undetected health problems that were identified by the CGA.[286] Staff-focused interventions with the implementation of a nurse or physician responsible for conducting a CGA showed a stronger effect for geriatrician-led interventions than nurse-led CGAs regarding the reduction of hospital admission rates.[56] Studies on nurse-led interventions observed either reduced or increased health care utilization. A meta-analysis on seven nurse-led interventions studies found no effect on clinical outcomes like hospitalization, ED readmission and hospital LOS.[287] Preston et al. indicated a lack of robust multicentre controlled studies and missing focus on patient-focused outcomes like pain and quality of life.[56] Furthermore, the general comparability of CGA-based interventions seemed to be difficult due to inconsistent study reporting. Those inconsistent results with mixed significance and effectiveness indicate the heterogeneity of CGA concepts and implementation

strategies. Future research on GEDIs must work out the most effective and feasible strategies for specific ED settings and care systems.

Despite of the well-established effectiveness of a CGA in the hospital setting, a sustainable and effective implementation in the ED appears to be far from easy. There is still no general agreement on the right and most effective form of a CGA. According to Gladman et al., the performance of each CGA depends on the context in which it is applied and the missing expertise of ED nurses and physicians on CGA leads to a "know-do-gap".[288] Their training and daily practice is mainly focused on the detection and treatment of acute problems in a short amount of time. Internalizing the concept of a holistic and comprehensive evaluation in a busy environment might be hard to accomplish without further education.[289]

5.1.8. Recommendations for CGA implementation

Carpenter and colleagues described an ideal, theoretical approach to the implementation of a CGA in ED routine.[282] The first step is the identification of vulnerable older patients who would benefit from further geriatric care by applying an accurate screening instrument. This patient would then receive a CGA with a holistic evaluation followed by a personalized intervention either targeting prevention or treatment of geriatric syndromes. The final step is the implementation of a follow-up to ensure the execution and provide an opportunity for possible alteration of the intervention. Preston and colleagues summarized the features of successful implementation policies after the evaluation of existing studies: A CGA strategy that involves adequate screening and assessment and the combination of social and medical care.[56] In addition, they highlighted the importance of initiating therapeutic strategies already in the ED and the beginning of the hospital stay.

5.2 Targeting Complexity – The German Setting

5.2.1. Demand and supply for geriatric care

In Germany, emphasis in geriatric care is mainly put on stationary or semi-stationary care facilities.[58] About 90% of geriatric care is conducted in stationery settings like hospitals and rehabilitation facilities and 8,5% in semi-stationary settings that are organised mostly by inpatient facilities.[290] In the years from 2005 to 2014, the number of geriatric beds increased by 48% according to a report from the BARMER health insurance company.[291] Furthermore, it has been predicted that the number of geriatric beds will increase up to 31% till 2030 to meet the rising demand in Germany due to the demographic change.

The necessity of implementing innovative models to improve care of geriatric patients in general and in acute care has been recognized by a German association for Geriatrics, the Bundesverband Geriatrie e.V. They published a white paper on the structure and demand of geriatric care in Germany based on data by the Federal Statistical Office of Germany (Statistisches Bundesamt).[292] The authors noted that although geriatric care was one of the

fastest developing specialities in Germany regarding case numbers and bed occupancy rates, this was not sufficient to cover the demand. Furthermore, they forewarned that this demand would increase further in the next decades. They anticipated an additional demand for nearly 15.000 additional geriatric inpatient beds till 2025. Interestingly, the authors identified a "hidden demand" in geriatric care for patients in other speciality departments like surgery, neurology and internal medicine. The authors called for a better identification of geriatric patients in central facilities like the ED. The rising demand for geriatric care which excels the supply calls for an extension of geriatric care facilities on one hand and a more effective way to identify patients who would benefit most from geriatric care on the other hand. This emphasises the importance of effective screening for the identification of geriatric patients at an early timepoint. There has been much effort in Germany towards the improvement of geriatric care in the ED promoted by position papers of geriatric and emergency organisations.[28,122] The emphasis was placed on raising awareness for the complexity and needs of geriatric ED patients and the encouragement for the implementation of screening methods. The desire for further education and training in geriatric emergency care has already been requested by German ED staff.[91]

5.2.2. Quality indicators for geriatric emergency care

An expert group of the DGINA including emergency nurses and physicians, a geriatric physician, health-economic and pharmaceutic experts and patient representatives recently developed 67 quality indicators (QI) as a framework for the implementation of high quality geriatric emergency care.[293] QIs are quantitative tools to evaluate the quality of procedures that influence patient outcomes and help to target potential performance issues.[294] If well-defined, they can improve assessment strategies, the quality of care and give the opportunity to benchmark with other ED providers.[293,295] The authors incorporated aspects from the US geriatric emergency department guideline and existing QIs for the ED medicine to develop 67 QIs consisting of 33 processes, 29 structures and 5 outcome indicators for personnel, equipment, medical treatment, care, communication and common risk factors of geriatric ED patients.[296] Five quality statements were emphasised as the most important and one of those was the implementation of effective and validated screening methods to identify patients with geriatric needs.

5.2.3. The "Geriatrischer Versorgunsverbund"

One future development of geriatric care in Germany could be based on the implementation of a "Geriatrischer Versorgungsverbund" (GVV). It was first published 2010 in the White Paper of the Bundesverband Geriatrie.[57] The concept of a GVV lies in the combination of a facility which serves as a competence centre and a satellite net of interdisciplinary care structures.[58] The "Geriatric Centre" could either be an independent geriatric hospital or in cooperation with a general hospital. It consists of stationary, semi-stationery and rehabilitation health care

structures and serves as a bridge between ambulatory and acute care. An important function would be the guidance and coordination of the geriatric patient through the interdisciplinary satellite net consisting of non-geriatric in- and outpatient care providers, pharmaceutics, hospices, nursing homes, public agencies and community supplies. The concept of a GVV serves the opportunity to provide a professional and multidisciplinary space which can provide the structure and equipment for the specific need of geriatric patients that is often still lacking in general hospitals. Interlocking in- and outpatient services might reduce hospitalizations and even offer punctual and concentrated care for ambulatory patients. The access to the GVV would be gained via primary care providers, hospitals and direct admissions from EDs. Regarding the allocation decisions for geriatric patients in an ED, this concept could provide an opportunity for patients with complex acute or subacute complaints that fail to fit into a distinct organ category or medical speciality. Instead of discharging frail patients until they return with a more acute condition or the admission to a medical ward with unknown and uncoordinated treatment pathways, the GVV could be a fitting address for comprehensive and personalized care.

As the first federal state, North Rhine-Westphalia (NRW) adopted the concept of a GVV into the "Krankenhausplan NRW 2015" with the focus on stationary care.[59] Hospitals without a geriatric unit had to join a cooperation with those that provided geriatric care to enable the possibility to assign patients with geriatric needs through mutual care standards and transfer criteria.[292] This cooperation was able to offer every geriatric patient the access to geriatric care in theory. One requirement of such a cooperation was the adequate selection of patients who would profit from geriatric care. However, an efficient geriatric screening instrument is still missing. The authors of the "Krankenhausplan NRW 2015" called for the screening of every patient aged 75 years and older at hospital admission or directly by the physician in the ED responsible for the admission.[59] They recommended no specific screening instrument but mentioned the ISAR score as a potential tool for Germany.

5.2.4. The ISAR score as a geriatric gatekeeper: limitations and chances

The ISAR score is one of the most commonly used screening tools and has been suggested for EDs in Germany.[28] As illustrated before, the ISAR score showed high sensitivity but low specificity in several studies.[31,60,187] The rationale of using instruments with a high sensitivity and lower specificity seems to be acceptable if the goal is to select vulnerable patients for basic and comparatively low effort care measures like fall and delirium prevention. However, for allocation decisions in the ED or shortly after hospital admission, concerning for example allocation to a geriatric department, this can result in an increased demand on geriatric beds. Today, the demand of specialized geriatric care already surpasses the supply, so this could further intensify the lack of available geriatric care.[292] This scenario is even more complex, because "falsely identified" patients who get access to specific geriatric care due to low

specificity of screening instruments could likely benefit from specialized geriatric care as well, which could increase the waiting time for patients that are in greater need. Furthermore, geriatric facilities might even profit economically from the admission of relatively healthy patients with better outcome probability, lesser care expense and treatment costs. Misclassifying patients who are not in need of specialized geriatric care on a grand scale might further reduce the disposability of highly specialized, little available and expensive resources which are imperatively needed for the increasing number of older high-risk patients over the next decades.

This implication raises doubts about the clinical usage of the ISAR score for allocation decisions in the ED leading beyond the mere question of a safety discharge. Nevertheless, the ISAR score is recommended as a screening instrument for German and international EDs despite the previously discussed doubts about its performance, which is explained by the rationale of raising awareness for geriatric emergency care.[54,122,175] Holding on to the ISAR score seems to arise from the dilemma of missing alternative effective measures for the establishment of a valid and reliable tool for geriatric allocation decisions.[26]

To face this problem, researchers aimed to improve the ISAR score by modifying its screening criteria and thresholds or combining it with another instrument. Shifting the cut-off criteria for polypharmacy could increase the ISAR scores clinimetric properties in geriatric patients as the number of prescribed drugs is often already high.[297,298] To increase the performance and informative value, Singler et al. have recommended to raise the threshold of a positive ISAR score from 2 to 3 points, which improved the specificity in a study on older German ED visitors from 24.8% (≥ 2 points) to 49.3%. (≥ 3 points) for adverse outcomes after 28 days.[183]

Scharf et al. demonstrated that the combination of the ISAR with a CGA could improve the discriminative ability.[187] This could speak in favour of screening strategies that include a more holistic view on complex geriatric patients.

5.2.5. The MPI as a multidimensional Instrument

The CGA-based MPI might be a promising candidate to fill the gap of suitable instruments for appropriate allocation decisions in the ED. It has demonstrated its ability to identify vulnerable patients effectively in different clinical settings and in comparison to other screening instruments.[30,200,206,217] The results of the presented publication have shown that the assessment is feasible in the ED and demonstrated its associations with important geriatric risk factors and patient-centred outcome parameters in this critical care setting.[52] Implementing the MPI in an acute care setting like the ED could offer a holistic view on the patient beyond an organ- or disease-centred approach. Future research should aim to analyse the effectiveness and eligibility of the MPI and its prognostic value for allocation decisions in the ED.

A limitation for an exclusive usage of the MPI might be its length in comparison with the ISAR score. The MPI consists of 53 items and is more time-consuming to conduct than shorter instruments. According to our experience, a trained ED member or consultant could assess the MPI in 20 to 30 minutes. It might compensate the relatively long assessment time with a more comprehensive and holistic evaluation of the patient. The MPI does not only provide information via its index score, but practitioners can likewise get information from the included assessment tools on nutrition, cognition and mobility.

The MPI-HOPE study has successfully recruited 343 patients in total with a follow-up period of 2 years. Based on the study's first results, the Department of Internal Medicine and Center for Molecular medicine in Cologne initiated the prospective randomised controlled study "Jede Jeck is anders" ("every human is different"; DRKS00017365). This study attempts to evaluate the implementation of a multidimensional CGA in older ED patients on clinical outcome parameters like length of hospital days, rehospitalization, utilization of ambulatory care structures and QOL. Older patients admitted to the ED will receive a CGA with the assessment of clinical, cognitive, participatory, socioeconomic- and socio-psychological factors, QOL, clinical prognosis by the MPI as well as assessment of geriatric resources and syndromes. The intervention group will receive a personalized treatment plan based on the CGA with recommendations for the subsequent care and initiation of contact with the general practitioner to close a potential information gap. The control group will receive usual care without further geriatric recommendations.[65] The early identification of geriatric syndromes and recommendation of treatment strategies might avoid hospitalization, delayed discharge and readmission to the ED.

5.2.6. The Geriatrie Check

An interdisciplinary German expert group has developed the 9-item "Geriatrie-Check" (geriatric check) as an instrument for the identification of geriatric patients in 2013.[63] It consists of two parts – while the first part assesses objective criteria, the second part collects information on subjective impairment in 5 domains as observed by the patients themselves or their caregivers. However, a positive screening result can be based on the objective criteria alone to save time. Recently, two studies have evaluated its validity in the setting of hospitalized neurological patients[299] and the internal medicine ED.[62] In the latter study, it was compared to the ISAR score and showed comparable properties with a high sensitivity (82%) and lower specificity (62.1%). While both the ISAR and the geriatric check showed higher sensitivity than nurses and physicians, the predictive validity was lower in comparison. The authors therefore proposed a procedure that starts with the ISAR score or geriatric check and is followed by an evaluation by nurses or physicians to improve resource allocation.

5.2.7. The Acutely Presenting Older Screening Program

An approach to improve geriatric care in the ED by using a screening tool to trigger further geriatric interventions has been conducted by Blommard et al. in the Netherlands.[65] The ED system in our neighbouring country faces similar challenges regarding overcrowding and an increment of older and frail patients.[300] Blommard et al. evaluated the implementation of the Acutely Presenting Older Patient (APOP) screening programm in the ED of a tertiary care hospital.[65,301] The APOP consists – in addition to information on age and gender - of seven yes and no questions about the form of arrival, daily assistance during the time before arrival, hospitalization in the last 6 months and cognition performance.[302] A recently published study combined an education program for ED staff with the implementation of an APOP screening program to trigger interventions during the ED stay and additionally, dependent on the patients clinical track, a CGA after hospital admission or recommendations for the priamry care provider after discharge from the ED.[65] The implementation of the program resulted in an increased number of conducted CGAs during hospitalization, improved communication with the general practitioner and follow-up care via the ED without increasing ED LOS and hospital admission rate. However, as information on the effectiveness of this program regarding other clinical outcomes is not availabe, further studies are needed to evaluate this model. This approach might be a promising example to research in German EDs.

5.2.8. The Interdisziplinäre Notfall- und Kurzliegeraufnahmestation (INKA)

One example of an ED innovation in Germany comparable to the concept of an geriatric observation unit is the implementation of a “Interdisziplinäre Notfall- und Kurzliegeraufnahmestation” (INKA) in the Albertinen-Hospital in Hamburg.[64] It has been implemented in 2010 and is a unit with 22 beds assigned to the ED that is mainly, but not exclusively aimed at older patients. Patients admitted to the ED with foreseeable need for stationary care are assigned to the INKA if the allocation aim is yet unclear, the allocation aim is clear but all beds are occupied or if the patient will likely be discharged within three days and requires interdisciplinary care. The concept is based on close cooperation with the geriatric ward. Daily geriatric ward rounds lead to early identification of patients that would benefit from geriatric care and allow for timely transfers to the geriatric ward. Therapy decision are made in cooperation with all care providers, such as GPs, relatives and nursing services, and continuation of care after discharge is considered early. The INKA has demonstrated to be successful in improving care for older patients whilst freeing up ressources in the ED and working cost-effectively.[64] In 2012, the INKA received a German innovation price in health care, the “Deutsche Innovationspreis im Gesundheitswesen”.[303]

While this innovative model shows promising effects, structural changes of the ED like the INKA require a dedicated and spatially divided ward, which might be costly to accomplish for

hospitals. Most of the research is therefore focused on the improvement of ED routines and the implementation of effective screening instruments for allocation decisions. It is paramount for researchers to work out the most effective assessments, treatment protocols and ways of information transmission in the German health care system and figure out how EDs can improve their role as a central nod in future geriatric care. Recently, the urgency to identify vulnerable patients has drastically increased with the world-wide appearance of COVID-19, which heavily affects older and frail people. The pandemic forced health care providers to act fast in the face of increased patient flow and decreased medical capacity.

5.3 The COVID-19 pandemic

The Severe Acute Respiratory Syndrome-Corona Virus 2 (Sars-Cov-2) was first identified in hopitalized patients in Wuhan, China in Dezember 2019 and led to a pandemic that is threatening nations and their health care systems all around the world.[66,304] As of August 23th in 2021, COVID-19 has been confirmed in over 206 million people and led to the death of almost 4.4 million.[305] Up to the date of this publication, the end of the pandemic is unpredictable.[306] Specific aspects of COVID-19 might have contributed to the rapid worldwide distribution of the virus. A long incubation period (mean 4 days, 2-7 days interquartile range), a possible transmission up to two days prior to the occurrence of first symptoms and the possbible transmission from asymptomatic individuals have aggravated the containment of outbreaks.[307-309] Major cornerstones to overcome the pandemic depend on containment and vaccination strategies.[310,311]

5.3.1. Pathophysiology and clincial manifestations

Sars-Cov-2 is one of seven ribonucleic acid-based coronaviruses that are known to infect humans, with four endemic straints leading to mild upper and lower respiratory tract infections in adults and children and two being responsible for global outbreaks in the last two decades.[304,312] There is ongoing research about the origin of Sars-Cov-2 and it is hypothesized that it is developed from a natural selection in either human or animal hosts with following zoonotic transfers.[66,313] The major transmission pathway from person to person is assumed to occur via droplets that are expelled during talking, coughing or sneezing, via aerosols and inhalation exposure and to a lesser degree from contaminated surfaces.[307,314] Sars-Cov-2 initially targets nasal and bronchial epithelial cells and pneumocytes and in later stages of infection endothelial cells of blood vessels, which might explain symptoms outside the respiratory system and possible complications in nearly every major organ system.[307,315]

The most common symptoms are fever, dry cough, shortness of breath, fatigue and myalgia; but symptoms unlike common respiratory diseases like nausea/vomiting or diarrhoea and olfactory and gustatory impairments might also occur.[307] A direct infiltration of cells in the central nervous system via the cribriform plate of the ethmoid bone might explain the early

development of anosmia and aguesia and a broad variety of neurological manifestations in later disease stages.[316-318] First retrospective observational studies showed that every third COVID-19 patient developed neurological manifestations ranging from dizziness, headache, taste- and smell impairment in milder courses of disease and ischemic stroke and cerebral haemorrhage in more severe infections.[319] However, asymptomatic manifestation are also possible and a meta-analysis estimated the amount at around 17%.[320] Most of the cases have only mild symptoms and can be treated ambulatory, while every sixth patient might develop dyspnea and reduced oyxgen saturation and about 5% can become critically ill with respiratory failure, septic shock and multiple organ failure.[321] Critically ill patients can develop complications like acute respiratory distress syndrome, cardiac diseases, encephalitis, and thromboembolic diseases.[307,322-324] Approximately 17 to 35% of hospitalized patients with COVID-19 require intensive care with most of them being treated by invasive mechanical ventilation.[307] The overall hospital mortality is estimated at around 15 to 20% with a higher mortality rate of patients being treated in the intensive care unit, but numbers differ depending on the patient cohort and health care system.[307]

5.3.2. Long-term impact of COVID-19

Another future threat might be “long-covid”, a collective term for symptoms that continue or arise up to 12 weeks after an acute infection and are not explained by an alternative diagnosis.[86,87] First review indicated that reported post-COVID-19 sequelae are multi-organic and can cause symptoms like dyspnea, thrombembolic events, chest pain, fatigue, headache, cognitive impairment, affective disorders, sleep disturbances and impaired pulmonary, cardiovasculary, inflammatory, renal and metabolic organ function.[86,325] The prevalence of “long-covid” is difficult to estimate because of heterogenous populations and the capacity of health and reporting systems.[86] It has been estimated that in the UK, 20% of patients reported symptoms after five weeks and 10% after four months.[326] First studies described a persistency of symptoms and organ damages up to six months after an infection with required hospitalization.[327,328] The long-term impact of the Sars-Cov-2 virus on organ systems is unknown and the need for long term observational research is crucial.

5.3.3. Mortality of COVID-19

Old and frail people are more disproportionately affected by COVID-19. Older age is one of the essential risk factors of an adverse course of disease or death.[69,71,72] A meta-analysis by Bonanad and collegues on five studies and over 600.000 subjects in China, Europe and the US evaluated the effect of age on mortality in patients with COVID-19.[70] While the mortality rate was lower than 1% in patients younger than 50 years, it increased exponentially with higher age by 9.5% in the age group of 60-69 and nearly 30% in patients aged 80 and above. Analyses with other measurements of disease severity like the case fatality rate (CFR; ratio of

diagnosed cases and deceased) and the infection fatality rate (IFR; ratio of infected and deceased) emphasise the strong influence of age on COVID-19 outcome.[329,330]

5.3.4. COVID-19 and the complexity of age

There are several age-related factors on cellular, anatomical and physiological level that might explain the increased vulnerability of older patients.[67,68,73] Changes in the respiratory system like an increased expression of entry factors on human respiratory cells for Sars-Cov-2,[331] a reduced number of cilia and cilated cells[332] and a reduced upper airway size[333] can increase the vulnerability towards COVID-19. Sarcopenia and weakness can impair overall mobility and the strength of respiratory muscles which decreases airway ventilation.[334] The increased general and chronic inflammation found in an aged immune system hamper the effectiveness of individual immunological cells and the whole inflammatory system.[148,149,335] Older people are often malnourished or at risk for malnutrition while an optimal nutrition status seems to be important for the immunological defence against viral infections.[336,337] Malnutrition can be a predictor of mortality in hospitalized older Covid-19 patients.[338]

Another risk factor for poor outcome in older patients is the development of delirium, which is associated with a higher rate of complications and mortality, longer mechanical ventilation time and longer intermediate care unit stay in critically ill patients.[339-341] Rising evidence suggests that COVID-19 seems to accelerate this risk additionally.[342] Kotfis and colleagues summarized different factors that increase the vulnerability of the brain in a COVID-19 illness: Direct effects from the Sars-Cov-2 virus like the infiltration of the CNS and an induction of central nervous system inflammation mediators, which might disturb the brain homeostasis before the homeostatic dysregulations due to systemic organ failures.[316] Treatment strategies of severe manifestations of COVID-19 like the application of corticosteroids, sedation procedures and mechanical ventilation might indirectly enhance the risk for delirium.[342-345]

Another important factor of vulnerability might be social isolation, which can emerge or aggravate from social distancing measures, an important component of non-pharmacological interventions to contain Sars-Cov-2 outbreaks in many countries.[67,346] Social isolation of older adults with reduced visits from relatives at home, care facilities or at the hospital can lead to aggravation of cognitive impairment, anxiety, depression or the risk for developing delirium.[67,342] Non-pharmacological interventions to contain the spread of Sars-Cov-2 could also have led to a worsening of non-communicable diseases that are highly prevalent in frail adults because of reduced outpatient visits, fewer diagnoses and reduced medication adherence.[73,347,348]

However, it is important to note that those factors should not be associated with chronological, but with biological age and the concept of frailty.[68,73] The ageing process is highly heterogeneous and differs individually, so implications and screening methods for vulnerable

adults with higher risk for severe COVID-19 courses should not only focus on age or the presentation of symptoms but on a holistic assessment of vulnerability and frailty.

5.3.5. Impact of frailty on COVID-19

A systematic review by Cosco and colleagues summarized the existing literature on the impact of frailty on mortality in hospitalized patients and found the majority of them reporting a positive association between higher level of frailty and mortality due to COVID-19.[88] The authors identified 26 studies with half of them having been conducted in the EU and half in the United Kingdom and one in Brazil. Frailty was mostly assessed by the CFS. A small amount of studies used either the Hospital Frailty Risk Score,[349] which is based on the International Classifcation of Diseases 10 codes, the FriEDs frailty phenotype[138] or the Frail Non-Disabled survey, which is a self-reporting screening tool.[350] Mortality rates ranged from 14 to 65% and were reported at a large range of timepoints (6-50 days), indicating a great variety of study designs and settings. However, the positive relationship was not consistent in all studies. Two studies using the CFS and the Frail Non-Disabled survey reported no predictive ability of frailty on hospital mortality.[351,352] Interestingly, two studies reported a lower association to mortality with increasing frailty than initially expected and excess mortality was observed in comparatively fit patients.[353,354] Cosco and colleagues suggested that this could be related to a selection effect brought up by a change in health policies towards the avoidance of hospital admission of old and more frail patients during COVID-19 surges.[88] Many factors could have complicated the comparability of these different results further. Treatment options and recommendations of COVID-19 developed over the course of the pandemic and clinical decision-making processes could have been changed in times of low hospital bed and intensive care capacity, both factors which may have influenced mortality outcomes.[310]

5.3.6. Frailty screening in COVID-19 patients

There is growing evidence that the additional assessment of frailty improves the prediction of adverse outcomes in older patients with COVID-19.[355] The assessment of frailty at hospital admission can add more depth of information to clinical decision-making apart from more apparent information like age and the number of comorbidities. First guidelines and strategies that were developed to cope with such crises raised concerns that allocation criteria like age, “life-years saved” or “long-term predicted life expectancy” could lead to an unjust treatment of patients with advanced age in a disease that is already disfavouring the old.[356,357] Frailty is a complex construct and age-related, but not every older patient with a temporarily reduced state of health is simultaneously frail. In addition, also people younger than 65 years can develop frailty. Especially in times of surges with high COVID-19 prevalence and limited capacity of hospital and intensive care beds, from which many countries suffered, it is important to enable a holistic view of the patient’s health state for suitable allocation decisions.[358-360]

5.3.7. The Clinical Frailty Scale

The National Institute for Health and Care Excellence (NICE) recommended in a rapid guideline in early 2020 a frailty screening of all patients at hospital admission irrespective of a suspected COVID-19 infection.[74] The Clinical Frailty Scale (CFS), a clinical judgment-based screening approach, has been suggested.[361] Domains describing the functional and cognitive status as well as existing comorbidity lead to a classification of the patients into one of nine categories from very fit over vulnerable and frail to terminally ill. The CFS has recently been updated for the increased usage due to the recommendations in the National Institute for Health and Care Excellence guidelines.[362] It has been recommended by German and Austrian societies in the faculties of internal-, emergency-, and intensive care medicine and geriatric-associated faculties in guidelines regarding allocation decisions for intensive care treatment during the COVID-19 pandemic.[75,76]

5.3.8. Challenges of frailty screening in COVID-19

Recommended screening tools for frailty in patients with COVID-19 and especially the CFS are easy to understand and quick to apply, which makes them sufficient for a broad usage in this global health crisis but can hardly survey the whole complexity of frailty in older patients. Additionally, the CFS is largely based on the clinical judgement and geriatric experience of its user. The authors of the CFS even recommended an utilization by clinicians with experience in geriatric medicine.[361] Furthermore, the classification depends on a correct assessment of the patient's living conditions, which can be difficult in cognitive impaired patients without accompanying relatives. The presentation of older patients might also change rapidly over the course of an illness, which must be taken into account when being assessed.[73,363] Frailty increases the risk of patients to present atypical symptoms which might impede diagnostic procedures in the ED.[122] This can be problematic when facing a disease with a high amount of asymptomatic and atypical symptoms, which requires strict hygiene measures and allocation decisions due to a high contagiosity. Atypical symptoms of COVID-19 infections like delirium and abdominal complaints are possible in older patients and failing to identify it at the ED can have dreadful consequences for the subsequent care.[357,364] Given its roots in a CGA and its multidimensionality, the MPI might be a potential alternative or addition to other screening tools. A study on 227 hospitalized older patients by Pilotto et al. showed a good predictive ability of the MPI on hospital mortality (AUC: 0.76, 95%CI: 0.68-0.83), but no association with ICU admission.[77] Another recent study on 653 ICU patients showed similar abilities in predicting mortality after ICU admission (AUC: 0.74, 95%CI: 0.70-0.78).[365] Further studies that compare different frailty instruments and screening strategies in the context of COVID-19 are needed. However, the assessment of frailty should not be the only pillar in clinical decision-making in times of shortage of care capacities. Clinical decision makers should note that the prevalence of frailty is unequally distributed and influenced by socio-economic factors like

poverty, education and ethnicity.[19,143,366] The American Geriatrics Society has included the consideration of cultural, ethical, and socioeconomic factors into their position statement for resource allocation strategies in the COVID-19 pandemic.[367]

Those aspects of the complexity of older patients highlight the importance of the availability of geriatric specialists and geriatric education in EDs and hospital staff to improve clinical decision-making. The consultation of specialists is also recommended to improve clinical decision-making.[74,363] There is a need to investigate how to enhance the assessment of frailty and how this information can improve clinical decision-making and ultimately the prognosis of older patients.

5.3.9. COVID-19 and the German ED

The worldwide outbreak of COVID-19 has affected many nations and their health care systems. In Germany, over 3.800.000 cases were reported and nearly 92.000 people died till August 23th, in 2021.[368] EDs and especially central emergency wards are on the frontline of allocation management of COVID-19 cases as an intersection of in- and outpatient care. Beside its responsibility for the care provision to non-COVID-19 emergency and acute conditions, EDs had to adapt to manage the challenges of a pandemic. The focus of EDs regarding COVID-19 lies in the identification of infected patients, risk stratification, allocation decisions and overall implementation of hygienic measures to prevent transmission within the ED.[78] Important early suggestions were the separation of COVID-19 and non-COVID-19 patients, the implementation of standard operational procedures and the establishment of screening procedures.[369,370]

Especially the relevance of screenings for hidden COVID-19 infections or patients with poor clinical prognosis should be recognized. Regarding the concept of frailty with a generally reduced capacity of the body's organ systems to external stressors and the development of atypical symptoms, frail patients are at high risk for atypical COVID-19 presentation.[371] A sore throat, unexplained hypoxemia or the development of geriatric syndromes like dehydration, functional decline, fall and delirium could indicate a COVID-19 infection.[357,372,373] A study in the US observed that 37% of ED patients with COVID-19 infections showed a delirium and no additional, typical COVID-19 symptoms.[341] This emphasises the importance of an early screening for frailty and geriatric syndromes in older ED patients, which might be caused by a COVID-19 infection. An online-survey of Finke and colleagues on the adaptation of German EDs towards the Pandemic has shown that most of the responding EDs have been well prepared regarding isolation policies, diagnostic and organisational procedures for the prognosed increment of COVID-19 incidence in the winter season 2020/2021.[78]

5.3.10. Influence of COVID-19 on ED visits

An interesting observation was the reduction in numbers of emergency cases in German EDs during the first wave of the pandemic in early 2020.[79,80] Slagman and colleagues summarized data of 36 EDs, with 29 of them being affiliated to a university hospital with maximum care.[79] The observed EDs experienced an overall reduction in the number of visitors by 13% in the first half of 2020 in comparison to the previous year. The maximum reduction of 39% occurred at those times with the highest COVID-19 prevalence and the most restricted outbreak constraints. A similar decrement was observed for patients at all age groups, but a higher decrement was observed for patients > 60 years. Non-urgent conditions and ambulant contact seemed to decrease more than urgent presentations that led to hospitalization. The reduction seemed to be comparable for traumatic and non-traumatic reasons. A similar development has been detected in other countries. EDs in the US observed a decrement of visitors by up to 42% in a four-week period during an early period of the pandemic.[81]

One suggestion for this development was that people experienced a higher threshold to seek medical advice because of the fear of a infection with COVID-19.[79,81] Lesser contact with relatives might also have contributed to the reduction of ED visits especially in older patients, because relatives often initiate a presentation in the ED.[374] The observation of decreased presentations with myocardial infarction, stroke and transient ischaemic attacks is worrisome.[79,81] Those conditions are associated with frailty and indicate an exacerbation of long developed chronic illnesses and physiological dysfunctions.[375,376] Patients with mild to medium symptoms might have delayed medical contact in fear of a COVID-19 infection, which might have led to aggravated relapses with worse clinical prognosis.

5.3.11. COVID-19 and HRQOL

As a worldwide public health emergency, the COVID-19 pandemic has not only impact on the direct health but also on QOL of people who are not directly affected by an infection but also by fear of infections or the loss of family members, isolation due to containment strategies, economic losses and uncertainty about the future.[82] First studies indicate an increasing burden on mental health in the general population.[83] Two surveys on HRQOL with over 2000 adult participants during the pandemic in the US and Italy showed a lower rating of general HRQOL in comparison to pre-pandemic values.[84,85] Age had a significant effect on HRQOL with the lowest ratings in younger age groups. Old age has been identified as a protective factor for low QOL and mental health in a small-sample study in Israel.[377] The authors suggested a richer life experience and a reduced fear of illness and death in older people as a potential reason for the observed resilience. On the contrary, a survey on Chinese population showed no difference in HRQOL levels compared to pre-pandemic time in the general population and the authors observed a decrease in HRQOL with higher age and higher number of chronic diseases.[378]

However, it is important to note that all the above-mentioned studies had an unequal age distribution and the highest age groups were commonly categorized by an age of 65 years or older. Reasons could be less access of older people to online-based surveys on which most of early studies on QOL are based upon.[83-85,378] This strongly limits the evidence because of an underrepresentation of COVID-19 high-risk adults who might have greater fear of an infection, are burdened by stricter isolation measures and might have less access to digital ways of coping with social isolation.

5.3.12. Long-Covid and HRQOL

Another important burden of COVID-19 on HRQOL might be the influence of chronic symptoms that remain or develop after an infection. Older age groups are at higher risk for an adverse disease manifestation and hospitalization which have been shown to lead to remnant symptoms.[73] There is growing evidence that post-COVID-19 symptoms of hospitalized patients are accompanied by a significant reduction of HRQOL.[89,90] A cohort-study by Walle-Hansen specifically on older hospitalized COVID-19 patients showed that more than half of the participants reported a clinically relevant decline in HRQOL measured by the EQ5D-5L up to six months after hospital discharge in comparison to HRQOL at admission.[327] The highest decrement was reported in the domains of mobility and activities of daily living. There is need for further research about the development of QOL and HRQOL after an COVID-19 infection. In addition, it is necessary to raise awareness of the lasting burden “long covid” might have in the future.

5.3.13. Implications of COVID-19 on the ageing society

In summary, the COVID-19 pandemic has intensified the perception of challenges in our health care system in general, but specifically with regard to acute and emergency care of older and frail patients. The challenge of identifying vulnerable patients in the ED has drastically increased since the beginning of the pandemic, as geriatric patients with multimorbidity and frailty are predominantly affected by severe illness courses and death.[67,71,88] Subsequently, the demand for geriatric and rehabilitation care might accelerate further, intensifying the need for an efficient and established screening instrument for vulnerable patients in the ED.

This pandemic might lead to great losses within a whole generation of older adults in the nearby future and a burden on another generation over the next decades. Chronic remnants of a COVID-19 infection might burden the health and HRQOL of todays and soon-to-be geriatric patients. First studies on post-COVID-19 symptoms showed a median age of 50 to 60 years of affected participants.[325] This age group of “baby boomers” might be disproportionally affected by COVID-19 remnants by being in a “sandwich-position”. As younger patients are more rarely affected by a severe course of disease and older age groups might escape an infection with an earlier vaccination, this “middle-aged” group could suffer high consequences

regarding future health.[70,71,379] Conceptualising frailty as a pathologic endpoint of multidimensional age- and lifestyle-related deteriorations of organ systems, COVID-19 might serve as an accelerator of the biological ageing process.[12] It might intensify the progress of the demographic development, whose burden for future health care systems is not only defined by the mere increment of older adults alone, but the increment of patients with a higher biological age, multimorbidity and frailty. If high-risk patients for chronic remnants of COVID-19 are typically patients with existing comorbidities, this might intensify or prolong the burden of non-communicable diseases on health care systems. Indirectly, the pandemic could impede the diagnostic and follow-up care of other chronic diseases, which might amplify the burden on individual HRQOL and future health care systems.

5.4 Conclusion

The ED is a central node point and at the front line of both short- and long-term challenges that will come up in the next decades. Its crucial function beside emergency care is the allocation of a broad variety of patients to the right subsequent care facilities. Especially older and vulnerable patients can benefit from the correct transfer to facilities with holistic treatment and infrastructure. As the number of older and frail patients with complex care needs will further increase over the next decades, the ED has to prepare for this development. The geriatric-friendly adaptation of ED infrastructure, education of personnel staff and implementation of efficient protocols and algorithms are paramount to prepare for this challenge. There has been ongoing research on how to implement geriatric care in this setting, but most has been conducted in the US. German researchers and policy makers should establish which concepts might be suited for the German health care system and how to implement them.

5.4.1. Outlook

A promising example is the INKA in Hamburg, which bridges adequate geriatric emergency care and cost-effectiveness.[64] The development of interdisciplinary central emergency wards in German hospitals with access to a broad variety of professionals and diagnostic procedures is an important step towards a more comprehensive approach towards complex geriatric patients. They offer the opportunity for geriatric specialists to execute assessments and treatment recommendations that extend the resources of ED staff, who might be more focused on high-paced emergency care. Geriatric observation units might be a concept that can be feasible for German EDs in hospitals with bigger infrastructural capacities. As time is often the most important resource in the assessment of geriatric needs, this might be an approach to remove vulnerable patients from the high-paced setting and prevent hospitalization. EDs in smaller hospitals and urban settings might benefit from the implementation of a geriatric champion or consultant, a tighter connection to clinics with geriatric specialization in the GVV, or care structured in the ambulatory sector for information exchange and follow-up controls.

However, with a missing specialisation for physicians, only few university professorships for geriatric medicine and insufficient implementation in curricula for medical students, the geriatric medicine in Germany is still in its infancy compared to other countries.[380] There is an urgent need to prepare the German health care system with its characteristics like decentralized organisation, distinction into acute and rehabilitative care and the emphasis on stationary care structures for the upcoming ageing society. Novel structures like the GVV have to be evaluated in their efficiency and cost effectiveness to lead geriatric patients from the ED to the clinical tracks that meet their needs in a personalized and comprehensive way.

5.4.2. Concepts to overcome the "efficiency-gap"

Essential for this task is the implementation of efficient and feasible screening instruments for frail and vulnerable patients. There has been a high amount of research on different screening instruments with different approaches to the concept of frailty with individual advantages and disadvantages over the last decades. Unfortunately, they have failed in the end to accurately and efficiently predict outcomes in geriatric ED patients.[282] There is an ongoing discussion on how geriatric research and clinicians can continue from this point. One recommendation is the optimization of existing screening and assessment instruments by combinational usage. An "ED-specific minimum geriatric assessment" instrument that covers the most frequent and influential factors that indicate geriatric need could serve as a screening instrument and trigger subsequent broader and more comprehensive assessment.[381,382] Another approach might be the improvement of information exchange from in- and outpatient services to implement more information on medical record and pre-ED data like social and systemic circumstances and actual disease severity that might improve accuracy and could even be estimated by artificial intelligence programs to cope with the rising complexity.[282]

A third approach might be the implementation of instruments like the MPI that expand the capacity of "simple" screening measures by CGA-based assessment algorithms to cover more of the complexity that derives from frailty.[36] Future research should evaluate the advantages and disadvantages of those and other approaches and identify those that fit best in particular health care systems and ED structures.

5.4.3. Holistic decision-making in the ED

The presented publication was able to demonstrate that the MPI can be conducted in the setting of the ED to assess the complexity of older patients either as a single instrument or in combination with a shorter screening tool. The newfound associations with HRQOL could add another dimension to the comprehensiveness of this instrument. The implementation of patient-centred outcomes like an improvement in HRQOL might be an additional pillar to improve clinical decision-making especially in multimorbid and frail patients. Future research on HRQOL as well as research on frailty might benefit from a uniform definition and

nomenclature of this concept to ameliorate the informative value of its measurement instruments and their implications for clinical practise. Especially the utility of HRQOL measurement in an ED setting is underrepresented in the literature up to this date, due to its limited feasibility in the setting of a high-paced ED. The long-term treatment of chronic conditions might overlap with concepts of palliative medicine, where the treatment goal shifts from remission to the reduction of symptoms and improving HRQOL. Geriatric, complex patients might as well benefit more from approaches that target functionality, reduction of symptoms and better HRQOL than traditional organ-centred guideline recommendations. There might be great potential in the implementation of this concept to strengthen holistic and patient-centred care approaches.

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7. Preliminary publication of results

- Original Paper: The prognostic signature of health-related quality of life in older patients admitted to the emergency department: a 6-month follow-up study by Rarek MP, Meyer AM, Pickert L, Pilotto A, Benzing T, Burst V, Polidori MC in Aging Clinical and Experimental Research (11/2020)

- Oral presentation: „A snapshot from the older patient's emergency department visit: Associations between the Multidimensional Prognostic Index (MPI) and health-related quality of life" by Rarek MP, Meyer AM, Pickert L, Burst V, Benzing T, Pilotto A, Polidori MC on the congress of the European Geriatric Medicine Society 2019 in Krakow, Poland (09/2019)

- Oral presentation: „Multidimensionale Prognoseberechnung in verschiedenen klinischen Settings" by Meyer AM, Pickert L, Rarek MP on the Wissenschaftsforum Geriatrie on the congress of the Deutschen Gesellschaft für Geriatrie 2018 in Cologne, Germany (09/2018)

- Poster presentation: „A snapshot from the older patient's emergency department visit: Design and preliminary results of the MPI – HOPE (Influence of the Multidimensional Prognostic Index on the Hospitalisation of Older Patients admitted to the emergency department) study" by Rarek MP, Meyer AM, Pickert L, Burst V, Pilotto A, Benzing T, Polidori MC on the congress of the European Geriatric Medicine Society 2018 in Berlin, Germany (09/2018)