Developing guidance on necessary & avoidable care transitions in senior citizens

Thesis

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Referat

Zielsetzung: Etliche Übergänge älterer Menschen zwischen Versorgungssettings wären vermeidbar. Die Krankenhauseinweisung oder der Umzug in ein Pflegeheim ist oft unnötig oder zumindest verfrüht. Die negativen Auswirkungen auf die Betroffenen und die Implikationen für das Gesundheitssystem sind gut beschrieben. Eine international konsentierte Definition vermeidbarer Transitionen lag bislang nicht vor. Die Auswahl eines geeigneten Instruments zur Bestimmung der Angemessenheit der Transition gestaltet sich schwierig ob der zahlreichen und unterschiedlich sorgfältig validierten Instrumente. Diese Dissertationsschrift schließt die Forschungslücken.

Methoden: Zwei in internationalen, PubMed-indexierten Zeitschriften publizierte Arbeiten werden präsentiert: Die erste berichtet über eine neue, konsentierte Definition für "vermeidbare Transitionen". Eine vierstufige Delphi-Befragung wurde durchgeführt, basierend auf Codes, die aus einer Literaturanalyse abgeleitet wurden. Die zweite Publikation berichtet über eine systematische Literaturübersicht zu Bewertungsinstrumenten für Entscheidungen über vermeidbare Transitionen älterer Menschen zwischen Versorgungssettings. Die Instrumente wurden hinsichtlich Objektivität, Zuverlässigkeit, Validität und Kosten analysiert.

Ergebnisse: Insgesamt 99 Experten aus neun Ländern nahmen an der Delphi-Befragung teil. Nachdem eine Mindestübereinstimmung von 90 % erreicht wurde, konnte ein Konsens über eine Definition erzielt werden, die drei Dimensionen umfasst: Nutzen-Schaden-Abwägung, Ressourcenverbrauch und die Präferenzen von Patient*innen oder informellen Pflegepersonen. Die systematische Literaturrecherche identifizierte 58 relevante Studien über 48 Bewertungsinstrumente. Die Studien und Instrumente wiesen eine ausgeprägte Heterogenität auf. Merkmale der Patienten wurden in 48 Instrumenten adressiert, klinische in 15, soziale in drei und Systemmerkmale in 15.

Folgerungen: Die neue Definition kann das Verständnis von vermeidbaren Transitionen verbessern und sowohl in der Forschung als auch in der klinischen Praxis angewendet werden. Die meisten identifizierten Bewertungsinstrumente berücksichtigen nur begrenzte Perspektiven und sollen das Urteil des Pflegepersonals ergänzen, nicht ersetzen. Die Ergebnisse der Untersuchung und eine anschließend entwickelte Online-Datenbank können die Entscheidung bei der Auswahl geeigneter Instrumente in der Praxis leiten.

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Content

1. Introduction and objective

Care transitions have been defined as changes in the setting of care provision (Kasdorf et al., 2021; Morrison et al., 2016), and represent rather a process than a specific point in time (Winqvist et al., 2023). Care transitions encompass care settings such as hospitals, nursing homes, primary care, home care and palliative care (Kasdorf et al., 2021) (WHO, 2019). Hence, a care transition is an umbrella term that embraces different types of transitions, such as (re)admission to a hospital or discharge from hospital to a nursing home or community. Moreover, care transitions occur not only between care settings but also within care settings (WHO, 2019), for instance, between wards and medical departments in the same hospital.

Older adults normally receive care from multiple healthcare providers and transition is frequently within and across healthcare settings (Kasdorf et al., 2021). These transitions are often associated with negative outcomes, such as a decline in autonomy, reduced quality of life, more adverse medical events, and even increased mortality, besides increased direct and opportunity costs for the healthcare system (Gurses; et al., 2024; Naylor & Keating, 2008; Storm et al., 2014). Care transitions for frail older adults tend to be more hazardous and problematic as opposed to those for less frail older adults (Winqvist et al., 2023). Older adults frequently have complex care needs, not only owing to their medical conditions but also to their cognitive state (Winqvist et al., 2023), and this poses greater demands and challenges for the entire healthcare system.

Some care transitions are regarded as avoidable. The phenomenon of avoidable care transitions has received increasing attention over the last decades due to its frequency and associated burden for the patients and the healthcare system (Gruneir, 2013; Lemoyne et al., 2019; OECD, 2023; Thwaites et al., 2017; van der Does et al., 2020; Yam, Wong, Chan, Leung, et al., 2010; Yam, Wong, Chan, Wong, et al., 2010).

The most researched example of potentially avoidable transitions are in context of avoidable (re)hospitalisations (OECD, 2023; OECD & Union, 2022; Soong & Bell, 2015; Tappen et al., 2020; Thwaites et al., 2017; Yam, Wong, Chan, Leung, et al., 2010; Yam, Wong, Chan, Wong, et al., 2010). Rehospitalisation is the "*subsequent hospital admission with a predefined time, generally 30 days of discharge – is frequent and costly and at the same time can be potentially preventable*" (Hijazi et al., 2017). Rehospitalisation itself represents a change in the location of care (i.e. care transition), but focuses on a specific setting (hospital) and timeframe (30 days). Thus, "care

transitions" is a collective term, and "rehospitalisation" is part of this term. International studies indicate a wide range of avoidable (re)admission rates from 5% to 79% (Renom-Guiteras et al., 2014; van der Does et al., 2020; Yam, Wong, Chan, Wong, et al., 2010). To a certain extent, the variation is probably due to different data collection methods and different populations among studies and countries (Renom-Guiteras et al., 2014; Soong & Bell, 2015; van der Does et al., 2020; Yam, Wong, Chan, Wong, et al., 2010). This, in fact, indicates that (re)admissions to hospitals are often avoidable.

Another example of avoidable care transitions can be in the context of long-term care (LTC) and emergency department (ED) settings. The LTC sites can include nursing homes, skilled nursing facilities, assisted living facilities and hospice care (Oakes et al., 2011). Internationally, the incidence of ED visits was estimated to be around 30 transfers per 100 LTC beds annually (Renom-Guiteras et al., 2014). The rates of transitions from LTC to ED vary greatly across LTC facilities, and a significant number of LTC to ED visits may be avoidable (Lemoyne et al., 2019; Oakes et al., 2011). Evidence on care transitions to ED classified as avoidable also shows variation in rates, some suggesting that 4% to 55% of nursing home to ED transitions are avoidable (Lemoyne et al., 2019) while others report on avoidability rates of 18% to 68% of LTC to ED transitions (Cummings et al., 2024). A considerable proportion of LTC patients can be treated in the ED for ambulatory care sensitive conditions (ASCS) (Hsieh et al., 2019; Oakes et al., 2011) such as urinary tract infection, heart failure and chronic obstructive pulmonary disease (Renom-Guiteras et al., 2014; Sarmento et al., 2020). Emergency transitions due to ASCS can be avoided (O'Cathain et al., 2013; OECD, 2021). Moreover, transitions to ED for reasons such as injuries related to accidental falls, fever, decreased food or fluid intake, and functional decline are also considered as avoidable (Lemoyne et al., 2019). LTC patients are by nature often frail and have high levels of dependency (Munene et al., 2020; Renom-Guiteras et al., 2014) and a high degree of medical complexity, prevalence of cognitive and functional impairments and psychiatric illnesses (Munene et al., 2020; Oakes et al., 2011). LTC residents transferred to ED can experience discontinuity in care, long waiting times in the ED and can acquire iatrogenic infections, thus becoming cognitively and functionally more impaired (Munene et al., 2020). Thus, care transitions of LTC patients increase the risk for variety complications (Munene et al., 2020) including delirium, polypharmacy, pressure ulcers and more (Oakes et al., 2011). Therefore, identifying and reducing avoidable care

transitions of LTC patients can contribute to decreasing morbidity and mortality of patients and also healthcare costs (Lemoyne et al., 2019).

Ambulatory care-sensitive conditions (ACSCs) are used as quality indicators in the primary care setting by the Organisation for Economic Co-operation and Development (OECD), representing a subtype of avoidable hospital admissions attributed to specific chronic diseases (OECD, 2021). Five core conditions (i.e., diabetes, hypertension, congestive heart failure, chronic obstructive pulmonary disease, and asthma) are considered important in European countries, where they show a substantial variation between countries (OECD & Union, 2018, 2022). These five ACSCs accounted for over 4.6 million hospital admissions across the European Union (EU) in 2015, representing 37 million bed days and amounting to 5.6% of all admissions that might have been avoided (OECD & Union, 2018). The evidence base for effective treatment of these conditions is well established and much of it can be addressed in primary care (OECD, 2023). While there are overall improvements in the quality of primary care, investments in primary care may still not be quick enough, probably resulting in unnecessary expenditure and expensive hospital care (OECD, 2023) associated with avoidable care transitions. In addition, high-quality primary care is not always available, as across 30 OECD countries avoidable hospitalizations still represent 6% of hospital bed-days (OECD, 2020). Across OECD countries in 2016, the average cost generated by avoidable hospitalisations for the five core ACSCs was estimated to be 21.1 billion USD (OECD, 2020). However, this is a rough estimation of the opportunity costs, as only the "hotel" component of hospital costs (such as personnel, capital and food costs) was considered, leaving out costs for medicines, treatment and diagnostic tests (OECD, 2020). This implies that the actual opportunity cost of avoidable hospitalisations associated with these five core ACSCs is considerably underestimated (OECD, 2020).

These examples show that avoidable care transitions happen across different care settings and are associated with considerable harm, especially for older adults, and healthcare systems. In addition, the World Health Organization (WHO) in their Global Patient Safety Action Plan 2021 – 2030 has set a major aim to eliminate avoidable harm in health care with the vision of "a world in which no one is harmed in health care, and every patient receives safe and respectful care, every time, everywhere" (WHO, 2021). This highlights the importance of addressing avoidable care transitions, and places this doctoral research project in line with a mission set by WHO.

Some care transition models have been designed and implemented, and have shown to have an impact in the real life setting by reducing hospital readmissions, healthcare costs and improving well-being in patients (Enderlin et al., 2013; Hall et al., 2020). The Chronic Care Model (CCM), which focuses on the outpatient clinic setting, helped to improve well-being in patients with asthma, diabetes, bipolar disorder, comorbid depression and cancer (Enderlin et al., 2013). The project Re-engineered Discharge (RED) employs a so-called "virtual patient advocate" discharge approach, using computer-generated patient instructions with focus on diagnostics, education, post-discharge care instructions with emergency plan, discharge summary transmission, and follow-up telephone reinforcement (Enderlin et al., 2013). Models such as Better Outcomes for Older Adults (BOOST), Care Transitions Intervention (CTI) and Transitional Care Model (TCM) were developed to reduce harm and improve transitions as older adults transition from one place to another, specifically from hospital to home (Hall et al., 2020). These models contribute to reductions in rehospitalisation rates and healthcare costs, and are particularly beneficial for high-risk older adults who transition frequently across care settings, and experience high rates of post-transfer complications, readmissions, morbidity and mortality (Hall et al., 2020). Another notable example is the Interventions to Reduce Acute Care Transfers (INTERACT) model focusing on nursing home to hospital transitions (Huckfeldt et al., 2018; Ouslander et al., 2014). INTERACT contributes to reduction of hospital admission rates and healthcare costs, and includes a variety of tools assisting nursing facility staff to identify, assess, document and communicate change in health conditions of nursing home residents (Huckfeldt et al., 2018; Ouslander et al., 2014).

Looking at readmission rates as a quality parameter reflects a belief that readmissions are avoidable and are a signal of insufficient care; however, this is questionable (van der Does et al., 2020). In fact, not all readmissions are preventable, but only a part of them, and the proportion of potentially avoidable readmissions would be a better indicator of quality of care, rather than the total number of readmissions (van der Does et al., 2020). However, it is crucial to emphasise that avoidable hospital readmissions do not represent all avoidable care transitions, but reflect only a certain part of it. The phenomenon of avoidable care transitions is particularly important in light of limited resources, when they are not used efficiently and are wasted for treatments related with avoidable transitions. This leads to a situation when those who do need a treatment are

insufficiently provided for and those for whom a care transition could have been avoided end up being over-treated. It is of utmost importance to tackle the avoidable care transitions to enhance resource management and minimize health risks. To achieve this, firstly it seems crucial to define avoidable care transitions and secondly, to identify such avoidable care transitions. However, measuring preventability still has some challenges, since a transparent definition and objective measuring tool is lacking (Soong & Bell, 2015; van der Does et al., 2020).

Scanning the literature on the topic, it becomes obvious that the concept of "avoidable care transitions" and related terms are interpreted and used differently throughout all publications, and no consensus on a definition has been reached so far (Gruneir, 2013; Kasdorf et al., 2021; Lemoyne et al., 2019; Morphet et al., 2015; Nolte et al., 2012; Vossius et al., 2013). Lack of a commonly accepted definition for "avoidable care transitions" (Gruneir, 2013; Kasdorf et al., 2021; Lemoyne et al., 2019; Nolte et al., 2012; Renom-Guiteras et al., 2014; Thwaites et al., 2017; Yam, Wong, Chan, Wong, et al., 2010) can lead to miscommunication in multinational studies (Thwaites et al., 2017; van der Does et al., 2020) or limit the practical use of research findings (Soong & Bell, 2015). Most definitions of "avoidable care transitions" are narrowly defined and touch upon a single or a few perspectives. For instance, some articles interpret the term "avoidable" from a system and/or clinical perspective, and other studies assess "avoidability" from a patient perspective (Thwaites et al., 2017; Yam, Wong, Chan, Leung, et al., 2010). It is evident that a joint agreed terminology will positively contribute to research and clinical communities. Delivery of a new consensus-based definition for "avoidable care transitions" addressed this knowledge gap.

Assessment tools can play a vital role in clinical practice as well as for research purposes by supporting a decision-making on avoidability of care transitions. To date, a number of various assessment tools have been developed and they are intended for specific settings and/or patients, implying there is no "gold standard" tool that can be applied to all types of care transitions. However, due to a large number of various existing assessment tools and their unique scope of use, choosing the right instrument remains challenging and time-consuming. Even within a specific type of care transition, (for example, care transitions from long term care to hospital), studies apply different assessment tools to identify avoidable care transitions (Renom-Guiteras et al., 2014). A decision on which assessment tool to use in a certain situation sort of becomes a matter of choice. A comprehensive overview of assessment tools seems reasonable. However,

former reviews that overviewed assessment tools or interventions dealing with avoidability of care transitions are limited to a specific subset of all care transitions (Coffey et al., 2019; Renom-Guiteras et al., 2014; Sempé et al., 2019; Woodhams et al., 2012). Therefore, it seemed timely to conduct a systematic literature review to extend and update the scientific evidence on various assessment tools dealing with avoidable care transitions among older adults without any restrictions to particular care settings.

Scope of the thesis

This work was performed within the TRANS-SENIOR project (TRANS-SENIOR) and was supported by the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie Actions [grant number 812656]. Eleven ESRs (Early Stage Researchers) spread across six countries (Netherlands, Belgium, Germany, Poland, Switzerland, Israel) participated over the course of the project. Moreover, seven partner organizations across participating countries collaborated within TRANS-SENIOR. The TRANS-SENIOR project was designed to train healthcare innovators who will shape future care for senior citizens. The dual focus of the TRANS-SENIOR research is on avoiding unnecessary care transitions and improving care for transitions that are needed. Eleven ESRs were allocated unique research topics within the field of care transitions among older adults.

The unique research topic of this doctoral work was focused on developing guidance on necessary and avoidable care transitions in senior citizens. Apart from purely research activities, and as part of TRANS-SENIOR project, the student also completed an academic secondment at a partner university in Israel and non-academic secondment across multiple sites of the Volkssolidarität Landesverband Sachsen-Anhalt. These secondments, coupled with regular online webinars and TRANS-SENIOR training events across European countries, fostered the student´s soft and academic skills, and provided practical insights into the care of older adults. These experiences indeed contributed positively to the overall understanding of the field of care transitions among older adults.

The goal of this doctoral research was to prepare a deliverable in the form of a practice tool to support decision-making by care professionals, senior citizens and informal caregivers on the avoidability of care transitions.

To accomplish the goal of this doctoral research three objectives were formulated:

1) Deliver a new consensus-based definition of "avoidable care transitions".

2) Deliver a comprehensive overview and critical analysis of existing assessment tools addressing avoidable care transitions among older adults.
3) Deliver the first of its kind online interactive database of identified assessment tools with instant filter options, to help users make an informed decision when choosing the right tool.
In order to address the objectives of this work, qualitative and quantitative research methods were used.

Structure and focus of the thesis

The cumulative thesis consists of two peer-reviewed articles in English with first authorship, published in open access PubMed indexed journals.
The first article titled "Avoidable Care Transitions: A Consensus-Based Definition Using a Delphi Technique" was published in Innovation in Aging with a journal impact factor of 7.0 (Makhmutov et al., 2023). This article addressed the first objective of this doctoral research and reports on a Delphi technique based on a literature review to deliver a new consensus-based definition of "avoidable care transitions" endorsed by a multidisciplinary and international panel of experts. A literature review identified existing definitions of "avoidable care transitions" and its related terms used interchangeably. In total 95 references were included, and 106 definitions were identified. Definitions were coded to find themes, resulting in three themes with two codes for each. The six codes laid grounds for the first round of a four-round Delphi survey. A pool of 99 experts from nine countries were invited to participate in the survey and provide feedback that was used to construct, refine and reach a consensus over a new definition with an agreement rate exceeding 90%. The new definition might enhance the common understanding of avoidable care transitions and is now ready for application in research and in quality and safety management in healthcare.
The second article titled "Assessment tools addressing avoidable care transitions in older adults: a systematic literature review" was accepted for publication in European Geriatric Medicine with a journal impact factor of 3.5. This article addressed the second objective of this doctoral research and reports on a systematic literature review overviewing assessment tools dealing with avoidable care transitions among older adults without limitation of the care settings. The search in three electronic databases revealed 1266 references, and screening for eligibility resulted in 58 articles for inclusion. In total, 48 assessment tools were identified, covering different concepts,

judgment processes, and transition destinations. A comprehensive overview was supplemented with a critical analysis of the identified assessment tools covering such aspects as objectivity, reliability and validity and other key characteristics. The evidence generated through synthesis and appraisal is now ready to be used as a source for informed decision-making for clinical and research communities when it comes to choosing the right tool.

Findings reported in both published articles formed the base of an online interactive database (www.decision4transition.com), thereby addressing the third objective of this doctoral research.

2. Discussion

While scanning the international scientific literature it became evident that two key elements in tackling avoidable care transitions, namely defining and identifying avoidable transitions, as discussed in this thesis, still raise some questions. It was crucial to deliver a clear definition for "avoidable care transitions", as it was logical to consider this as a prerequisite before addressing identification of avoidable transitions. The new definition embraces multiple perspectives, and most importantly, it includes a notion of "patient preferences", which has not been addressed in former definitions. All of the identified assessment tools are not comprehensive and encompass only one or a few dimensions, and "patient preferences" was among other perspectives missing in many tools. Therefore, the perspective of patient preferences was under-represented in both the former definitions and the identified assessment tools. This is a major drawback since patient perspectives could play a key role in fully understanding how to prevent avoidable transitions in care (Thwaites et al., 2017; van der Does et al., 2020). In some studies, the preventability is assessed by a few physicians, but their assessment can be constrained to look for causes primarily within their own specific setting (van der Does et al., 2020). Thus, a multidisciplinary approach may help to embrace a patient´s overall situation in terms of comorbidities, polypharmacy, nursing care, social and psychological needs (van der Does et al., 2020). Patient and relatives as a factor were viewed as a potential risk factor for avoidable care transitions (Kasdorf et al., 2021). Therefore, involving older adults and informal caregivers plays a crucial role in preventing avoidable care transitions and promotes not only person- and family-centred care (PFCC) (Backman et al., 2021), but also the concept of ageing in place (Rahmati et

al., 2023; Ratnayake et al., 2022). At the overarching level, health policy decisions are also relevant to older adults and informal caregivers, and influence the healthcare system in general (Kolade et al., 2024). Involving older adults and informal caregivers in health policy development informs policy-makers about their needs and outcomes, and can lead to carefully designed and relevant policies that enhance cost-effective healthcare and long-term interventions (Kolade et al., 2024). Indeed, this highlights the need for responsive health policies (Kolade et al., 2024). A recent review co-authored by a doctoral student further reports on strategies for engaging older adults and informal caregivers in health policy development (Kolade et al., 2024). Our findings reflect the importance of involving older adults and informal caregivers, and are therefore in line with solid evidence on this topic (Johnson et al., 2023; Munene et al., 2020; Rockville, 2023).

However, addressing the phenomenon of avoidable care transitions should not be limited by additionally accounting for patient preferences only. The approach to addressing avoidable care transitions should be as comprehensive as possible, meaning taking into account other aspects that play a role in dealing with avoidability of transitions, for example social, clinical and system level factors that were also reflected in a recently published paper (Kasdorf et al., 2021).

The new definition is rather general and non-specific to particular care settings and can serve as an overall guiding principle. Similarly, we found that there is no such thing as a gold standard among identified assessment tools, meaning that tools are mostly limited to specific care settings, and normally there is no consensus on which tool to use when given a particular care setting. Just like the new definition, the identified assessment tools are meant to support decision-making, with intention to supplement as opposed to substituting the care professional´s judgement.

These overarching findings are drawn from results stemming from both articles, and indicate that both publications are interconnected and follow a logical sequence, with first addressing “defining” and the second addressing “identification” of avoidable care transitions. Finally, the results of both articles formed the base of an online database.

Defining avoidable care transitions

A new consensus-based definition for “avoidable care transitions” was successfully reached after four Delphi survey rounds involving a multidisciplinary and international panel of experts comprising researchers and providers. The following definition was

considered final: “Avoidable care transitions (1) are without significant patient-relevant benefits or have a risk of harm outweighing patient-relevant benefits and/or (2) are when a comparable health outcome could be achieved in lower resource settings using the resources available in that place/health care system and/ or (3) violate a patient’s/informal caregiver’s preference or an agreed care plan”.
The new definition was based on former definitions and experts´ opinions.
The resulting definition addressed shortcomings of the former definitions, comprising three distinct dimensions: 1) the balance of benefit and harm to a patient, 2) resource consumption and 3) a patient´s or informal caregiver´s preferences. Former definitions were narrowly defined and touched mainly upon a single perspective. The first two dimensions of the new definition are based on and can be traced back to the former definitions. However, the third dimension relating to a patient´s or informal caregiver´s preferences was not embraced by the former definitions. The third element that related to violation of preferences and of an agreed care plan was incorporated into the consensus-based definition following the experts´ feedback during the Delphi survey.
A strength of this article lies in its well-established methodological approach. Around 30% of the invited participants were experts in the field of care transitions, while the rest provided various perspectives owing to their different backgrounds and countries.
However, this study also has limitations. First, there was a low response rate during the Delphi survey. Second, the literature search was limited to two databases and publications in English. Third, the study represents the views of only researchers and providers, which means that even though a patient perspective was incorporated into the new definition during the Delphi process, patients or their representatives were not personally involved in the process. Fourth, some potentially different and important ideas may not have been collected and incorporated in the resulting definition, since the Delphi study involved experts only from certain countries (predominantly European), while other countries with different social conditions were not covered. Fifth, most of the identified experts resided in Germany, which explains the prevalence of German experts in the pool of invited individuals. Nevertheless, since the survey did not collect personal data to guarantee anonymity, the number of participating experts from a particular country remained unknown.

Identifying avoidable care transitions

In a systematic literature review we identified 58 studies and reviewed 48 assessment tools including their sub-types that deal with avoidable care transitions.

Overall, identified tools differed in various ways, specifically in terms of the components covered, their focus, format of use, and data sources used. All of the tools are not comprehensive with respect to the dimensions covered, as they addressed only one or a few perspectives. Comparable findings were also reflected in former systematic reviews by Renom-Guiteras et al. (2014) and Kansagara et al. (2011).

We discovered that half of the tools have rather good discriminatory power. However, there is no gold standard assessment tool applicable to all types of avoidable care transitions. Tools mainly focus on specific patients, conditions or settings and may have the capacity to predict avoidability for specific situations, limiting their application to these situations only. Furthermore, there may be several tools that can be suitable to a specific situation. In light of aforementioned limitations, it is evident that some assessment tools are less useful in addressing avoidable care transitions.

Although assessment tools can be useful in clinical practice, it is worthwhile to bear in mind that they are meant to support decision-making and supplement the care professional´s judgement, instead of replacing it. Therefore, judgements stemming even from tools with good performance should be interpreted with care, and an ultimate decision should be made by a care professional.

The strength of this manuscript lies in its rich pool of identified assessment tools with further critical analysis, which was not limited to a particular care setting or acute care destination. Studies originating from only western countries were considered for inclusion in the review, which may be seen as a limitation as some potentially eligible studies as well as assessment tools might not have been included. However, to consider non-western countries would also be way out of the scope of this doctoral research, as this is an EU-funded project that primarily focuses on European countries, and the search was already extended beyond EU level to all western countries.

Practice tool to support decision-making by care professionals, senior citizens and informal caregivers on avoidability of care transitions

An online database (www.decision4transition.com) was launched that systematically summarises the findings of both published articles and allows to instantly filter identified assessment tools based on their properties. However, given limitations of the presented

tools and the evolving phase of the database that might not necessarily include all existing tools, there may not be a fully suitable tool for some specific situations. In this case, a new consensus-based definition presented in the online database can always be used as an overall guiding principle when addressing avoidable care transitions.
This underlines the importance of this work, which sheds light on various assessment tools and thus helps a reader to make an informed decision when choosing the right tool.

Implications for Research and Practice

Although the consensus-based definition could be used in research and in practice, it may require additional evaluation and enhancement. Further studies are needed to seek perspectives from a more diverse pool of participants such as frontline clinical providers, patients and their representatives. Involving experts from other non-European countries with developing healthcare systems will further enhance the definition and its utilization outside European countries. In addition, careful translation of the definition into various languages will ensure its widespread use. Overall, the new definition has dimensions related to clinical parameters, resource utilization and patients´ preferences and thus represents the voices of health professionals and the perspectives of healthcare service users. This delivers added value to the new definition as 1) it engages diverse stakeholders in the decision-making process and 2) it supports the concept of ageing in place, as older adults may prefer to stay in their homes as long as possible despite increased risk.
Further to the systematic review described in the second publication, it would be reasonable to suggest conducting another review on assessment tools with focus on non-western countries. This may yield additional information on assessment tools used in those countries as well as enrich the evidence presented in our online database.
Further to launching the online database, we suggest replenishing it with further assessment tools identified by other reviews or added on an individual basis. This will ensure a diversity of tools presented in the online database and attract a wider audience of clinicians and researchers who might benefit from such an initiative.
Active dissemination activities such as publications in scientific journals or participation in scientific conferences could ensure widespread use of an online database.
Moreover, to ensure the database initiative is developing and is kept up to date, open access could be granted to motivated volunteering enthusiasts who could add more

items to the portfolio of assessment tools, and double-check the database for errors and correct them as necessary. Alternatively, an institute or any other interested entity could take over the database and turn it into a commercial project, to invest raised revenue into further development of the database.

Since there is no gold standard assessment tool and in light of the mentioned drawbacks of identified assessment tools, it is reasonable to conclude that an assessment tool, which includes multiple dimensions and is tailored to a local context, has greater credibility. We would therefore advocate for comprehensive assessment tools tailored to local contexts.

In Germany, decision-making on avoidability of care transitions may vary from one place to another and is dependent on different local guidelines or on care professionals´ own judgement, meaning there is no single approach across the country. This may lead to inequality in decision-making, limited transparency, and fragmented care. In light of this, we believe the findings of this doctoral research and in particular the interactive database comprising identified assessment tools could serve as a starting point to harmonise and support decision-making by care professionals, senior citizens and informal caregivers on the avoidability of care transitions country-wide. This will promote equity, shared decision-making, strengthen the voice of senior citizens and informal caregivers, and enhance transparency of decision-making.

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4. Theses

1. The new consensus-based definition on “avoidable care transitions of seniors” embraces multiple dimensions, addresses the shortcomings of the former definitions, and promotes person- and family-centred care as well as the notion of aging in place.

2. All of the identified assessment tools addressing avoidable care transitions in older adults are not comprehensive with respect to the dimensions covered, making them less useful in addressing avoidable care transitions.

3. “Patient preferences” is an under-represented perspective in both, former definitions and identified assessment tools. Our findings reflect the importance of patient engagement and their preferences and are therefore in line with solid evidence on this topic.

4. Addressing the phenomenon of avoidable care transitions should not be limited by additionally accounting for merely patient preferences. It should rather be a comprehensive approach.

5. Selecting the right assessment tool might be challenging and time-consuming. Our new online database represents our research findings in interactive and systematic manner, and promotes informed decision-making when choosing the right assessment tool for addressing avoidable care transitions.

Declaration of contribution of all authors to the publications of this dissertation

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All of the authors participated in the design of this study. Study protocol preparation: RM. Development of the search string and database search as part of the literature review: RM. Development of the Delphi questionnaire: RM. Data collection: All authors. Data extraction: All authors. Data interpretation and analysis: All authors. Drafting of the manuscript: RM. Critical revision of the manuscript: All authors. Study coordination: RM. Supervision: GM, ME, SF. All of the authors read and approved the final manuscript.

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All of the authors participated in the design of this study. Study protocol preparation and registration: RM. Development of the search string and database search: RM. Screening, study selection and data extraction: RM, ARG, ACE, EMAF, CRG, SF. Data analysis: RM, SF. Risk of bias assessment: RM, ARG, ACE, EMAF, CRG, SF. Study coordination: RM. Supervision: GM, ME, SF. All of the authors contributed to interpretation of results, read and approved the final manuscript.

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Avoidable Care Transitions: A Consensus-Based Definition Using a Delphi Technique

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Abstract

Background and Objectives: Older adults are at increased risk of frequent transitions between care settings, even though some care transitions are avoidable. The term "avoidable care transitions" is not clearly defined in the research literature. This study aimed to find a consensus-based definition for "avoidable care transitions."

Research Design and Methods: This study was conducted as part of the TRANS-SENIOR research network. A 4-round Delphi survey was based on a literature review that identified existing definitions of "avoidable care transitions." Articles in MEDLINE via PubMed and CINAHL were searched. In total 95 references were included, and 106 definitions were identified. Definitions were coded to find themes, resulting in 3 themes with 2 codes for each.

Results: In total, 99 experts from 9 countries were invited, and the response rates in Delphi Rounds 1, 2, 3, and 4 were 37.5%, 19.1%, 33.3%, and 23.3%, respectively. Upon reaching the predefined minimum of 90% agreement, the following definition was declared as final: "Avoidable care transitions (a) are without significant patient-relevant benefits or with a risk of harm outweighing patient-relevant benefits and/or (b) are when a comparable health outcome could be achieved in lower resource settings using the resources available in that place/health care system, and/or (c) violate a patient's/informal caregiver's preference or an agreed care plan."

Discussion and Implications: Consensus on a definition for "avoidable care transitions" was reached by a multidisciplinary and international panel of experts comprising researchers and providers. The resulting definition consists of 3 distinct dimensions relating to the balance of benefit and harm to a patient, resource consumption, and a patient's or informal caregiver's preferences. The new definition might enhance the common understanding of avoidable care transitions and is now ready for application in research and quality and safety management in health care.

Translational Significance: The concept of "avoidable care transitions" is mainly interpreted from a single perspective: the health care system's or clinician's perspective. Nevertheless, no consensus on defining avoidable care transitions has been reached. A systematically developed definition seemed necessary. The resulting consensus-based definition embraces multiple dimensions and addresses the shortcomings of the former definitions. It can guide patients, clinicians, and policymakers in decision-making and lay the groundwork for practical solutions aimed at identifying and reducing avoidable care transitions, thus resulting in positive implications at the clinical, system, and patient levels. The new definition may also improve comparability among future studies.

Keywords: Literature review, Survey, Terminology

Background and Objectives

Older adults are at an increased risk of frequent transitions between care settings. These transitions are often associated with negative outcomes for the person concerned, such as a decline in autonomy, reduced quality of life, more adverse medical events, and even increased mortality, as well as for the health care system with increased direct and opportunity costs (Naylor & Keating, 2008; Storm et al., 2014).

Care transitions have been defined as changes in the setting of care provision (Morrison et al., 2016), encompassing care settings such as hospitals, nursing homes (NH), primary care, home care, and palliative care. Hence, a care transition is an umbrella term that embraces different types of transitions, such as readmission and discharge. Moreover, care transitions occur not only between care settings but also within care settings (World Health Organization, 2016), for instance, between wards and medical departments in the same hospital.

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Some of these care transitions are avoidable, and the phenomenon of avoidable transitions has received greater attention within the last two decades, resulting in more research due to the striking numbers of avoidable care transitions and due to the increased burden on patients and health systems (Enderlin et al., 2013; Gruneir, 2013; Hall et al., 2020; Lemoyne et al., 2019; Theresa Dreyer, 2014; Thwaites et al., 2017; van der Does et al., 2020; Yam, Wong, Chan, Leung, et al., 2010; Yam, Wong, Chan, Wong, et al., 2010). Thus, certain types of avoidable transitions are used as outcomes in research, such as re-hospitalization within 30 days of discharge, which is a widely accepted indicator of quality of care (Blume et al., 2021). Ambulatory care-sensitive conditions (ACSCs) are used as quality indicators in the primary care setting by the Organization for Economic Cooperation and Development (OECD), representing a subtype of avoidable hospital admissions attributed to specific chronic diseases (OECD, 2021). Although ACSCs cover more than 30 conditions for which hospitalization is deemed avoidable, there is no single, universal list of ACSCs that is internationally established and used (Purdy et al., 2009). Five core conditions (i.e., diabetes, hypertension, congestive heart failure, chronic obstructive pulmonary disease, and asthma) are considered important in European countries and show substantial variation between European countries (OECD & European Union, 2018, 2022). These five ACSCs accounted for over 4.6 million hospital admissions across the European Union (EU) in 2015, representing 37 million bed days and amounting to 5.6% of all admissions that might have been avoided (OECD & European Union, 2018).

Overall, hospital readmission rates vary widely across studies depending on the methodology and investigated population, ranging from 5% to 80% (van der Does et al., 2020; Yam, Wong, Chan, Wong, et al., 2010). The variability between studies regarding the magnitude of avoidable transitions can be explained to a certain extent by varying disease prevalence and availability of hospital care or institutional care or different assessment methods (e.g., chart review by one clinician, multidisciplinary meetings, or patient interviews) among studies and countries (Soong & Bell, 2015; van der Does et al., 2020; Yam, Wong, Chan, Wong, et al., 2010).

It is important to note that avoidable re-hospitalizations represent only a part of all avoidable care transitions. For example, avoidable hospital admissions occur among people living at home or in NHs (Afonso-Argilés et al., 2020).

Scanning the literature on the topic, it becomes obvious that the concept of "avoidable care transitions" and related terms are interpreted and used differently throughout all publications, and no consensus on a definition has been reached thus far (Gruneir, 2013; Lemoyne et al., 2019; Morphet et al., 2015; Nolte et al., 2012; Vossius et al., 2013). Some studies interpret the term "potentially avoidable" from a system and/or clinician perspective, and other studies assess "avoidability" from a patient perspective (Thwaites et al., 2017; Yam, Wong, Chan, Leung, et al., 2010). For example, patient factors may include socioeconomic status, health status, and a person's behaviors, such as noncompliance with treatment or failure of a person to seek prompt medical attention when symptoms recur (Yam, Wong, Chan, Leung, et al., 2010). Clinical factors refer to the appropriateness of assessment and treatment, for instance, the adequacy of clinical management and stabilization prior to discharge or outpatient care after discharge (Yam, Wong, Chan, Leung, et al., 2010). System factors normally relate to the availability, accessibility, and coordination of care across the health care system, such as the provision of resources at home that meet a person's needs (Yam, Wong, Chan, Leung, et al., 2010). These factors are also reflected in two very recent studies, confirming that these factors are still relevant and important today. For example, Kasdorf et al. (2021) identified four factors for potentially avoidable transitions: the health care system, organization, health care professionals, and patients and relatives. These four factors could be grouped into more general, overarching factors, such as system-, clinician-, and patient-related factors, as described earlier. Another study by Schippel et al. (2022) identified three risk factors for burdensome transitions, namely, transparent communication in the face of an incurable disease, coordination of care, and consideration of patient preferences. These three factors, as in the previous example, could also be grouped into overarching clinician-, system-, and patient-related factors.

A comprehensive consensus-based definition for "avoidable care transitions" seems timely, and the potential for forestalling avoidable transitions appears to be expansive. It is important to involve researchers and providers when addressing the avoidability of care transitions. A clear definition might foster a mutual understanding among different stakeholders and patients to support decision-making and care planning.

The aim of this study was to deliver a new research-informed, consensus-based definition for "avoidable care transitions."

Research Design and Methods

This study comprised two consecutive parts: (a) a preparatory literature review as the basis for (b) a Delphi survey.

Literature Review in Preparation for the Delphi Survey

The objective of the literature review was to identify definitions of interest, that is, existing definitions of "avoidable care transitions" and its related terms that were used interchangeably or described the same issue.

Search strategy

A literature search in the MEDLINE via PubMed and CINAHL electronic databases was conducted in two steps between February and April 2020. The first search step was sensitive and yielded a broad range of results, while the second search step was more specific and provided fewer but better-matching results. The two search steps were independent. Part of the results from the first search and all of the results from the second search were reviewed. The searches included the words avoidable, transition, and health care, and their related terms. We did not include specific search terms for the population or care settings because the aim was to gain a broad understanding of avoidable care transitions. A summary of the search terms is shown in Table 1. The reference lists of the included publications were screened for further eligible publications that included additional definitions. The literature review aimed to achieve data saturation by retrieving a complete representation of definitions of interest, rather than having a complete representation of the literature by retrieving every single definition from every single publication that exists. Screening and data extraction were performed simultaneously, and the stage when further retrieved

Table 1. Search Terms in the Literature Review

Order	Terms
First search	avoidable, inappropriate, burdensome, unfavorable, undesirable, preventable, inadequate, transit*, transfer*, discharge, shift, handover, hospitals*, re-admission*, handoff, health*, nurs*, medic*, hospital*, care.
Second search	avoid*, inappropriate, burden*, unfavour*, undesir*, prevent*, inadequate, transit*, transfer*, discharge*, admission*, readmission*, visit*, stay*, re-hospitali*.

Note: "*" indicates that a search term may have various endings after an asterisk. For example, "avoid*" can be "avoid," "avoidable," "avoidability," and so on.

definitions did not add new information to core ideas discovered in the already retrieved definitions was defined as data saturation. Two researchers independently conducted the full-text screening (R.M. and C.M.J.). Any conflicts were resolved by a third reviewer.

Inclusion criteria

English-language references published from January 2005 onwards were considered for inclusion. The literature review by Kralik et al. (2006) explored how the term "transition" has been used in the health care literature; they searched for papers published between 1994 and 2004. The authors of the review noted that the concept of transition had undergone altered understandings in the social science and health disciplines over time, with nurses contributing to more recent understandings of the transition process (Kralik et al., 2006). Taking into account this literature review and the notion that a concept evolves over time, we decided to search for articles published after 2004 (i.e., from January 2005) to find the most relevant definitions of interest, and at the same time, this time frame allowed for some variation in the definitions that we believe only enriched our search results.

A study was deemed eligible if it presented a complete or partial definition of the subject of "avoidable care transitions" and related terms. Complete definitions were included that consisted of definiendum and definiens, where a definiendum was an "avoidable care transition" or related/synonym terms, and definiens were characteristics of such terms. Partial definitions comprised of definiens were also included (i.e., descriptions or explanations of a term that could be implicitly inferred as definiens for a definiendum).

Synthesis

Retrieved definitions were inductively coded to identify themes. The coding was conducted by two researchers (R.M. and S.F.), and the codes were further reviewed, commented on, and adjusted several times until the research team members (R.M., S.F., G.M., and M.E.) reached a full consensus.

Delphi Survey

The Delphi survey is a method designed to gather the most reliable consensus from a group of experts. This is achieved by a series of structured questionnaires or so-called rounds, coupled with controlled opinion feedback (Dalkey & Helmer, 1963). Researchers employ the method to translate scientific knowledge and professional experience into informed judgment and to support decision-making (Akins et al., 2005). This approach enables feedback from a greater number of experts than could feasibly be included in a group or committee meeting and from participants who are geographically widespread. The following four fundamental principles are considered important for defining a procedure as a "Delphi": anonymity, iteration, controlled feedback, and statistical aggregation of group responses (Rowe & Wright, 1999). The Delphi method is used to make the best use of available information but not to create new knowledge (Bleijlevens et al., 2016).

Participants

This study is part of the TRANS-SENIOR network, an EU-funded project with an overall focus on transitional care innovation for older adults. TRANS-SENIOR includes 11 early-stage researchers, seven partner organizations including the World Health Organization, and beneficiaries in six countries: Germany, the Netherlands, Belgium, Switzerland, Poland, and Israel.

Candidates for the Delphi survey had to be fluent in English and affiliated with the health care system (i.e., a member of a health care profession, working in a health care sector, research in health care, etc.). Selected members within the TRANS-SENIOR Consortium, among other individually chosen participants identified via the research team's professional networks, were invited to participate in the Delphi survey. TRANS-SENIOR members represented a good sampling pool for the Delphi survey because they are experts in the field of transitional care among older adults. The TRANS-SENIOR Consortium was also encouraged to invite other colleagues in their network. This ensured the richness of information gathered from the experts because they were located in different countries, namely, Germany, the Netherlands, Belgium, Switzerland, Poland, Israel, Iraq, Spain, and Austria.

According to former studies that recruited from 10 to 100 experts (Akins et al., 2005; Armstrong et al., 2005; Bleijlevens et al., 2016; De Vet et al., 2005; Howell & Kemp, 2005; Nekolaichuk et al., 2005; Stolee et al., 2005), we aimed for approximately 20–50 experts in our sample as a good and feasible compromise, because too few experts may be insufficient for data saturation and involving more than 100 participants could make data analysis too resource-consuming.

Delphi strategy

The Delphi questionnaire was pilot-tested with three individual representatives of the target group and was further adapted before commencing with the first round of the official Delphi survey.

The Delphi survey was conducted between November 2020 and July 2021. The internet-based survey tool Qualtrics was used as a platform. In each round, the participants received an invitation email with a brief study summary and a link asking them to participate in the online survey. They were asked to forward the invitation email to other relevant experts. The invited individuals were also asked to complete the survey in approximately 2 weeks; a reminder email was sent to the whole sample. An invitation email was sent to all identified experts over all rounds (i.e., invitations to participate were not limited only to those who completed earlier rounds).

Codes that were synthesized during the literature review formed the base for the first round of the Delphi survey. The participants were provided with these codes and with corresponding examples to further illustrate the codes. They were asked to rank the importance of the proposed codes from

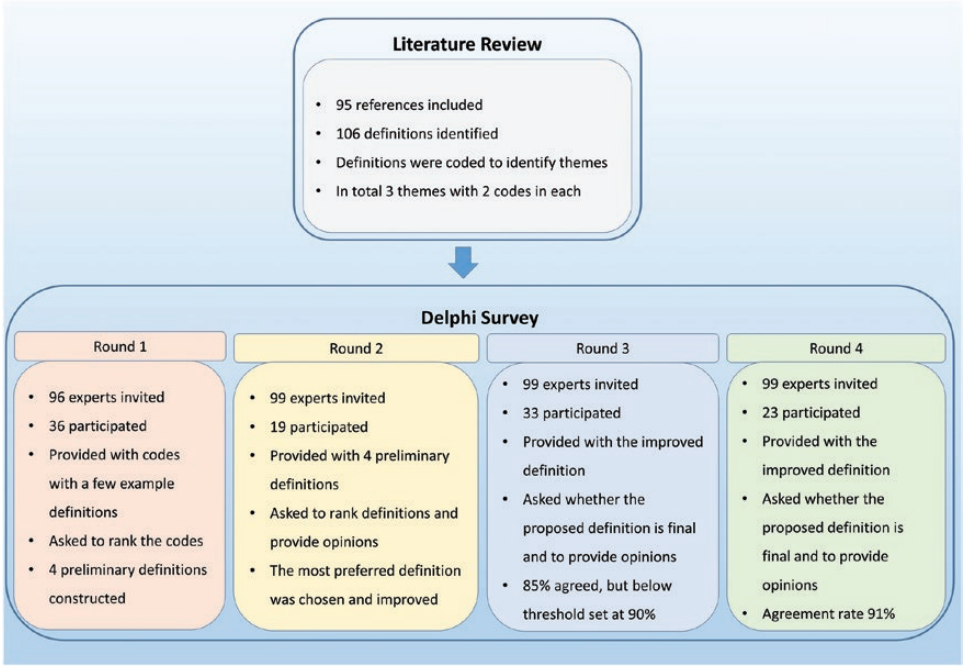

Figure 1. Flowchart of the study procedures and participant selection process.

0 to 10, in which 0 was "*not at all important*" and 10 was "*extremely important*," and to provide professional opinions. Four preliminary definitions were developed by two researchers (R.M. and S.F.) based on the codes and participants' feedback from Round 1. We developed four preliminary definitions with different formulations and tried to keep all key meanings/ideas that emerged from the codes and feedback in each definition. This allowed some variation among four preliminary definitions while still preserving common key meanings/ideas. Four preliminary definitions were further reviewed, commented on, and adjusted several times until the research team members reached a full consensus. In Round 2, the participants were provided with four preliminary definitions and were asked to provide their professional opinions and rank the definitions in order of preference. In Round 3, the participants were asked whether the proposed definition was final and if the answer was "no," to provide their professional opinions on how to further improve the proposed definition. Round 3 could be iteratively repeated until an agreement of at least 90% was reached.

Delphi round analysis

The research team calculated a statistical aggregation of the group responses and performed a qualitative analysis on open-formulated text data gathered from the Delphi survey rounds. During the qualitative analysis, the proposed definitions were altered by reformulating or incorporating or removing some elements from the definitions according to the experts' feedback. Upon completion of each round, a summary of the findings from the previous round was sent to the pool of identified experts. Following a study protocol (not published), the predefined agreement rate in the group of participants concerning a proposed definition was set at a minimum of 90%, which corresponds to that in a comparable study by Bleijlevens et al. (2016). Upon fulfillment of this requirement, the proposed definition was claimed as final, meaning that a consensus regarding the definition had been reached. Following the completion of the Delphi survey, the final definition was communicated to all the experts.

Results

The literature review revealed more than 100 definitions, and consecutive synthesis yielded six codes in total. During the survey, 96 experts were invited to the first round and 99 to the following rounds, and the response rates in Delphi rounds 1, 2, 3, and 4 were 37.5%, 19.1%, 33.3%, and 23.3%, respectively. At the time of the survey, experts were located in nine countries, and the majority of them were employed as researchers with vast clinical experience; some held clinical positions such as general practitioner, physician, geriatrician, or nurse. Experts were from various backgrounds, including public health, primary care, medicine, nursing science, epidemiology, health science, emergency medicine, geriatrics, health services research, and health economics. Four Delphi survey rounds were conducted, and consensus was reached on a new definition for "avoidable care transitions" with a 91% agreement rate. A flowchart of the study procedures and participant selection process is shown in Figure 1.

Literature Review

As a result of the review, 95 references were included, and 106 definitions were identified. A list of the 95 included references is provided in the Appendix. The key messages described in the identified definitions led to a total of six codes. Each code was assigned a short description and grouped into one of the themes, resulting in three themes with two codes for each. A summary of the themes and codes is shown in Table 2.

Delphi Survey

Round 1

In total, 96 experts were identified and were sent an invitation email to participate in Round 1 of the Delphi survey. The invited experts were located in nine countries: Germany

(n = 66), Poland (n = 3), Belgium (n = 9), the Netherlands (n = 7), Switzerland (n = 6), Israel (n = 2), Spain (n = 1), Iraq (n = 1), and Austria (n = 1). A total of 36 experts participated in the survey (37.5% response rate). On a scale from 0 to 10, each code was rated 5 or above by more than 83% of the experts, implying that all the codes were relevant and important. The vast majority of the participants agreed that the proposed six codes were comprehensive. The experts also suggested taking a patient's and his or her caregiver's preferences into account. Finally, four preliminary definitions were constructed using the codes and the experts' suggestions (Table 3).

Round 2

Three additional experts from Israel joined the expert panel: one with a background in geriatric and internal medicine, one with a background in geriatric medicine, and another with a background in public health. In total, 99 experts were sent an invitation email to complete Round 2, 19 of whom participated in the survey (19.1% response rate). As a result of this round, the most preferred definition was chosen and modified according to the experts' feedback. The most preferred definition and its modified version are shown in Figure 2. The definition was adjusted by removing two elements from it and reformulating some parts. The first element was removed, as some experts suggested that avoidable care transitions are not always short-term and not necessarily frequent. Another element, "inadequate diagnosis/therapy/health care management," was also removed, as it was believed to be too broad and very difficult to determine. It was also suggested to incorporate an aspect such as "violation of established care plan." Finally, the modified definition was proposed to the experts in Round 3.

Round 3

Ninety-nine participants were invited to participate in Round 3, 33 of whom participated in the survey (33.3% response rate). In this round, almost 85% of the expert panel agreed with the proposed definition. However, the agreement rate was below the set threshold of 90%. The definition was further adjusted in accordance with the feedback. The proposed definition and its adjusted version are shown in Figure 2. Six commentaries were provided on how to improve the proposed definition. The majority of the commentaries were accounted for and incorporated into the proposed definition. However, some commentaries were not accounted for in the proposed definition because our research team considered them to be very detailed and specific. The rationale behind this is that incorporating very detailed and specific aspects would considerably extend the definition, thus making it impractical or inconvenient to use. The definition was improved by adding two elements and reformulating some parts. The first element related to the "usage of resources available in a particular place or health care system." The second added element related to when "nobody accepts responsibility for care." Finally, the adjusted definition was proposed in Round 4.

Round 4

The 99 participants were invited to participate in Round 4, 23 of whom participated in the survey (23.2% response rate). The experts' commentaries were accounted for, and the following component was removed from the proposed definition: "when decision-makers do not properly accept the responsibility for care." In the end, 21 out of 23 individuals agreed with the definition, thus resulting in an agreement rate of 91%.

Table 2. Summary of Themes and Codes from 95 References on Avoidable Care Transitions

Theme	Code	Description
1. Identification by frequency, shift of responsibility, and low extent of measures/ interventions	Code 1. Short-term, highly frequent transitions and back and forth "ping-pong" (repeating between place A and place B), which can be related to responsibility aversion and finding the right place of care.	Frequent transitions between care settings with a short length of stay in between, with a likelihood of little benefit. **Mainly back and forth from the same settings or institutions** with the intention to avoid taking responsibility or due to being unable to find an appropriate place of care.
	Code 2. Short-term, highly frequent transitions (i.e., chain-like, when a care setting is an intermediate/temporary step with inadequate care in the overall transfer process that could have been avoided, like from place A to place B, to place C, and so on).	Frequent transitions between care settings with a short length of stay in between, with the likelihood of little benefit. **One setting after the other with inadequate care taking place in single settings between the origin and destination**, with the intention to transfer responsibility or due to being unable to find the proper place of care.
2. Benefit–harm balance	Code 3. Absence of benefit (MCID: minimal clinically important difference)	Transitions where there are neither beneficial nor harmful effects.
	Code 4. Presence of harm.	Transitions with associated harm OR harm that outweighs the positive effects (note: often associated with end-of-life care OR terminal illness).
3. Existing alternatives with equivalent or even better outcomes and lower resource utilization	Code 5. Current opportunities.	Transition where the same/similar outcome can be reached in an alternative setting with possible lower resource utilization.
	Code 6. Foregone opportunities.	Inappropriate use of resources in the past may lead to avoidable transitions in the present or could include diagnosis/therapy-related errors; management-related errors; and quality of provided services.

Table 3. Preliminary Definitions Generated from Round 1 Delphi Survey and Submitted for Round 2 Feedback

Version	Definitions
1	Avoidable care transitions (1) are short-term and frequent between care settings or (2) are without significant benefit to a patient's quality of life or (3) imply a risk of harm outweighing the benefit to a patient's quality of life or (4) indicate that the same health outcome is feasible in lower resource settings or (5) are caused by inadequate diagnosis/therapy/health care management or (6) violate a patient's preference.
2	Avoidable care transitions are transitions (1) where no proper place of care could be found, indicated by frequent changes in care settings or (2) caused by inadequate diagnosis/therapy/health care management or (3) where the same health outcome is feasible in lower resource settings or (4) without potential significant benefit or with a high risk of harm to a patient's quality of life or (5) where a patient's preference is violated.
3	Avoidable care transitions are transitions (1) that are short-term and frequent between care settings or (2) where responsibility is not properly taken or (3) where no proper place of care could be found or (4) without potential significant benefit or with a high risk of harm to a patient's quality of life or (5) where the same health outcome is feasible in lower resource settings or (6) caused by inadequate diagnosis/therapy/health care management or (7) where a patient's preference is violated.
4	Avoidable care transitions are transitions (1) that are burdensome or (2) that happen in the end-of-life stage of a patient or (3) where a patient's preference is violated or (4) without potential significant benefit or with a high risk of harm to a patient's quality of life or (5) where the same health outcome is feasible in lower resource settings or (6) caused by inadequate diagnosis/therapy/health care management.

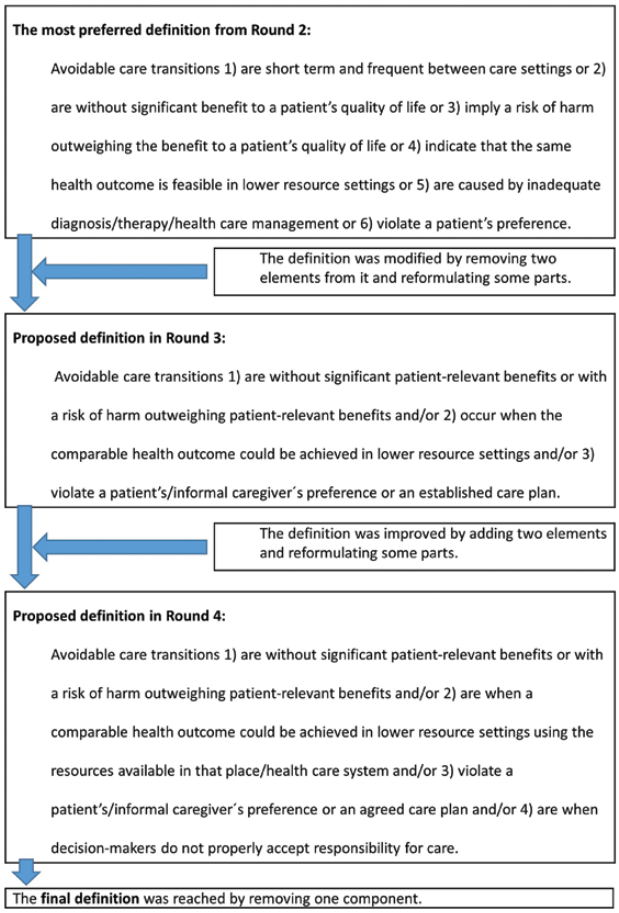

Figure 2. Flow diagram shows how the preferred definition from Round 2 was modified in subsequent rounds to reach its final version.

The following definition was considered final: "Avoidable care transitions (1) are without significant patient-relevant benefits or with a risk of harm outweighing patient-relevant benefits and/or (2) are when a comparable health outcome could be achieved in lower resource settings using the resources available in that place/health care system and/or (3) violate a patient's/informal caregiver's preference or an agreed care plan."

Discussion

Consensus on the definition of "avoidable care transitions" was successfully reached after four Delphi survey rounds by a multidisciplinary and international panel of experts comprising researchers and providers. The new systematically developed definition addresses several limitations that were inherent in former definitions.

The resulting definition consists of three distinct dimensions relating to the balance of benefit and harm to a patient, resource consumption, and a patient's or informal caregiver's preferences. Former definitions were narrowly defined and touched mainly upon a single perspective. For example, Ouslander et al. (2009) referred to the benefit and risk of harm to a patient in the case of hospitalization among NH residents, where such transitions may be "… inappropriate, because the transfer exposes NH [nursing home] residents to additional risks associated with hospitalization, without substantial potential benefit for the residents' clinical and functional status or quality of life." Another example shows the perspective of resource consumption: "… inappropriate transfers represent situations in which care in a lower-cost setting (i.e., the NH) would be as safe as and less disruptive than care in a higher-cost hospital setting" (Lemoyne et al., 2019). The third element that related to the violation of preferences and of an agreed care plan was incorporated into the consensus-based definition following the experts' feedback during the Delphi survey. The definition developed in this study was based on former definitions and experts' opinions and was approved by the international group of experts during the Delphi process. The development process of the definition involved incorporating, removing, and reformulating some elements. In particular, as a result of Delphi Round 1, four preliminary definitions were constructed using the codes and by additionally incorporating one element on a "patient" factor, as was suggested by the experts. As a result of Round 2, the most preferred definition was modified by (a) removing two elements on "short-term and frequent transitions" and "inadequate health care management," (b) incorporating an element on "violation of the established care plan," and (c) reformulating some elements. As a result of the subsequent rounds, the final definition was achieved by incorporating the element of "resource usage in a particular place or health care system," followed by reformulation of some elements. The new definition is more saturated and embraces multiple perspectives, thus overcoming the shortcomings of former

definitions identified through the literature review. This was a necessary and important step to facilitate the understanding of "avoidable care transitions."

The new definition was developed using well-established methodological approaches based (a) on the relevant scientific literature acquired via a systematic literature search process and (b) on a reliable consensus of opinion from a group of experts by using a Delphi technique. This combination of methodological approaches has also been implemented in a number of studies in various research disciplines (Bleijlevens et al., 2016; Guseva Canu et al., 2021; Vakil et al., 2006; van der Horst et al., 2017). Other studies employed only the Delphi survey (Adams et al., 2021; Dribin et al., 2020; van den Steene et al., 2019; Zanker et al., 2019). The present study was as complex as these examples and aimed to develop new definitions for various topics, such as physical restraints, multiple, and complex needs among children, anaphylaxis outcomes, sarcopenia, hyperacusis, occupational burnout, and gastroesophageal reflux disease. Former studies dealing with other topics have substantially contributed to the harmonization of their corresponding fields of study and were well-received and frequently cited (Bleijlevens et al., 2016; Guseva Canu et al., 2021; Vakil et al., 2006; van der Horst et al., 2017). Therefore, we expect a comparable effect and an impact on transition research.

Strengths and Limitations

A strength of this study is that a well-established methodological approach was used to reach a consensus over a new definition. Approximately 30% of the invited experts were members of the TRANS-SENIOR Consortium with a focus on care transitions. The rest of the participants strengthened this study further by providing various perspectives because they came from different countries and diverse backgrounds.

A limitation of our Delphi survey was the relatively low response rate among experts invited to participate. Nevertheless, the recruitment aim of approximately 20–50 experts was reached. Second, the literature search was limited to only two databases; however, data saturation was achieved. This study presents the views of only researchers and providers, which leads to another limitation: even though a patient perspective was incorporated into the new definition during the Delphi process, patients or their representatives were not personally involved in the process. Furthermore, the literature review was limited to English-language publications. On the other hand, it was rational to consider English-language publications because the literature review focused on terminology in English, and the results were reported in English. Within and among countries, there are considerable differences in health that are closely linked with social conditions (Commission on Social Determinants of Health, 2008). Political, social, and economic forces in turn shape these conditions (Commission on Social Determinants of Health, 2008). Obviously, different countries have different social conditions, which might also affect how people view and perceive health and health care. This leads to another limitation of this study: some potentially different and important ideas may not have been collected and incorporated in the resulting definition, because the Delphi study involved experts only from certain countries (predominantly European), while other countries with different social conditions were not covered. Hence, this study represents the views of experts from predominantly developed countries with developed health systems, which may limit the applicability of the findings, especially for other, non-European countries or countries with developing health care systems. In addition, invitations to participate in the Delphi study were sent to experts identified by using our institute's network. Most of the identified experts resided in Germany, which explains the prevalence of German experts in the pool of invited individuals. However, because the survey was anonymous, we did not have data on those who participated, as participants' characteristics were not collected to guarantee anonymity. Hence, the number of participating experts from a particular country remained unknown.

Implications and Future Research

Although the consensus-based definition could be used in research and in practice, it may require additional evaluation and enhancement. Further studies with different designs are needed that seek the perspectives of a more diverse pool of participants, for example, frontline clinical providers, patients, patient representatives, and patients' families and caregivers. Involving experts from other, non-European countries or countries with developing health care systems will certainly be beneficial to further enrich the definition. Careful translation of the definition into various languages will ensure its widespread use.

Growing research points to the importance of identifying and reducing avoidable care transitions due to the increased burden on patients and health systems. However, the phenomenon of avoidable care transitions has been interpreted differently across studies, and no consensus has been reached thus far. The absence of a commonly accepted, consensus-based definition for this phenomenon may have contributed to limited comparability across studies and hindered the identification of avoidable transitions. Efforts have been made to discriminate avoidable care transitions from other types of transitions, but there is still disagreement on how to systematically define and identify such avoidable care transitions (Shams et al., 2015). It seemed logical to systematically define the phenomenon of avoidability in the first place before addressing the identification of avoidable care transitions. Therefore, it was vital to come up with a new definition first to "speak the same language" when addressing avoidable care transitions.

The new definition is rather general and nonspecific to a particular care transition and population. The definition's multiple aspects allow its use across different care settings in countries with predominantly developed health care systems. The definition can be used not only as a single guide but also in conjunction with other means in the decision-making process, such as local guidelines and expert opinions. Furthermore, it can be used not only to develop new guidelines, policies, and decision tools that touch upon avoidable care transitions but also to analyze and adapt existing tools.

In the case of a transition from an NH to a hospital, decision-makers guided by the new definition will ask themselves the following questions: Will the patient receive a much higher potential benefit in a hospital setting as opposed to the risks associated with the transfer or staying at a nursing home? Can the patient achieve a comparable health outcome in a lower resource setting, for example, in an ambulatory care setting? Does the patient or his or her caregiver prefer a transition to a hospital? Asking oneself these questions in practice may be challenging. However, this can be achieved by designing educational programs that are rooted in

comprehensive theoretical frameworks for the implementation of innovations (e.g., active implementation frameworks, www.activeimplementation.org).

As older adults tend to prefer aging in place (Vasunilashorn et al., 2012), their right of choice becomes particularly essential in light of the increasing risk of frequent care transitions when a person gets older. This points to the importance of patient preferences in decision-making, which was addressed in the consensus-based definition but was not covered in the former definitions. The new definition has dimensions related to clinical parameters, resource utilization, and patients' preferences and thus represents the voices of health professionals and the perspectives of health care service users. This delivers added value to the new definition as (1) it engages diverse stakeholders in the decision-making process and (2) it supports the concept of aging in place, as older adults may prefer to stay in their homes as long as possible despite increased risk.

Because older adults are at increased risk of frequent transitions and associated negative outcomes, it is possible that the new definition may be applied more frequently in situations involving older adults as opposed to situations involving younger individuals. Thus, older adults may represent a larger proportion of the population who might benefit from decisions guided by the new definition. In particular, this may help to reduce unnecessary transitions and associated negative outcomes such as moral hazard and unnecessary treatment for older adults. In addition, this may save substantial health care costs, which may be further allocated to the medical management of those older adults who truly need it.

Implications

The adverse impact of avoidable care transitions and the lack of consensus on what avoidable care transitions mean underline the importance of this research. The newly developed definition has the potential to improve the shared understanding of avoidable care transitions and is now available for use in a variety of contexts, including policy-making, intervention development, research, and quality and safety management in health care. In particular, the consensus-based definition can further guide studies aimed at identifying and reducing avoidable care transitions and support the classification and synthesis of these studies.

Supplementary Material

Supplementary data are available at *Innovation in Aging* online.

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Conflict of Interest

None.

Data Availability

All the data generated or analyzed during this study are not publicly available. The data analysis from the literature review may be provided by the corresponding author upon reasonable request. Delphi survey data are not available because the participants were informed that access was granted only to the research team.

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Author Contributions

All of the authors participated in the design of this study. Data collection: All authors. Data extraction: All authors. Data interpretation and analysis: All authors. Drafting of the manuscript: R. Makhmutov. Critical revision of the manuscript: All authors. Supervision: G. Meyer, M. E. Ellen, and S. Fleischer. All of the authors read and approved the final manuscript.

Ethics Approval and Consent to Participate

An official document was received on October 29, 2020 (# 2020-179), from the Ethical Committee (Medical Faculty, Martin Luther University Halle-Wittenberg) stating that no formal ethical approval was needed because this study was conducted in accordance with the data protection requirements and the ICH-GCP guidelines. Information on the survey was sent directly to the potential participants. All the addressed individuals had the opportunity to ask questions about the survey beforehand. In the Introduction section of the online Delphi survey, participants were informed that starting the survey indicated their informed consent to take part in the survey and to provide the data for analysis.

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Appendix

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REVIEW

Assessment tools addressing avoidable care transitions in older adults: a systematic literature review

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Key summary points

Aim To identify and comprehensively describe the assessment tools addressing avoidable care transitions that can support stakeholders´ decisions on older adults.

Findings All of the 48 reviewed tools are not comprehensive with respect to the dimensions covered, making them less useful in addressing avoidable care transitions. The review findings are systematically summarised in a clinically accessible website (www.decision4transition.com), which allows to instantly filter assessment tools based on their properties.

Message The review findings and the online database are now ready for use in clinical routine to support informed decision-making of stakeholders when choosing the right assessment tool addressing avoidable care transitions.

Abstract

Purpose The phenomenon of avoidable care transitions has received increasing attention over the last decades due to its frequency and associated burden for the patients and the healthcare system. A number of assessment tools to identify avoidable transitions have been designed and implemented. The selection of the most appropriate tool appears to be challenging and time-consuming. This systematic review aimed to identify and comprehensively describe the assessment tools that can support stakeholders´ care transition decisions on older adults.

Methods This study was conducted as part of the TRANS-SENIOR research network. A systematic search was conducted in MEDLINE via PubMed, CINAHL, and CENTRAL. No restrictions regarding publication date and language were applied.

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Results The search in three electronic databases revealed 1266 references and screening for eligibility resulted in 58 articles for inclusion. A total of 48 assessment tools were identified covering different concepts, judgement processes, and transition destinations. We found variation in the comprehensiveness of the tools with regard to dimensions used in the judgement process.

Conclusion All tools are not comprehensive with respect to the dimensions covered, as they address only one or a few perspectives. Although assessment tools can be useful in clinical practice, it is worth it to bear in mind that they are meant to support decision-making and supplement the care professional´s judgement, instead of replacing it. Our review might guide clinicians and researchers in choosing the right tool for identification of avoidable care transitions, and thus support informed decision-making.

Keywords Decision-making · Preventable care transitions · Decision support tools · Older adults

Background

Older adults have an increased risk of frequent transitions across care settings. These transitions are often associated with negative outcomes for the person concerned, such as a decline in autonomy, reduced quality of life, more adverse medical events, and even increased mortality, as well as increased direct and opportunity costs for the healthcare system [1–3]. Care transitions have been defined as changes in the care provision setting [4, 5], encompassing care settings, such as hospitals, nursing homes, primary care, home care, and palliative care. Therefore, a care transition is an umbrella term that covers different types of transitions, such as (re)admissions and discharges. In addition, care transitions occur not only between care settings but also within care settings [6, 7], for example between wards and medical departments in the same hospital.

Some of these care transitions are regarded as avoidable. The phenomenon of avoidable care transitions has received increasing attention over the last decades due to its frequency and associated burden for the patients and the healthcare system [8–13].

Hospital (re)admission is one of the most common types of avoidable care transitions. International studies indicate a wide range of avoidable (re)admission rates from 5 to 79% [11, 13–17]. To a certain extent, the variation is likely due to different data collection methods, different populations among studies and countries, and differences in the definition of "avoidable" across settings and agencies [11, 13, 14, 16, 18].

It is of utmost importance to reduce the number of avoidable care transitions to minimize the burden on patients and healthcare systems. To achieve this, it is essential, first and foremost, to establish a clear definition of avoidable care transitions. Second, the identification of these avoidable care transitions becomes imperative. A recent study by Makhmutov et al. [19], addressed the challenge of a transparent definition and delivered a comprehensive consensus-based definition for "avoidable care transitions" endorsed by an international panel of experts. Existing tools are intended for specific settings and/or patients, implying that there is no "gold standard" tool that can be applied to all types of care transitions. Even within a specific type of care transition (e.g., care transitions from long-term care facilities to hospital), studies apply different assessment tools to identify avoidable care transitions [14].

Reviews that overviewed assessment tools or interventions dealing with avoidability of care transitions focused on specific types of care transitions [14, 20–23]. However, no systematic literature review has evaluated the scientific evidence on the existing assessment tools dealing with avoidable care transitions among older adults without any restriction to particular care settings. Such a systematic review would not only extend and update the previous reviews but also might guide researchers and clinicians in informed decision-making in choosing the right tool.

Thus, the aim of our systematic literature review is twofold: (1) to provide a comprehensive overview of assessment tools dealing with avoidable care transitions among older adults and (2) to provide a critical analysis of the identified assessment tools.

Methods

Search strategy and selection criteria

The review protocol has been registered under PROSPERO registration number CRD42022312516. A systematic search was conducted in MEDLINE via PubMed, CINAHL, and CENTRAL on June 23, 2022. No restrictions regarding publication date and language were applied. Since the review is embedded within the TRANS-SENIOR project on older adults and European long-term care systems, we included studies that examined older adults aged 60 years and above and that were conducted not only in European countries, but also in other Western countries. Western countries cover European countries (EU 27 countries and the UK, Iceland, Norway, Switzerland), North America (USA, Canada), Australia, and New Zealand.

We subdivided the articles into two categories and included studies which used (1) assessment tools (fully or partially) as an intervention to support decision-making on avoidability of care transitions compared to usual care (e.g., including alternative interventions or no interventions at all, depending on normal care standards), and (2) assessment tools as an instrument to determine risk for or incidence of avoidable care transitions. For the first category, RCTs and controlled trials were eligible for inclusion. For the second category, all study designs were considered, except for editorials, conference abstracts, commentaries, and opinion papers. Articles were excluded when they did not meet the inclusion criteria.

The search string was developed by one author (RM), reviewed by the co-authors (SF, GM, and ME), and tested multiple times until consensus on the final search string was reached by all of the authors. A medical librarian was not involved in designing the search strategy. The complete final search string is displayed in Supplementary file 7 (*Final search string*), and embraces search terms such as "tool", "avoidable", "transition", and "older adults" and their related terms.

All search results from the three databases were imported to the EndNote citation manager software and checked for duplicates automatically and manually. Remaining studies were exported to the Covidence systematic review management software. A list of included and de-duplicated studies was screened twice in Covidence software, to identify eligible articles for both categories. Title and abstract, and full-text screening were performed independently by a pair of reviewers (RM and ARG/ACE/EMAF/CRG/SF). Forward citation tracking was conducted, and reference lists of included studies were screened to identify relevant references.

Data analysis

Included studies

The systematic literature review followed the PRISMA reporting guidelines.

Two PRISMA flow diagrams display the screening process of studies included in category 1 and 2, followed by summary of the included studies.

Two different data extraction forms were developed and pilot-tested for the two categories. Two researchers (RM and ARG/ACE/EMAF/CRG) independently extracted data on the study characteristics and the assessment tools. In the case of disagreement, a third author was consulted to reach consensus.

Data extraction forms included I) information on study characteristics such as design, aims, population, and settings; II) details on identified assessment tools such as concepts covered by the assessment tools, target population, type of care transitions targeted, how an assessment tool is organised (i.e. table form, check-list or other), where used or tested; and III) details on study outcomes as reported.

We conducted a risk-of-bias assessment of included studies within category 1. Two reviewers from the research team independently reviewed each study using the revised Cochrane risk-of-bias tool for randomized trials (RoB 2) [24]. Results were compared, and in the case of disagreement, a third reviewer from the research team was consulted to reach consensus. We refrained from formal risk-of-bias assessment of studies within category 2. The research team considered that risk-of-bias assessment in this case would not have provided any substantial information.

Identified assessment tools

To fulfil aim 2 of this review, we conducted a critical analysis of the identified assessment tools addressing four major criteria that were inspired by Bühner [25], i.e., objectivity (process, evaluation, interpretation), reliability (inter- and intra-rater), validity (convergent), and costs (time for completion of a tool, specific input required for a tool, specific training required to use a tool). Supplementary file 1 displays the template for the analysis of the tools. This template was designed by two authors (RM, SF) and reviewed by the co-authors. This review did not aim to report only on the best-performing assessment tools, but rather to describe and analyse all identified assessment tools.

We clustered concepts covered by assessment tools into overarching so-called patient, clinical, social, and system level factors [26], because it would enhance comparison among assessment tools and unify findings. These factors are also reflected in four recent publications [17, 27–29], confirming relevancy and importance of these factors. Patient factors refer to socioeconomic status, health status, and behaviour of a person such as noncompliance with treatment or failure to seek medical attention when needed [13, 26]. Clinical factors cover appropriateness of assessment and treatment, such as adequacy of clinical management, appropriate discharge planning, or outpatient care following discharge [13, 26]. Social factors include three elements, namely, coping, carer system, and community service [13, 26]. System factors relate to the availability, accessibility, and coordination of care across the health care system, for example, provision of resources at home according to a person´s needs [13, 26].

Overall, assessment tools were summarised with respect to concepts covered, judgement process, focus of measurement, and usage by specific group of persons. A fictional vignette case was also developed to illustrate application of different tools in actual clinical practice. Furthermore, the tools identified from studies included as part of category 1

were summarised in more detail within the article, as these tools were reported in RCTs and controlled trials, thus allowing to draw compelling evidence on the tools. Representing our review findings through an interactive and practical format seemed to be the next logical step, hence, a new online interactive database summarising the review findings was developed and launched.

Results

Included studies

Fifty-eight articles were included, of which 9 belong to category 1 (*assessment tools as an intervention to support decision-making on avoidability of care transitions compared to usual care: RCTs and controlled trials*) [30–38] and 49 to category 2 (*assessment tools as an instrument to determine risk for or incidence of avoidable care transitions: all study design with some exceptions*) [39–87]. Figures 1 and 2 display the selection process of the studies.

Supplementary file 2 (*Characteristics of the included studies*) presents an overview of the characteristics of the included studies. Studies belonging to category 2 represented various study designs, such as routine data analyses, cohort studies, surveys, interviews, cross-sectional studies, and pre-post interventions. Most of the studies exclusively focussed on a particular assessment tool, while others reported on an intervention or a strategy where an assessment tool was part of it, such as INTERACT intervention [34, 37], Aged Care Emergency Service (ACE)

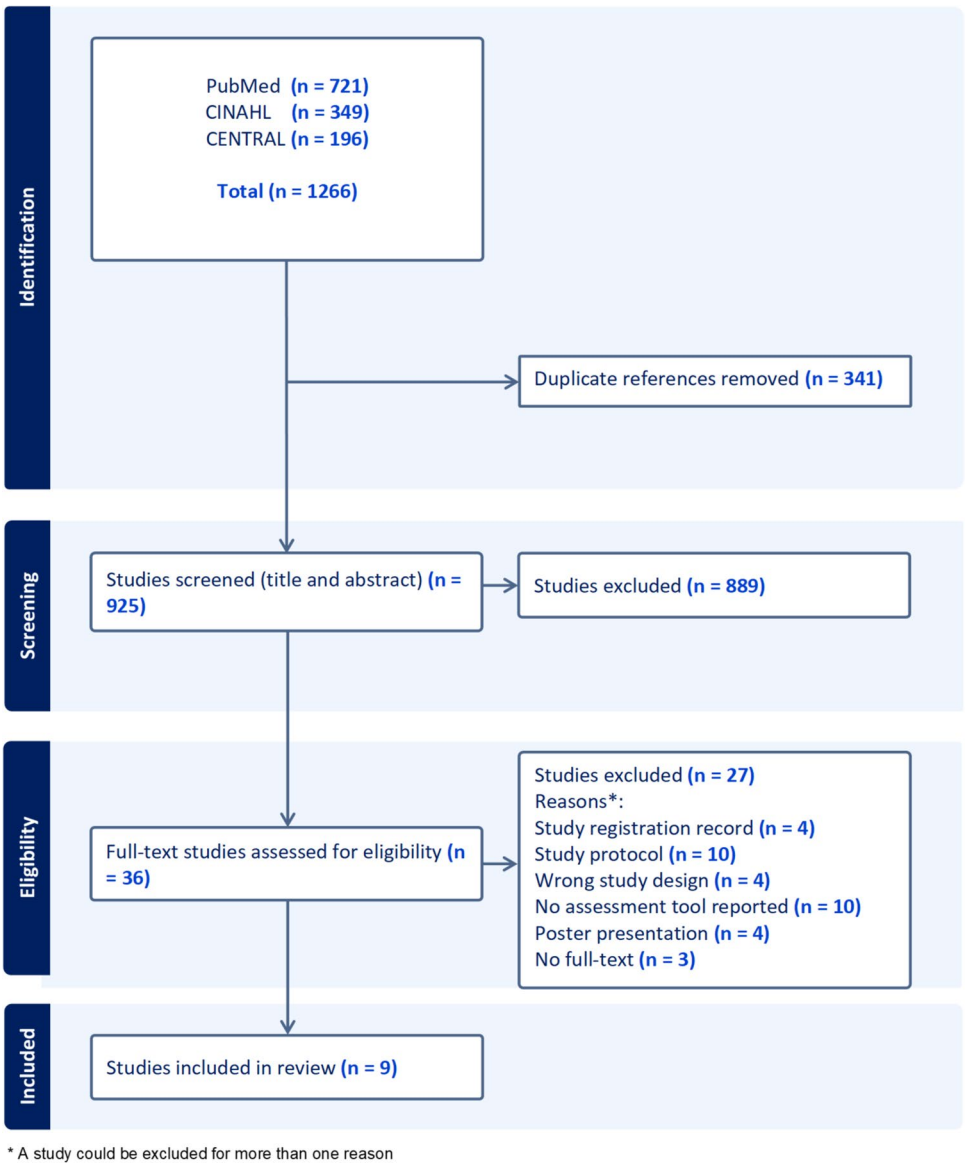

Fig. 1 PRISMA flow diagram for studies screened as part of category 1

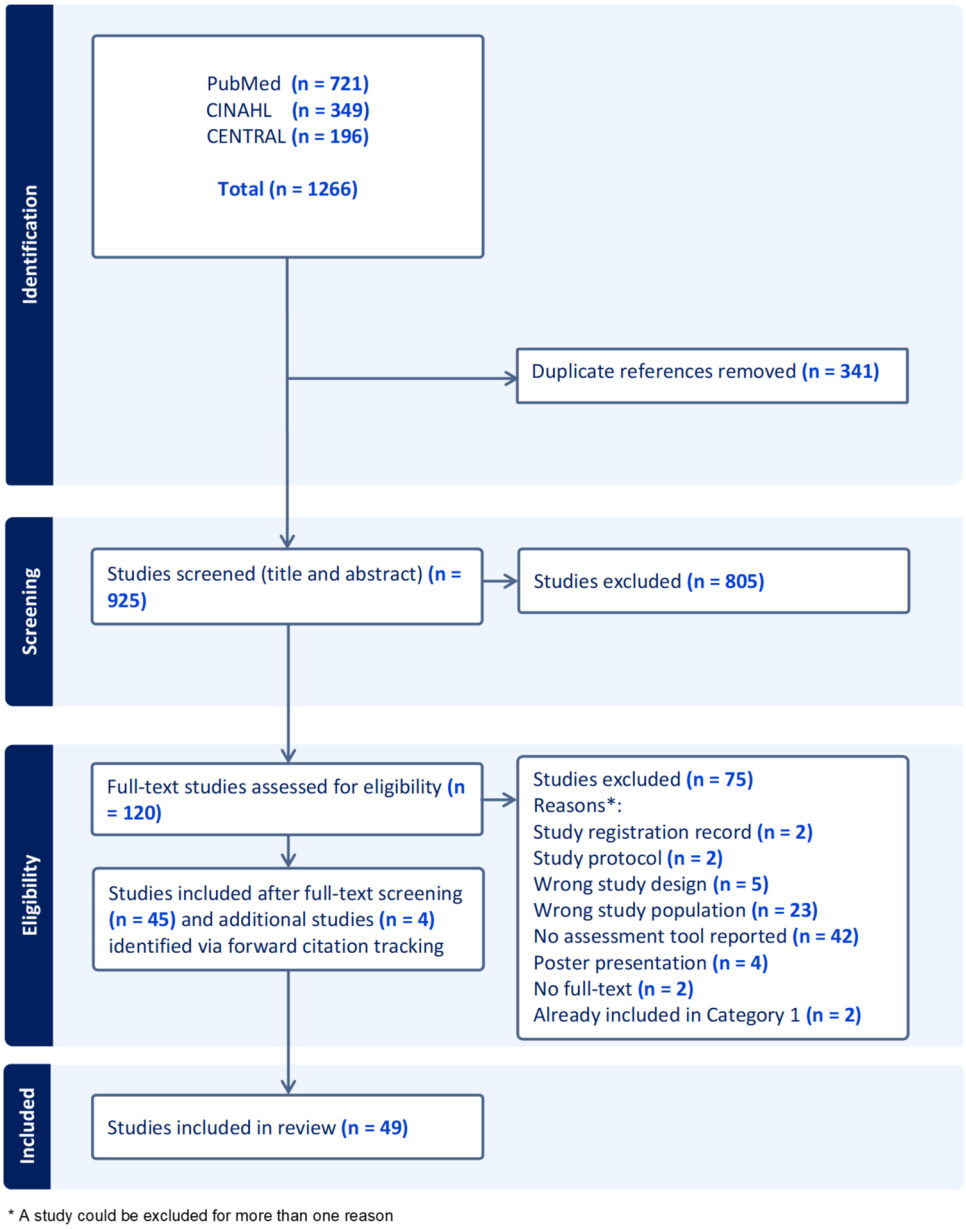

Fig. 2 PRISMA flow diagram for studies screened as part of category 2

service model [32, 33], and Better Health in Residents of Care Homes with Nursing (BHiRCH-NH) intervention [35].

Populations from several care settings were studied, including hospitals, nursing homes, emergency departments, and intensive care units. The majority of studies considered the general population, while some others focused on specific groups, for example, patients with community-acquired pneumonia (CAP) [40, 55], residents at the end-of-life [66], patients with polymedication [63], patients with acute heart failure [79], and patients with chronic obstructive pulmonary disease (COPD) [78]. Investigated acute-care destinations also varied considerably among studies, for instance, (re)hospitalisations [41, 43–45, 86], transfers from long-term care facilities or community to hospital or emergency department (ED) [56, 58, 60, 62, 73], transitions to intensive care units (ICU) [80], and transitions to or discharges from ED [70, 78, 79].

Rates of avoidable care transitions also varied substantially from 1.6% to 77% [47, 48, 69, 73].

The results of the risk-of-bias assessment of the included studies in category 1 are presented in the Supplementary file 4 (*RoB table*). Nine articles reported on six studies; therefore, critical appraisal has been done for six primary articles representing each study. Three articles [32, 33, 36] were assessed as showing a high risk of selection bias through lack of proper randomization and two [32, 34] articles indicated a high risk in the domain of missing outcome data. Overall, two articles [35, 38] were judged as having some

concerns for bias, while the other four publications were rated as having a high risk for bias.

Identified assessment tools

A total of 48 assessment tools dealing with avoidable care transitions were identified from the included studies. Results of the critical analysis are displayed in Supplementary file 3 (*Characteristics of the tools*). Those assessment tools without their own name were given the name of the first author of the corresponding study.

Some of the identified assessment tools were reported to perform poorly. For example, Johnston, Longman [60] concluded that the Preventability Assessment Tool (PAT) is not a valid tool for assessing preventability of unplanned hospital admissions.

As can be seen from Supplementary file 3 (*Characteristics of the tools*), the assessment tools differ widely with respect to concepts they cover. For example, Appropriateness Evaluation Protocol (AEP) and care pathway from the BHiRCH-NH intervention include a list of conditions or diseases (e.g., dehydration, congestive heart failure) [35, 46]; the tools by Bermejo Higuera, Gozalo, and Ong consist of pre-defined criteria in the form of statements [47, 56, 66]; the Walter indicator, rectal bleeding admission guide and algorithm, and the CURB-65 score include laboratory or clinical characteristics [59, 61, 70]; the Comprehensive Geriatric Assessment (CGA) includes physical/functional/social/economic and mental dimensions [85, 87]; patient´s care preferences, clinical care resources, and quality of acute care, among other things, are addressed by Structured Implicit Record review (SIR) [69, 73]. Overall, 48 tools cover patient factors, whereas 15 tools cover clinical factors, three social factors, and 15 system level factors. Ideally, a tool should include all four factors, which would make a tool fully comprehensive. The more factors a tool has, the more comprehensive it becomes in addressing avoidability of care transitions. However, none of the identified tools included all four factors. Table 1 provides an overview of identified assessment tools, with further information on factors covered by each tool.

The assessment tools differ whether they provide a specific outcome or have a specific judgement process. For example, the Ottawa Heart Failure Risk Scale (OHFRS) [79] provides a specific outcome, where a score is calculated based on ten criteria and the resulting score is transformed into percentage risk of serious adverse events for ED patients with acute heart failure. On the other hand, the Preventability Assessment Tool (PAT) is less specific in judgement process, which delegates a decision to a reviewer on how preventable an admission was, based on pre-defined factors such as patient, self-care, primary care, coordination of care, access to (non)clinical care, and hospital admission characteristics factors [60].

Some assessment tools also differ in what they specifically measure in the first instance, based on which a final judgement is made. For example, the CURB-65 score measures mortality risk and severity in community-acquired pneumonia, based on which recommendations are made regarding the avoidability of care transitions [40, 61]. Focus of measurement of other tools also include, but are limited to: expected probability of death (LACE index) [45, 74]; adverse health outcomes (ISAR scale) [59]; 1-year mortality (Silver code, Walter indicator) [59, 88, 89].

Assessment tools are intended for use by various people. For example, by care professionals (e.g., INTERACT´s care paths, ACE´s model evidence-based algorithms, AEP) [31–33, 46, 50]; by study researchers (LACE index, PAR-risk score, tool by Ong et al., tool by Gozalo et al.) [56, 57, 66, 74], though one tool was specifically designed for use by nursing home (NH) residents, their families, caregivers, and friends [38].

Since there is no gold standard assessment tool, there may be several tools that can be suitable in a specific situation. Hence, a decision about which assessment tool to use in a certain situation becomes a matter of choice. Box 1 presents a fictional vignette case that illustrates the application of different assessment tools and their outcomes in actual clinical practice.

Results stemming from application of the tools identified from studies included as part of category 1 are summarised as follows. The Aged Care Emergency Service (ACE) model [32, 33] seems to be promising, as it demonstrated its potential to successfully reduce hospital and ED visits of older adults with complex healthcare needs living in residential aged care facilities. The complex intervention entitled "Better Health in Residents of Care Homes with Nursing (BHiRCH-NH)" seems to be safe, since proper adverse event data collection did not reveal the intervention caused harm [30, 35]. However, despite successful recruitment and retention of participants, the study showed limited engagement of participants with the intervention tools [30, 35]. It was observed that increased use of core INTERACT tools reduced potentially avoidable hospitalizations in intervention and control skilled nursing facilities, while preserving the safety of nursing facility residents [31, 34, 37]. A study by Selker, Beshansky [36] showed that ACI-TIPI instrument has potential for substantial reductions in admissions to the Coronary Care Units (CCU), telemetry units, and hospitals, particularly in settings with high rates of overuse, without causing a negative impact on care. The evaluation of a novel decision guide "Go to the Hospital or Stay Here?" in a randomized-controlled trial observed that there were no decrease in transitions to hospital and no increase in decisional preparation, when compared with the control group [38]. On

Table 1 An overview of identified assessment tools

#	Tool name	Concepts grouped into patient, clinical, social, and system factors	Target population	Care transition
1	INTERACT tools (with focus on care paths only)	Patient factors	Nursing home residents	Nursing home → Hospital, Nursing home → Emergency department
2	QI review tool (from project INTERACT II)	Patient factors, Clinical factors	Nursing home residents	Nursing home → Hospital
3	INTERACT II tools (with focus on care paths only)	Patient factors	Nursing home residents	Nursing home → Hospital
4	Root cause analysis (INTERACT QI Acute care transfers (ACT) tool)	Patient factors, Clinical factors	Nursing home residents	Nursing home → Hospital
5	ACE model (with focus on evidence-based algorithms only)	Patient factors	Nursing home residents	Nursing home → Hospital, Nursing home → Emergency department
6	A complex intervention to reduce avoidable hospital admissions in nursing homes (with focus on a care pathway only)	Patient factors	Nursing home residents	→ Hospitalizations
7	Novel Decision Guide "Go to the Hospital or Stay Here?"	Patient factors, Social factors System factors	Nursing home residents, families, caregivers, and friends	Nursing home → Hospital
8	ACI-TIPI acute cardiac ischemia time-insensitive predictive instrument	Patient factors	ED patients with chest pain	→ Hospital and CCU (coronary care unit) admissions
9	Appropriateness Evaluation Protocol (AEP) (with focus on criteria of appropriateness of admission only)	Patient factors, Clinical factors, System factors	Adult patients with acute conditions (reliable for any type of diagnosis). Not suitable for paediatric, obstetric, or psychiatric patients	→ Hospitalizations
10	Appropriateness Evaluation Protocol French version (AEPf)	Patient factors, Clinical factors, System factors	Nursing home residents, hospitalized patients via emergency department, emergency department patients, and patients discharged from acute geriatric unit	→ Hospitalizations, → Rehospitalizations, Nursing home → Acute geriatric unit
11	Appropriateness Evaluation Protocol Geriatric adaptation (AEPg)	Patient factors, Clinical factors, System factors	Nursing home residents	Nursing home → Acute geriatric unit
12	Adapted AEP	Likely Patient factors, Clinical factors, System factors	Older adults	→ Hospitalizations
13	AEP Italian version	Likely Patient factors, Clinical factors, System factors	Medical patients	→ Hospitalizations
14	AEP Spanish version	Likely Patient factors, Clinical factors, System factors	Medical patients	→ Emergency department, Emergency → Hospital, Consultation → Hospital, Home → Hospital
15	Modified Italian AEP	Patient factors, Clinical factors System factors	Community-acquired pneumonia patients	→ Hospitalizations
16	CURB-65 score (in hospital setting)	Patient factors	Community-acquired pneumonia patients admitted to hospital	→ Hospitalizations
	CURB-65 score (for Community setting)	Patient factors	Community-acquired pneumonia patients in community	→ Hospitalizations

Table 1 (continued)

#	Tool name	Concepts grouped into patient, clinical, social, and system factors	Target population	Care transition
17	Risk Nomogram	Patient factors	Community patients discharged from the emergency department	Community → Emergency department readmissions within 28 days of emergency department discharge
18	HOSPITAL score	Patient factors, Clinical factors	Discharged acute and non-acute patients (medical and surgical wards), patients with polymedications	→ 30-day rehospitalizations
19	Simplified HOSPITAL score	Patient factors	Medical patients	→ 30-day rehospitalizations
20	LACE index	Patient factors	Medical and surgical patients discharged to the community	→ 30-day rehospitalizations
21	Revised LACE index	Patient factors	Older adults	→ 30-day rehospitalizations
22	New Zealand version of Patients at Risk of Hospital Readmission (PARR) predictive risk tool	Patient factors	Medical patients	→ 30-day rehospitalizations
23	PAR-Risk Score	Patient factors	Medical patients	Home → 30-day rehospitalizations
24	EOL care pathway	Patient factors, Clinical factors, Social factors	Nursing home residents	Nursing home → Hospital
25	The Identification of Seniors at Risk (ISAR) scale	Patient factors	Emergency department patients	Emergency department → Home or usual Nursing home, Emergency department → Acute hospital, Emergency department → Long term nursing care
26	The Silver Code	Patient factors	Emergency department patients	Emergency department → Home or usual Nursing home, Emergency department → Acute hospital, Emergency department → Long term nursing care, → Hospitalizations, → Emergency department readmissions
27	The Walter indicator	Patient factors	Hospital patients	Emergency department → Home or usual Nursing home, Emergency department → Acute hospital, Emergency department → Long term nursing care
28	Preventability Assessment Tool (PAT)	Patient factors, Clinical factors System factors	Community-dwelling patients with unplanned hospitalizations, with a primary discharge diagnosis of COPD, CHF, angina pectoris or diabetes complications	→ Hospitalization
29	Quality assessment instrument	Patient factors, Clinical factors, System factors	Medical patients	→ Hospitalization
30	SIR (structured implicit record review)	Patient factors, Clinical factors, System factors	Nursing home residents	Nursing home → Hospital, Nursing home-Emergency department

Table 1 (continued)

#	Tool name	Concepts grouped into patient, clinical, social, and system factors	Target population	Care transition
31	Rectal bleeding admission guide and algorithm	Patient factors	Acute LGIB (Acute lower gastrointestinal bleeding) surgical patients	Community → Hospital, Community → Surgical unit, Community → Emergency department
32	Potentially Avoidable Readmission (PAR) algorithm	Patient factors	Inpatients hospitalized for heart failure, acute myocardial infarction, pneumonia, or chronic obstructive pulmonary disease	→ 30-day Rehospitalizations
33	RAFT (Reducing Avoidable Facility Transfers) model	Likely Patient factors, Clinical factors, System factors	Nursing home residents	Nursing home → Hospital, Nursing home → Emergency department
34	Ottawa Heart Failure Risk Scale (OHFRS)	Patient factors	Patients with shortness of breath due to acute heart failure	→ Emergency department admissions, → Emergency department discharges
35	The Ottawa COPD (chronic obstructive pulmonary disease) Risk Scale (OCRS)	Patient factors	Patients with shortness of breath or respiratory distress caused by COPD	→ Emergency department admissions, → Emergency department discharges
36	Comprehensive Geriatric Assessment	Patient factors	Older adults, nursing home residents	→ Hospitalizations, Nursing home → Hospital, Nursing home → Emergency department
37	Standardised chart review method (with ORIGINAL trigger tool)	Patient factors	Hospital patients with multimorbidity (from 3 chronic medical conditions) and polypharmacy (from 5 chronic medications)	→ Drug-related hospital admissions (DRAs)
38	Standardised chart review method (with REVISED trigger tool)	Patient factors	Hospital patients with multimorbidity (from 3 chronic medical conditions) and polypharmacy (from 5 chronic medications)	→ Drug-related hospital admissions (DRAs)
39	Tool on appropriate referrals by Bermejo Higuera et al	Patient factors, System factors	Nursing home residents	Nursing home → Emergency department
40	Tool by Codde et al	Patient factors, System factors	Nursing home residents	Nursing home → Emergency department
41	A prediction rule to identify low-risk patients with community-acquired pneumonia (Pneumonia Severity Index, PSI)	Patient factors	Patients with community-acquired pneumonia (CAP)	→ Hospitalizations
42	Tool by Gozalo et al	Patient factors, System factors	Nursing home residents with cognitive and functional impairment	Nursing home → Hospital
43	Tool by Ong et al	Patient factors	Nursing home residents	Nursing home → Hospital
44	Modified Early Warning Score (MEWS)	Patient factors	Emergency (non)surgical patients	Emergency department → Intensive Care Unit (ICU), Emergency department → High Dependency Unit (HDU)
45	The 80 + score	Patient factors, Likely Social factors	Patients hospitalized to medical and surgical departments	→ Rehospitalizations (Emergency department admissions or readmissions)

Table 1 (continued)

#	Tool name	Concepts grouped into patient, clinical, social, and system factors	Target population	Care transition
46	The TRST	Patient factors	Patients hospitalized to medical and surgical departments, emergency department patients	→ Emergency department readmissions within 30 and 120 days after emergency department discharge, → Hospitalizations within 30 and 120 days after emergency department discharge, → Nursing home admissions within 30 and 120 days after emergency department discharge
47	ERA index	Patient factors	Hospitalized patients	→ 30-day Rehospitalizations, Hospitalizations, → ED
48	Risk prediction model for PARAs	Patient factors	Hospitalized patients who were discharged back to their place of residence	→ Rehospitalizations

the other hand, the intervention group participants rated the guide as being very helpful and showing an increase in knowledge and decline in decisional conflicts [38]. Further information is available in Supplementary file 2 (*Characteristics of the included studies*), column "outcome".

Overall, as can be seen from Supplementary file 8 (*Summary of tools with filter options*), half of assessment tools with reported C-statistic had values greater than 0.7, indicating good discriminatory power.

An online database was launched (www.decision4transition.com) that systematically summarises our findings and allows to instantly filter assessment tools based on their properties. The database has six major filter categories, with further filter options within each category. The database also provides a new consensus-based definition for "avoidable care transitions" [19] for overall guiding principles on avoidability of care transitions.

Box 1. A fictional vignette case

For a 70-year-old male living in the community setting with community-acquired pneumonia, presence of confusion, respiratory rate of 30/min, and systolic blood pressure of 85 mm Hg, two eligible assessment tools may be used to support informed decision-making on the appropriateness of a possible hospitalisation. Namely CURB-65 for community setting and a Prediction Rule to identify low-risk patients with community-acquired pneumonia. When CURB-65 is used, the patient scores 4 out of 4 points, implying high mortality risk and urgent need for hospital admission. When the Prediction Rule assessment tool is applied using the information available, the patient scores 130 points, implying the upper boundary of risk (class IV out of five possible), and the need or appropriateness for inpatient care. However, if more data on coexisting illnesses, abnormal physical examination, or laboratory findings were available, the Prediction Rule tool would be more precise, and, thus, a more appropriate tool to be used for this case.

Discussion

We identified 58 studies and reviewed 48 assessment tools including their sub-types that deal with avoidable care transitions.

Rates of avoidable care transitions ranged considerably among the studies, ranging from 2 to 77%. The designs, populations, and acute-care destinations varied widely.

The identified tools differed in various ways: components covered (*e.g., clinical/laboratory dimensions vs. statements*), focus (*e.g., focus on avoidable nature of care transitions vs. focus on appropriateness of care transitions*), usage by

specific group of persons (*e.g., tools applied by care professionals vs. tools applied by study authors vs. tool designed for use by patients and caregivers*), the data sources used (*e.g., administrative databases vs. patient´s medical charts vs. interviews*), judgement process (*e.g., whether tools have a specific judgement process or not*), and focus of measurement (*e.g., what tools measure in the first instance, based on which a final judgement is made; such as mortality risk or adverse health outcomes*).

It has been argued that avoidability is not limited to a single factor, instead, it should include a set of various factors where each plays a distinct role in determining avoidable care transitions, such as patient, social, clinical, and system level factors [17, 26–28, 90]. With regard to this, all of the tools identified in this review are not comprehensive with respect to the dimensions covered, as they addressed only one or a few perspectives. Comparable findings are also reflected in a systematic review by Renom-Guiteras, Uhrenfeldt [14] and Kansagara, Englander [23].

Tools that focus on specific patients, conditions, or settings may have the capacity to predict avoidability for specific situations, limiting their application to these situations only. For example, as shown in Supplementary file 8 (*Summary of tools with filter options*), some assessment tools are intended for patients with specific conditions, such as pneumonia or heart failure, but their application in older adults with multimorbidity may be limited. Similarly, other tools are used for surgical patients and are focused on specific settings, such as surgical wards or emergency departments, which limit their use for general hospital patients or nursing home residents. Comparable findings are reflected in an earlier review [23]. However, in contrast to Kansagara, Englander [23], who reported that most risk prediction models have poor performance, we found that half of assessment tools with reported C-statistic had values greater than 0.70, indicating rather good discriminatory power.

In light of the aforementioned limitations, it is evident that some assessment tools are less useful in addressing avoidable care transitions. In addition, not all the tools are easily available for their use.

Although assessment tools can be useful in clinical practice, it is worth to bear in mind that they are meant to support decision-making and supplement the care professional´s judgement, instead of replacing it [17, 36, 40, 42, 78, 79]. Therefore, judgements stemming even from tools with good performance should be interpreted with care, and an ultimate decision should be made by a care professional.

This review benefits from a relatively rich pool of identified assessment tools with further critical analysis, which was not limited to a particular care setting or acute-care destination. We focused on including studies that originated from western countries, which may seem to be a limitation as we might possibly have missed some other eligible studies, as well as assessment tools. However, this is an EU-funded project that primarily focuses on European countries, and we have already expanded our search to other western countries that could be comparable to a certain extent in terms of population pyramid, level of development of their healthcare systems, and the way their health systems function. The evaluation of the included articles and tools was performed by a team of different reviewers, which may have added some subjective evaluative judgements. However, as described at the methods section, the procedures followed the recommendations by the PRISMA statement [91], which should have minimised this risk.

We do not advocate for a generalizable assessment tool that works well in most places or countries even for a specific situation (i.e., specific acute-care destination or specific condition), as countries even within unions like the EU still differ in their local context, such as reimbursement policies and financial incentives. Research literature highlights the importance of embracing multiple dimensions rather than focusing just on a few when addressing the avoidability of care transitions. In light of this, it is reasonable to conclude that an assessment tool, which includes multiple dimensions and is tailored to a local context, has greater credibility. We would, therefore, advocate for comprehensive assessment tools tailored to local contexts.

Further to launching an online database (www.decision4transition.com), we suggest replenishing it with further assessment tools identified by other reviews or added on individual basis. We believe that clinical and research communities might benefit from such an initiative.

Conclusion

Our systematic review presents a comprehensive overview of a large number of tools addressing avoidable care transitions. The evidence generated through synthesis and appraisal is now ready to be used as a source for informed decision-making for clinical and research communities when it comes to choosing the right tool.

We noticed considerable heterogeneity among studies as well as assessment tools. Most tools were limited to a single or few perspectives that are used in the judgement process. Some assessment tools did not provide a specific judgement, but rather delegated such judgement to a reviewer by navigating over a series of items. Further research is justified in order 1) to develop multi-dimensional comprehensive assessment tools tailored to local contexts and 2) to periodically replenish the online database (www.decision4transition.com) with further assessment tools.

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Data availability Data supporting the results reported in the article are available as follows: 1) study protocol is publicly available in PROSPERO (registration number: CRD42022312516) 2) analysis data, data on included studies, data on excluded studies, final search string, risk-of-bias assessment results, PRISMA check-list, and data on assessment tools are available as online supplementary files.

Declarations

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

Ethics approval and consent to participate None reported.

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Supplementary file 1: Analysis of tools template

Aim: To come up with a list of quality criteria to analyse each assessment tool. Results of this analysis can serve as a source for informed decision making for clinical and research communities when it comes to choosing the right assessment tool.

Proposed criteria:

Abbreviations: Y - yes, N - no, NI – no information, NA – not applicable.

1. Concepts/components covered

Provide information on concepts/components the assessment tool covers. For example, the tool can cover clinical and/or laboratory characteristics, but can also include other various concepts or components.

2. What the tool measures/does

Provide information on what the assessment tool measures/does. For example, the tool can measure mortality, specific risks, etc.

3. Objectivity

3.1. Process *(possible answers: Y, N, comments/short justification).*

Are instructions of the assessment tool clear? Is it clear how to use the assessment tool? Is the assessment tool self-explaining (i.e. whether the tool is structured intuitively, or the tool has explanations/instructions within the tool itself, etc.)?

3.2. Evaluation *(possible answers: Y, N, comments/short justification).*

In calculating outcome/tool result/score, is there **any** subjective judgement involved? If at least one element of a tool involves subjective judgement, then the answer is yes.

For example, the tool may have pre-defined criteria, but assessment may include element of subjective judgement (for example, when measuring level of pain; higher level of pain corresponding to higher scores). On the other hand, the tool may have

pre-defined criteria, but assessment does not include any element of subjective judgement (for example, when measuring blood pressure or heart beat rate; where specific values of measurement correspond to a specific score).

3.3. Interpretation *(possible answers: Y, N, comments/short justification).*

Is there any clear guidance on how to arrive at a final assessment tool´s judgement? Is it clear how to interpret evaluation results?

A tool may have rules/thresholds of how to convert a score/evaluation result into a risk category or tool´s final judgement. For example, scores 0-2 mean a patient is at low risk of deterioration and should not be hospitalized/hospitalization could be avoided, scores 5-7 mean a patient is at high risk for deterioration and should be hospitalized. Also provide rules/thresholds on converting evaluation into tool´s judgement.

4. Reliability

4.1. Inter-rater reliability *(possible answers: Y, NI. If Y, provide results as reported).*

Extent of agreement among independent observers who administered an assessment tool. Was this reported?

4.2. Intra-rater reliability *(possible answers: Y, NI. If Y, provide results as reported).*

Extent of agreement among repeated administrations of an assessment tool performed by a single observer. Was this reported?

5. Validity

5.1. Convergent validity *(possible answers: Y, NI. If Y, provide brief info how it was assessed and results as reported).*

Was convergent validity reported?

"In convergent validity, we examine the degree to which the operationalization is similar to (converges on) other operationalizations that it theoretically should be similar to" (1). In simple words, in this analysis we interpret this concept of convergent validity as a sort of comparison between an assessment tool´s output/result AND a "golden standard"/observed result. We will therefore consider the following assessment types that fit the concept of convergent validity.

Discrimination refers to how well the assessment tool can separate one group from another (for example, avoidable vs. unavoidable care transitions).
It is commonly measured using ROC curves, and area under the ROC curve is a useful parameter summarizing ROC curve. Area under the ROC curve is equivalent to Concordance statistic (C statistic). The C statistic can also be interpreted as the rank correlation between predicted probabilities of the outcome occurring and the observed response. It can also be measured by sensitivity/specificity, PPV/NPV, Brier score (combine calibration and discrimination). (2)

Calibration refers to a measure of how well the predicted probabilities agree with the observed probabilities (is a property related to goodness of fit of a model). It can be measured for example by Hosmer-Lemeshow goodness of fit test, Brier score (combine calibration and discrimination). (2)
Gold Standard. We refer to this assessment type as a comparison of an index assessment tool to a "gold standard" (i.e. for example another assessment tool or expert consensus).

6. Costs

6.1. Time to completion *(possible answers: Y, NI. If Y, provide results as reported or brief description/comment).*

Were any information on approximate time to complete the assessment tool in min or other information that may pertain to completion time reported?

6.2. Specific input data required *(possible answers: Y, N, NI, short description if Y or N).*

Are some data required as input for the assessment tool relatively time-consuming/resource-consuming to collect?

The assessment tool may require data relatively quick and cheap to collect, for example readily available data from patient´s medical record or certain quick measurements (i.e. previous hospitalizations, known comorbidities, blood pressure, heart rate). The assessment tool may also require specific time-consuming data (i.e. laboratory analyses of blood sample).

6.3. Specific training required *(possible answers: Y, N, NI, short description if Y).*

Does the assessment tool require specific training to use it?

7. Who completed the tool?

Provide information on who completed the assessment tool. For example, it could be study authors, nurses, physicians, etc.

8. When/where/how the tool was/can be completed?

Provide information on when/where/how the assessment tool was completed. For example, when can refer to at admission/at discharge, where can refer to hospital/nursing home, how can refer to retrospectively/prospectively.

9. Language

Provide information on the language used in the assessment tool.

10. Tool can be seen/accessed in

Provide information on where the assessment tool can be seen/accessed.

Tool name (reported in…)	
Concept/components covered	
What the tool measures/does	
Objectivity	
Process	
Evaluation	
Interpretation	
Reliability	
Inter-rater	
Intra-rater	
Validity	
Convergent	
Costs	
Time to completion	
Specific input data required	
Specific training required	
Who completed the tool?	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Language	**Tool can be seen/accessed in:**

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Supplementary file 2: Characteristics of the included studies

List of abbreviations

RACF: Residential Aged Care Facility

ED: Emergency Department

ACE: The Aged Care Emergency program

RN: Registered Nurse

BHiRCH-NH: Better Health in Residents in Care Homes with Nursing

INTERACT: Interventions to Reduce Acute Care Transfers

NH: Nursing Home

NF: Nursing Facility

SNF: Skilled Nursing Facility

AEP: Appropriateness Evaluation Protocol

HOSPITAL score: low Haemoglobin at discharge, discharge from an Oncology service, low Sodium on discharge, Procedure during hospital stay, urgent/emergent admission, number of hospital admission and Length of stay.

LACE index: Length of stay (days), Acute (emergent) admission, Charlson Comorbidity Index and number of ED visits within six months.

AUC- Area Under Curve

SAE- Serious Adverse Events

HF- Heart Failure

COPD- Chronic Obstructive Pulmonary Disease

ERA- Elders Risk Assessment

EOL-End Of Life

PAR-Potentially Avoidable Readmissions

GP- General Practitioner

ISAR- Identification of Seniors At Risk

PAT- Preventability Assessment Tool

PPH- Potentially Preventable Hospitalizations

CAP- Community Acquired Pneumonia

PSI- Pneumonia Severity Index

SIR- Structured Implicit Review

LGIB- Acute Lower Gastrointestinal Bleeding

TRST- Triage Risk Screening Tool

RAFT- Reducing Avoidable Facility Transfers

OHFRS- Ottawa Heart Failure Risk Scale

OCRS- Ottawa COPD Risk Scale

MEWS- Modified Early Warning Score

HDU- High Dependency Unit

ICU- Intensive Care Unit

CGA- Comprehensive Geriatric Assessment

TREAT- Triage and Rapid Elderly Assessment Team

LOS- Length Of Stay

ADE- Adverse Drug Event

DRA- Drug Related Admission

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
	Category 1						
1	Hullick et al. (2016)	Australia	Controlled pre-post design	12 RACFs (4 RACFs for the intervention group). For each of the four intervention RACFs, two control RACFs were selected.	RACF - hospital/ED	The ACE service model has 7 key elements. 1. An ED advanced practice nurse with aged care skills 2. More than 20 evidence based algorithms 3. An education program for RACFs clinical staff	***1) ED presentation.*** The intervention RACFs shows higher monthly presentation values, consistent with their selection as the initial sites that might benefit the majority from such an intervention. When analysing both the impact of time and the matched controls, the non-significant parameter estimate for the Group × Time interaction suggests that patients from intervention RACFs and control RACFs had a similar change in the odds of ED presentation in any given month pre- to post-intervention. ***2) ED length of stay.*** Control RACFs ED length of stay reduced from 496.7 min to 481.7 min while the intervention RACFs ED length of stay reduced further from 496.3 min to 435.7 min.

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
						4. An ED RN led telephone consultation service for RACF staff 5. Establishment of the purpose of the ED transfer based on the older person's goals of care 6. proactive case management 7. A collaborative respectful relationship among organizations to achieve optimal patient outcomes.	***3) Hospital admission following ED presentation.*** The odds of hospital admission tended to increase (by ~35 %) from pre- to post-intervention across all RACFs, with this increase being significant (p= 0.01). ***4) Hospital length of stay.*** The hospital length of stay tended to decrease post- intervention in both treatment groups, but to a greater extent in intervention RACFs with their length of stay reducing from 9.4 days to 6.3 days after the intervention, compared to the control RACFs that reduced from 10.0 days to 8.0 days. ***5) 28-day hospital readmissions.*** Patients from intervention RACFs and control RACFs had a similarly negligible change in the odds of 28 day hospital admission pre- to post-intervention (OR = 1.18, p= 0.49). 28-day hospital readmission decreased in both groups, but to a lesser extent in intervention RACFs.

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
2	Hullick et al. (2021)	Australia	A stepped wedge nonrandomized cluster trial	Nine hospital EDs and 81 RACFs that primarily transferred residents to the 9 EDs were engaged in the ACE program.	RACF - hospital/ED	The Aged Care Emergency (ACE) program has 7 key elements. 1. An ED advanced practice nurse with aged care skills 2. More than 20 evidence based algorithms 3. an education program for RACFs clinical staff 4. An ED RN led telephone consultation service for RACF staff	***1) Hospital admissions.*** The average number of hospital admissions per month per 1,000 RACF bed-days was similar in the control and intervention conditions (1.03 vs 1.01). After adjusting for clustering and confounding variables, the rate for hospital admissions was .79 times the control period (i.e., a 21% reduction in the rate of hospital admission). ***2) ED visits.*** In the crude analysis, earlier clusters had higher overall rates of transfer and admissions, with an average of 1.55 (1.26) ED visits per month per 1,000 RACF bed-days in the control condition compared with an average of 1.48 (1.16) in the post intervention condition. After adjusting for clustering and confounding variables, the ED presentation rate in the intervention period was .80 times that of the control period (i.e., a 20% reduction in the rate of ED visit).

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
						5. Establishment of the purpose of the ED transfer based on the older person's goals of care 6. proactive case management 7. A collaborative respectful relationship among organizations to achieve optimal patient outcomes	
3	Sampson et al. (2020)	UK	Pilot cluster randomised controlled trial	12 nursing homes (7 in West Yorkshire and 5 in Greater London). 5 NHs in	Avoidable hospital admissions	BHiRCH-NH intervention consisted of 3 items adapted from the INTERACT programme: Stop and Watch early warning tool (S&W), Care	This was a pilot-trial and analyses were mainly descriptive. Despite excellent recruitment and retention, the limited engagement with the intervention tools and support for their implementation in the pilot trial has led the authors to conclude that a definitive trial of this intervention is not warranted.
4	Downs et al. (2021)						

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
	This is a report on a research programme that includes the publication on pilot cluster RCT by Sampson et al. (2020), which appears to be the focus of			intervention and 7 NHs in control groups.		pathway, The situation, background, assessment recommendation (SBAR).	

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
	this report.						
5	Kane et al. (2017) *This is the primary paper with RCT. This paper by Kane et al. 2017, and other two by Tappen et al. 2018 and Huckfeldt*	USA	Cluster randomized trial	A sample size of 9050 and 8380 residents in intervention NHs in the pre-intervention and intervention periods, respectively, and 14 428 and 13 472 residents in control NHs in the pre	NH - hospital/ED	INTERACT program is based on 3 core tenets: (1) recognition and management of acute conditions before they become severe enough to require hospitalization; (2) providing communication, documentation, and decision support tools that allow for effective management in the NH without hospital	***1) Rate of hospitalizations per 1000 resident-days***. Both intervention and control NHs exhibited between 3 and 4 hospitalizations per 1000 resident-days in most months of the sample period. For a facility with a census of 100, this rate translates to 3 or 4 residents being admitted to the hospital every 10 days. ***2) Potentially avoidable hospitalizations.*** The intervention NHs exhibited a slightly higher rate of potentially avoidable hospitalizations in the pre-intervention period and converged with control NHs during the intervention period. **3)** ***ED visits rates without admission.*** Trends for ED visits without admission were also very similar between the intervention and control groups.

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
	et al. 2018 are considered as 1 study with 3 publications.			intervention and intervention periods, respectively.		admission when safe and feasible; and (3) emphasizing advance care planning, hospice, and palliative care to encourage goals of care discussions and reduce hospitalizations in people with end-stage illness among whom the risks and discomforts of hospital care often outweigh the benefits.	**4) *Hospitalization rates***. There was no significant reduction in hospitalizations within 30 days of NH admission or 31 or more days after NH admission.
6	Tappen et al. (2018)	USA	Secondary analysis of a	264 NFs randomized into	NF-hospital	The INTERACT Quality Improvement Program: involves a	**1) *Resident-quarter level safety measures using the MDS for the following measures: unintentional weight loss (exclusive of physician-prescribed weight-loss), malnutrition, hip fracture, pneumonia, wound***

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
			randomized controlled implementation trial	intervention and comparison groups Intervention NFs (n=88) Control NFs (n=176)		set of tools and resources designed to address the primary reasons for potentially avoidable hospital admissions of NF residents.	***infection, septicemia, urinary tract infection, and falls resulting in injury (minor or major).*** Across all measures, there were no statistically significant differences in the percentage of resident-quarters exhibiting MDS-derived safety measures between the intervention and control groups in either the pre-intervention or intervention years. **2)** ***Whether the following items increased, decreased or remained the same over the last month: unintentional weight loss, dehydration, incidence of falls, new pressure ulcers, severe pain, and unexpected deaths.*** There were no statistically significant increases in safety indicators over time [fall rates (P=.321), new pressure ulcers (P=.274), severe pain (P=.687), weight loss (P=.946), or dehydration (P=.661)]. There were also no statistically significant changes in safety measures by level of engagement across the 12 months of INTERACT

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
							implementation for weight loss [F (2, 141.48) = 0.52, P=.471], dehydration [F(2, 127.33)=2.32, P=.130], fall rates [F(2, 109.21)=0.28, P=.559], or pressure ulcer [F(2, 109.71)=0.21, P=.652]. There was insufficient variability in unexpected deaths for analysis. However, there were statistically significant differences by engagement group for severe pain [F (2, 153.31)=2.90, P=.005] with the highly engaged(engagement group 3) reporting significantly lower incidence of severe pain when compared to the low engagement (group 1) [b=0.11, t(201.45)=1.99, P=.012] and moderate engagement (group 2) [b=0.12, t(204.67)=2.40, P=.002].
7	Huckfeldt et al. (2018)	USA	Secondary analysis from a randomized controlled trial	Skilled nursing facilities (N = 264)	SNF-hospital/ED	The Interventions to Reduce Acute Care Transfers (INTERACT) program includes a set of tools that address factors leading to avoidable hospital admissions and ED visits of SNF residents.	***1) Hospitalizations and potentially avoidable hospitalizations.*** The increased-use group had relative reductions of 11.2% in all-cause hospitalizations and 18.9% in PAHs (potentially avoidable hospitalizations) (both p<.001), whereas the low-use group had nonsignificant relative reductions of 1.6% in all-cause hospitalizations and 4.8% in PAHs.

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
						INTERACT has 7 tools in total: “Stop and Watch”; Situation, Background, Assessment, Recommendation (SBAR) Communication Form and Progress Note; Hospitalization Tracking tool; root-cause analysis Quality Improvement Review tool; Hospital Transfer Form; decision support tools (Care Paths, Change in Condition File Cards);	

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
						and Advance Care Planning tools.	
8	Selker et al. (1998)	USA	Controlled clinical trial	ED patients with chest pain. 10689 patients: 4738 intervention group, 5951 control group.	Hospital and CCU (coronary care unit) admissions	Acute cardiac ischemia time-insensitive predictive instrument (ACI-TIPI) (software based).	***Emergency department triage to a coronary care unit (CCU), telemetry unit, ward, or home:*** **1)** For patients without cardiac ischemia, in hospitals with high-capacity CCUs and relatively low-capacity cardiac telemetry units, use of ACI-TIPI was associated with a reduction in CCU admissions from 15% to 12%, a change of -16%, and an increase in emergency department discharges to home from 49% to 52%, a change of 6%. **2)** Across all hospitals, for patients evaluated by unsupervised residents, use of ACI-TIPI was associated with a reduction in CCU admissions from 14% to 10%, a change of -32%; a reduction in telemetry unit admissions from 39% to 31%, a change of -20%, and an increase in discharges to home from 45% to 56%, a change of 25%. **3)** Among patients with stable angina, in hospitals with high-capacity CCUs, use of ACI-TIPI was associated with a reduction in CCU admissions from 26% to 13%, a change of -50%, and an increase in discharges to home from 20% to 22%, a change of 10%.

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
							4) At hospitals with high-capacity telemetry units, use of ACI-TIPI was associated with a reduction in telemetry unit admissions from 68% to 59%, a change of -14%, and an increase in emergency department discharges to home from 10% to 21%, a change of 100%. **5)** Among patients with acute myocardial infarction or unstable angina, use of ACI-TIPI did not change appropriate admission (96%) to the CCU or telemetry unit at hospitals with high-capacity CCUs or telemetry units.
9	Tappen et al. (2020)	USA	Mixed method RCT with qualitative data embedded in the quantitative data	Nursing home residents and family members from 15 long-term care facilities. 192 participants (128 residents and 64 family members).	NH-hospital	Novel Decision Guide "Go to the Hospital or Stay Here?" for Nursing Home Residents and Families.	***1) Effectiveness of the use of the guide in increasing the perception of preparation for decision making and reducing decisional conflict (change in the intervention group from pretest to posttest).*** Decisional conflict was significantly lower at posttest with an average of 9,98 compared to the pretest with an average of 13,11. ***2) Differences on the posttest scores in decisional conflict between control and intervention groups.***

Number	Authors publication year	Country	Method /Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
							The intervention group had statistically significant lower decisional conflict (8,95) compared to the control group. ***3) Effectiveness of the decision aid in improving residents´ and family members´ knowledge over time compared to the control group.*** Of individuals who completed the pretest and posttest, there were statistically significant improvements overall for both groups, but the intervention group showed a greater improvement in knowledge from pretest to posttest compared to the control group. ***4) Differences in rehospitalization rates between groups.*** There were few rehospitalizations in the sample, 5 for the control group and 8 for intervention group. The difference in numbers of transfers from the NH to an acute care facility was not statistically significant across groups.

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
	Category 2						
1	Abdoulhadi et al. (2015)	France	Retrospective descriptive study	40 Patients from NHs, referred directly by their attending physician or the NH's coordinating physician to a geriatric short-stay medical service.	NH - acute geriatric unit	1. They used AEPf - a French version of the AEP 2. They also proposed AEPg - geriatric adaptation of AEP	***Appropriateness of admissions.*** **1.** AEPf according to AEPf 21 admissions (52,5%) are relevant. Expert jury justified 12 admissions (30%). **2.** AEPg according to AEPg 31 admissions (77,5%) are relevant. Expert jury justified 2 admissions (5%).
2	Aliberti et al. (2011)	Italy	An observational, retrospective study	N=580 patients. Patients >= 18 years of age and satisfying	Hospitalizations	CURB-65 score	***1) The CURB-65 score was calculated for every patient who referred to the ER during the study period. Appropriateness of hospitalizations.*** Out of 580 patients included in the study, 218 patients were classified with a CURB-65 score of 0 or 1 on admission to the ER, and among

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
				the criteria for CAP were included in this study.			them 127 (58%) were hospitalized (Group 1), while 91 were sent home (Group 2). Among the 127 patients belonging to Group 1, reasons that justified hospitalization were found in 104 (83%) patients. No clinical justification for hospitalization was identified in 23 patients (17%). A total of 362 patients were classified with a CURB-65 score of 2-to-5 on admission to the ER, and among them 360 (99%) were hospitalized, while 2 were sent home. Among patients with CURB-65 score of 2-to-5 who were hospitalized, 54 (15%) patients died.
3	Almeida et al. (2006)	Portugal	Routine data analysis	690 admissions/patients, 975 hospitalization days	Hospitalizations	Adapted AEP	***1) Appropriateness of admissions.*** 170 (24.6%) admissions are inappropriate 520 (75,4) admissions are appropriate. ***2) Appropriateness of hospitalization days.*** 365 (37.4%) inappropriate hospitalization days 610 (62,6%) appropriate hospitalization days.

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
4	Arendts et al. (2015)	Australia	Prospective cohort study	1143 patients. Patients aged 65 years or over who had been medically assessed in the ED and designated for discharge back to the community.	Unplanned ED revisit within 28 days from discharge	Risk Nomogram	**1) *Any visit to an ED within 28 days of discharge, excluding planned reviews.*** Overall revisit rate 28.4%. In 1143 patients, the odds of revisit increases progressively with increasing strata of predicted risk, culminating in an OR of 9.7 (95 % CI 4.7–19.9) in the highest risk group. The 28-day revisit rates across strata range from 16 % through 65 %, with the difference between strata being statistically highly significant ($p<0.001$).
5	Attena et al. (2001)	Italy	Concurrent method (survey)	533 admissions	Hospitalizations	AEP Italian version	**1) *Appropriateness of admissions.*** 84 (15.8%) admissions were considered inappropriate. ***2) Appropriateness of hospitalization days.*** 170 (35.5%) index days of stay were considered inappropriate.

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6	Aubert et al. (2017)	USA, Canada, Switzerland, Israel	Retrospective study	117,065 discharges. Consecutive medical patients discharged from each participating hospital.	30 day potentially avoidable readmissions	1) HOSPITAL score 2) Simplified HOSPITAL score	**1) *30-day potentially avoidable readmissions.*** The simplified HOSPITAL score classified 70.4% (n=82,383) discharges as unlikely, and 29.6% (n=34,682) as likely to be followed by a 30-day potentially avoidable readmission. The percentage of discharges followed by a potentially avoidable readmission was 6.4% in the low-risk category and 17.3% in the high-risk category. **2) *Any 30-day readmissions.*** Overall, 29.6% of the patients were classified as high-risk, and 27.2% of them had any 30-day readmission.
7	Baig et al. (2018)	New Zealand	Admissions data analysis	180,118 admissions. Adult admissions	Hospital readmissions	1. LACE Index for Readmission - Length of stay (days), Acute (emergent) admission, Charlson Comorbidity	***AUC score in predicting 30 day readmissions.*** **1)** The LACE index achieved an AUC score of 0.658 in predicting 30- day readmissions.

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
				from three hospitals.		Index and number of ED visits within six months. 2. New Zealand version of Patients At Risk of Hospital Readmission (PARR) using admissions data from the New Zealand hospitals.	**2)** The PARR algorithm achieved an AUC score of 0.628 in predicting 30-day readmissions
8	Baré et al. (1995)	Spain	Cross sectional study (a retrospective analysis of patients´ medical	639 medical records of adult patients admitted to a hospital were reviewed	Hospitalizations	AEP	**1)** ***Inappropriate hospital admissions.*** The rate of inappropriate hospital admissions was 9.1% (58/639). **2)** ***Inappropriate hospitalization days.*** Overall 29.2% of hospitalization days (1963/6731) were inappropriate.

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			records using AEP)				**3) *Reasons for (in)appropriate admissions.*** Inappropriate admissions were primarily attributable to hospitalizations for diagnostic and/or therapeutic services that could have been rendered on an ambulatory basis (70.7% of cases). In the group of 581 appropriate admissions, about 47% of the reasons were surgery or use of facilities available only in the hospital, followed by intravenous medications and/or fluid replacement in 18.2% of cases, acute or progressive cardiorespiratory failure in 14.5% and persistent fever > 38º for more than five days in 8.1%. **4) *Reasons for unnecessary days of care.*** Inappropriate admissions to hospital, and optimizable health care planning and a conservative physician's attitude (postponed discharge) were the most frequent reasons for unnecessary days of care.

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9	Bermejo Higuera Jc (2010)	Spain	Descriptive retrospective cross-sectional study	Older people who were referred from a nursing home (intermediate care unit) to the Hospital University. 45 residents (62 referrals in total)	NH- ED	Tool on appropriate referrals by Bermejo Higuera et al	***1) Appropriateness of referrals.*** 98.4% of referrals met one or more of the appropriateness criteria. 67.7% met criterion 1, 20.97% met criterion 2, 77.4% met criterion 3. (referral is deemed appropriate if at least 1 of 3 criteria addressed by a tool is met) ***2) Causes of referrals.*** The most common causes of referral were: suspected post-fall fracture (20 cases, 32.3%) exacerbation of respiratory disease (7 cases, 11.3%); treatment of anaemia syndrome (transfusion) (5 cases, 8.1%); poor general condition (malaise, asthenia, 5 cases 8.1%); digestive and or bowel rhythm disturbances (abdominal pain, repeated vomiting 4 cases, 6.5%); blood glucose disturbances (3 cases, 4.8%) and acute functional impairment (3 cases, 4.8%).
10	Burke et al. (2017)	USA	Retrospective cohort study	Total of 9181 patients. PPR group (1252,	Potentially preventable	HOSPITAL score	***1) Potentially avoidable readmissions.***

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				13.6%), No PPR group (7929, 86.4%). Medical inpatients discharged from 6 hospitals.	30-day readmissions		9181 patients were discharged after treatment for one of the HRRP-targeted conditions [pneumonia (n = 3335, 4.2%), HF (n = 3189, 4.0%), COPD (n = 1890, 2.4%), acute myocardial infarction (n = 767, 1.0%)]. The potentially avoidable readmission rate across these diagnoses was 13.6% overall.
11	Codde et al. (2010)	Australia	Retrospective medical chart review descriptive study analysing data from a single tertiary	603 discharges. Patients discharged from Emergency Department to their Residential Aged Care Facilities	RACF- ED	Tool by Codde et al. List of Exclusion criteria and potentially avoidable reasons for emergency department (ED) presentation	***1) Avoidable ED presentations.*** Of the 603 discharged cases, 235 were reviewed (39%). In total, 161 of these were coded as potentially avoidable. Assuming a representative sample, this equates to 69% of discharged patients, and 31% of total transfers, as potentially avoidable.

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			hospital ED patient database	without admission to an observation ward in Emergency Department or admission to Hospital.			
12	Davido et al. (1991)	France	Analysis of data taken from patient records and/or patients themselves.	371 patients. Patients admitted to a hospital through the medical emergency department.	Hospitalizations	AEPf (French version)	***1) Inappropriate admissions.*** 25% prevalence of inappropriate admissions.

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13	De Giorgi et al. (2016)	Italy	A retrospective, observational, cross-sectional study	613 readmitted patients	30 day potentially avoidable rehospitalizations	1. HOSPITAL score 2. Elders Risk Assessment (ERA) index	***1) Death (in-hospital mortality, and death at the end of follow-up).*** Death during readmission was recorded in 110 patients (17.9%), and death at the end of follow-up in 366 (59.7%). ***2) Avoidable and non-avoidable 30-day readmissions*** Re-hospitalization could be classified as avoidable in 286 cases (46.7%).
14	Donzé et al. (2013)	USA	Retrospective cohort study	7123 unique patients accounted for all 9212 index discharges. Patient discharges from all medical services of the Brigham and	30 day potentially avoidable hospital readmissions	HOSPITAL score	***1) Estimated probability and observed proportion of potentially avoidable readmissions.*** The risk of potentially avoidable readmission was stratified into 3 categories: low, intermediate, and high. Low-risk patients with 0 to 4 points (49.3% of patients) had a 5.2% estimated risk of potentially avoidable readmission and an observed proportion of 5.4% in the derivation set; high-risk patients with 7 or more points (24.4% of patients) had an 18.3% estimated probability of potentially avoidable readmission and an observed probability of 18.7%.

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				Women's Hospital.			
15	Donzé et al. (2016)	USA, Canada, Israel, Switzerland	Multicentre multinational retrospective cohort study	9 hospitals in 4 countries 7 are university hospitals and 2 are community hospitals. 117 065 patients. Patients discharged alive from the medical services of 9 hospitals in 4 different countries.	30 day potentially avoidable hospital readmissions	HOSPITAL score	***1) Estimated probability and observed proportion of potentially avoidable readmissions.*** Estimated risk of potentially avoidable readmission calculated with the HOSPITAL score matched the observed proportion of potentially avoidable readmissions in each risk group: 5.8% for the low-risk group; 11.9%, intermediate; and 22.8%, high risk.

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
16	Duflos et al. (2017)	France	Prospective study	500 referrals related to 423 patients. Prospectively included consecutive patients who visited the ED for a medical examination.	Hospitalizations	AEPf (French version)	***1) Appropriateness of admissions.*** Among the 288 admissions, 45 (15.6%) were potentially avoidable with high likelihood, 47 (16.3%) were potentially avoidable with moderate likelihood, and 196 (68.1%) were unavoidable.
17	Fine et al. (1997)	USA	Analysis of data from a hospital database	Patients with pneumonia. 1. MEDISGROUPS DERIVATION COHORT (N=14,199) patients. 2. MEDISGROUP	Hospitalizations	A prediction rule to identify low-risk patients with community-acquired pneumonia	***1) Mortality.*** No significant differences in mortality in each of the five risk classes were found among the three study cohorts. Mortality was low for risk classes I, II, and III, ranging from 0.1 to 0.4 percent for class I, from 0.6 to 0.7 percent for class II, and from 0.9 to 2.8 percent for class III. ***2) Hospitalizations.***

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				S VALIDATION COHORT (N = 38,039) patients. 3. PNEUMONIA PORT VALIDATION COHORT TOTAL (N=2,287) patients.			Among outpatients, the rate of subsequent hospitalization within 30 days ranged from 5.1 percent for class I patients to 20.0 percent for class IV. None of the 62 class I, II, or III outpatients who were subsequently hospitalized died, and only 1 was admitted to an intensive care unit. Of the eight outpatients in classes IV or V who were subsequently hospitalized, three died and one was admitted to an intensive care unit. Among inpatients, admissions to intensive care units ranged from 4.3 percent for class I to 17.3 percent for class V. For all 1236 inpatients who were discharged alive, the proportion who stayed in the hospital three days or fewer was 26.1 percent for class I and 3.7 percent for class V.
18	Gozalo et al. (2011)	USA	MDS data and Demicare claims data analysis	474,829 nursing home residents.	Nursing home - Hospital	Tool by Gozalo et al. on Three types of transitions that were classified as being potentially burdensome.	***1) Burdensome transitions.*** A total of 90,228 nursing home residents (19.0%) had at least one burdensome transition in the last 90 days of life. The distribution of the type of burdensome transition was as follows: 55,039 subjects (11.6%) had a health care transition in the last 3 days of life, 12,827 (2.7%) had a lack of continuity in nursing home provider after a hospitalization in the

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							last 90 days of life, and 38,573 (8.1%) had multiple hospitalizations in the last 90 of life.
19	Higi et al. (2021)	Switzerland	Cohort study	5985 internal medicine patients.	30-day potentially avoidable hospital readmission from patient´s homes.	PAR-Risk Score	***1) 30-day potentially avoidable hospital readmission (PAR).*** Of the eligible patients, 340 patients (5.7%) were identified as having experienced a PAR by the SQLape software, whereas it was 562 (7.7%) in the derivation patient cohort.
20	Horey et al. (2012)	Australia	Data sources included interviews with RACF staff and GPs, RACF manager surveys,	14 RACFs with a total of 1033 resident places.	RACF-Hospital	EOL care pathway. Liverpool Care Pathway for the Dying Patient, adapted and evaluated for use in Australian RACFs.	***1) Acceptability.*** Pathways were used 63 times (36% of all deaths and 43% of deaths when sudden deaths not on pathways were excluded). There were three levels of uptake of EOL care pathways across the 14 RACFs. A high-uptake group (four RACFs) used pathways for 68% of all deaths (93% of deaths when sudden deaths not on pathways were excluded); a moderate-uptake group (six RACFs) used pathways for 34% of all deaths (41% when sudden deaths not on pathways were excluded); and a low-

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
			and the prospective audits of deaths and EOL care pathway use.				or no-uptake group (four RACFs) used pathways for 10% of all deaths (11% when sudden deaths not on pathways were excluded). ***2) Feasibility.*** The proportion of deaths in hospital and RACFs remained constant in pre- and post- implementation manager surveys, but significantly fewer residents were transferred to hospital and subsequently returned to the RACF at the end of the project. RACF managers reported that before the introduction of pathways, their reviews of resident records revealed that little was written about the care provided. The pathways encouraged documentation, and the audits demonstrated that care for residents on pathways was consistent with best practice at EOL, regardless of an RACF's level of pathway uptake. Almost all people on a pathway had appropriate medicines ordered as needed. Non- essential medicines were discontinued for 76% of those on pathways, and inappropriate interventions and observations were discontinued for 60% of those on pathways.

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21	Inzitari et al. (2015)	Spain	Cohort study	265 patients. Patients consecutively transferred to the SCU of Parc Sanitari Pere Virgili from the ED of Vall d'Hebron University Hospital in Barcelona.	Different discharge destination were considered. Discharge to the usual living situation (home or usual nursing home) versus a different discharge destination (death, return to the acute	(1) The Identification of Seniors at Risk (ISAR) scale. (2) the Silver Code (3) the Walter indicator	***1) Discharge to the usual living situation (home or usual nursing home) versus a different discharge destination (death, return to the acute hospital, or transfer to long-term nursing care).*** Of 265 patients, 80.8% were discharged to the previous living situation, whereas 11.7% were transferred to long-term care, 3.4% returned to the ED, and 4.2% died.

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					hospital, or transfer to long-term nursing care).		
22	Johnston et al. (2020)	Australia	Routine data analysis, prospective study. Patient questionnaire, PAT (preventability assessment tool), GP (family physician	275 patients. Community dwelling patients with unplanned admissions to three hospitals in NSW, Australia, with a primary discharge diagnosis of COPD, CHF, angina	PPH (potentially preventable hospitalizations) for patients living in the community.	Preventability Assessment Tool (PAT)	***1) Assessments made by using PAT and assessment of the expert panel.*** There was low agreement between the assessments of the hospital doctors and nurses regarding which admissions were deemed preventable (K= 0.21; 95% CI = 0.09–0.34). The agreement between hospital nurses and hospital doctors for admissions being preventable was only 18% although agreement for non-preventable admissions (including admissions assessed as not preventable and those unclassifiable) was higher at 46%. Overall disagreement between the hospital nurses and hospital doctors was 36%. There was very low agreement between the Expert Panels and the hospital nurse regarding the assessment of the preventability of individual admissions (K= 0.17; 95% CI = 0.05–0.28). Of the 119 admissions assessed as preventable by

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			interview), extraction of hospital clinical data.	pectoris or diabetes complications.			Expert Panel, only 53 (45%) were assessed as preventable by the hospital nurses. Similarly, there was very low agreement between the Expert Panel and the hospital doctor regarding the assessment of the preventability of individual admissions (K= 0.13; 95% CI = 0.01–0.25). Of the 119 admissions assessed as preventable by Expert Panel, only 51 (45%) were assessed as preventable by the hospital doctors.
23	Karmakar and Wilsher (2010)	New Zealand	Retrospective cohort study	174 patients. Hospital patients with a discharge diagnosis of pneumonia.	Hospitalizations	The CURB 65 score	***1) Using the score patients were grouped into 3 categories: Mild CAP (CURB 65 score 0–1) Moderate CAP (CURB 65 score 2) Severe CAP (CURB 65 score 3 or more).*** Ninety-one patients appeared to have mild CAP with a score of 0–1. Twelve of these patients were discharged from the emergency department or admitting unit without formal admission, but the rest were admitted with an average length of stay of 5.5 days. No significant reason to justify hospital admission was identified for 23 of those 52 patients. One died in this group. Fifty-three (30.5%) patients appeared to have moderate CAP with CURB 65 score of 2. All were admitted with a mean hospital stay of 8.2 days (1–25 days) and two required ICU admission. There was one in-hospital death. Thirty patients appeared to

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							have severe CAP (CURB 65 >= 3) and most had multiple comorbidities and poor level of function precluding admission to ICU (Table 4). One patient with no such comorbidities was referred to the ICU. The average length of hospital stay was 9 days. There were four in-hospital deaths.
24	Lamb et al. (2011)	USA	Observational study; qualitative and quantitative analysis	26 NHs. Site coordinators and staff who participated in project orientation and conference calls and completed QI tools.	NH- Hospital	QI review tool (project INTERACT II)	***1) Reasons for transfer.*** The most common reasons for transfers that were rated avoidable or possibly avoidable were in the categories of missed opportunities for preventing the transfer before or after the onset of symptoms (31.9%); resident or family insistence on transfer (13.9%); communication gaps between nursing staff, families, PCPs, specialists, and out-side facilities (13.0%); advance directives and end-of-life care not in place or not followed (11.1%); and gaps in staff knowledge or skill (9.7%).
25	Lázaro Cebas et al. (2022)	Spain	A single-centre study with	A total of 589 of hospitalized and	Readmissions	HOSPITAL score	***1) 30-day readmissions intervention VS. control group.***

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			an intervention group and a retrospective control group.	polymedicated patients were included in the present study: 286 patients in the intervention group and 303 in the control group intervention.			The 30-day readmission rate was 20.13% (n=61) in the control group and 16.43% (n=47) in the intervention group. ***2) 30-day readmissions in 3 subgroups classified according to the HOSPITAL score.*** In the subgroup of patients with a low risk of potentially avoidable readmission, the 30-day readmission rate was similar between the control and intervention groups (11.89% vs 12.43%). In the subgroups of patients with intermediate and high risk of potentially avoidable readmission, reductions in readmission rates were observed in the intervention group.
26	Migliorati et al. (2006)	Italy	Retrospective review of medical records	148 patients, discharged with the diagnosis of pneumonia or a pneumonia-	Unnecessary hospital admissions	1. Pneumonia Severity Index (PSI) 2. Modified Italian Appropriateness Evaluation Protocol (AEP)	***1) Survival rate at 30 days.*** The overall survival rate at 30 days was 87.8%. The survival rate was, respectively, 86% and 92% in the groups of patients with appropriate and inappropriate admission according to the modified AEP. ***2) Appropriateness of admissions and hospital stay.***

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				related disease.			Overall, in accordance to the modified AEP, 52 (35%) hospital admissions were not appropriate; of these, 21 (54%) occurred in patients with low-risk class according to the PSI. According to the modified AEP, the appropriateness of the hospital stay occurred in 45% and 63% of days, respectively, for the groups of patients with low- and high-risk PSI score.
27	Oddone et al. (1996)	USA	Surveys	Phase 1, 156 patients admitted to the general medicine service at the Durham VAMC. Phase 2, 514 patients accounting for 811 readmissions	Hospitalizations	Quality assessment instrument	***1) Preventability of readmissions.*** In phase I, residents and attending physicians rated 33% and 34% of admissions as preventable, respectively. In phase 2, 277 (34%) of 811 readmissions were deemed preventable.

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				within 6 months of a general medicine service discharge at nine VAMCs.			
28	Ong et al. (2011)	UK	Retrospective case analysis	3772 acute hospital admissions from care homes.	Care home to hospital	Tool by Ong et al., on time to death as an indication of the inappropriateness of admissions	***1) Mortality.*** Of the 340 admissions, 93 died during their index admission (27.3%), 15 care home residents died within 24 h of admission, accounting for a significant proportion of the 38 (40.8%) who died within 3 days of hospital admission. Of the 93 deaths 16.1% (15) were within 4–7 days, and 43% (40) occurred at 8–28 days. The most common causes of death taken from death certificates included pneumonia (31.5%), stroke (21.0%) and heart failure (13.5%). ***2) Reasons for hospitalizations.***

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							The most cited reasons for admission were the lack of advance care plans, access to General Practitioners (GPs) out of hours, as well as general access to palliative care and specialist nurses, and poor communication between patient, relatives, GPs, hospitals and care home staff
29	Ouslander et al. (2014)	USA	An overview of the INTERACT program for medical directors and primary care clinicians in long term care	-	NH-hospital	INTERACT tools	-

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
30	Ouslander et al. (2011)	USA	Surveys	25 NHs	Hospitalizations	INTERACT II tools	***1) Hospitalization rates.*** The 25 NHs that completed the 6-month INTERACT II intervention had a 17% reduction in hospitalization rates, representing a mean absolute reduction of 0.69 (1.47) hospitalizations per 1,000 resident days (P= 0.02 relative to comparison NHs). Engaged NHs had the highest reduction (24%, P=0.01 relative to comparison NHs), representing a mean absolute reduction of 0.90 (1.28) hospitalizations per 1,000 resident days. NHs that were not engaged had only a 6% reduction. The 11 comparison facilities had a 3% reduction in hospitalization rates (from 2.69 to 2.61 hospitalizations per 1,000 resident days). ***2) Costs of the INTERACT II intervention.*** When combining costs borne by the study team and costs borne by the facility, the estimated average total cost of the 6-month INTERACT II intervention was approximately $7,700 per facility.

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31	Ouslander et al. (2009)	USA	Prospective quality improvement initiative	3 NHs	NH- hospital	1) INTERACT intervention which contains tools 2) SIR structured implicit record review	***1. Hospitalizations, number and per 1000 resident days.*** Compared with baseline, the facilities had a 58%, 44%, and 36% reduction in hospitalizations per 1000 resident days; the overall reduction in the 3 facilities combined was 50%. The average hospitalization rate during the intervention for the 3 pilot facilities (1.54/1000 resident days) was slightly lower than the average rate for all 377 Georgia NHs in the baseline phase (1.62/1000 resident days). ***2. Potentially avoidable hospitalizations.*** The baseline rate of potentially avoidable hospitalizations was 77% of the 30 hospitalizations reviewed in the 3 pilot facilities (compared with 68% for all 200 hospitalizations rated during baseline). Thus, the intervention was associated with a 28% absolute reduction in hospitalizations rated as potentially avoidable by the Expert Panel (77% to 49%). This represents a relative reduction of 36% (28%/77%).

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							3. Reasons for avoidable hospitalizations, and factors that could have enhanced NHs´ ability to prevent hospitalization. Factors frequently considered somewhat or very important for rating the hospitalization as potentially avoidable included the availability of on-site physician care, the availability of registered nurses and nurse practitioners or physician assistants, the overall quality of NH care related to assessing and managing changes in condition, and the need for better advance care planning. Re- sources frequently rated as potentially helpful in preventing avoidable hospitalizations included greater on-site availability of physician or nurse practitioner or physician assistants, more registered nurses providing care, availability of lab results within 3 hours, and the capability of the NH to administer intravenous fluids. ***4. Diagnoses associated with potentially avoidable hospitalizations.*** When compared with the distribution of diagnoses for the 105 potentially avoidable hospitalizations for which data were available

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
							among the 200 hospitalizations reviewed for baseline data, the proportion of hospitalizations related to de- hydration/metabolic disturbances and gastrointestinal conditions were substantially higher (16% versus 7%, and 19% versus 7%, respectively).
32	Patel et al. (2014)	UK	Retrospective for prealgorithm (i.e. developing a tool) prospective for postalgorithm (evaluation)	57 patients presenting to the single institution with acute LGIB. This included all community and ED referrals.	Community-Hospital, Community-Surgical Unit, Community-ED	Rectal bleeding admission guide and algorithm	***1) Avoidable admissions.*** Thirty-seven percent (21/57) of patients met all three of the criteria of the scoring system, indicating they could be treated without admission. Ninety-five per cent of these patients (20/21) were discharged home without hospital stay meaning that 35% (20/57) of potential admissions were avoided. One patient was admitted although he met the criteria for discharge as he was elderly and presentation was late at night. One patient was subsequently readmitted at the time of outpatient endoscopy with a diagnosis of severe colitis of potential admissions were avoided. Sixty-five per cent (36/57) did not meet the scoring criteria for outpatient treatment and were admitted to hospital. ***2) Patient satisfaction.***

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
							There were 10 responses to the patient satisfaction questionnaire: 80% rated the service as excellent and 10% as good; 70% rated the speed of service good or excellent; 90% felt they were given satisfactory information; and 80% knew who to contact if they had concerns.
33	Pérès et al. (2002)	France	Prospective, routine data analysis, phone calls	322 patients consecutively discharged from an acute geriatric unit.	Rehospitalizations	AEPf (French version)	***1) Incidence of rehospitalization.*** In total, 50 rehospitalizations at one month were recorded, representing an overall incidence of 16.2%, among the 309 subjects followed. ***2) Avoidable rehospitalizations according to the AEPf criteria.*** Of the 21 readmissions that took place in the same department, 5 (23.8%) were deemed avoidable according to the AEPf criteria.

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34	Popejoy et al. (2019)	USA	Cross-sectional descriptive study	16 nursing homes (NHs). 5168 residents.	Nursing home-Hospital	INTERACT QI Acute Care Transfers (ACTs) tool, v.3.0.	***1) Avoidable and unavoidable hospital transfers.*** There were 1516 ACTs submitted in 2014, 1336 in 2015, and 1144 in 2016. Over one-half of transfers (n = 2112 [54%]) were identified as avoidable using the team-based approach described earlier. A total of 1835 (46%) transfers were identified as unavoidable. ***2) QI opportunities related to avoidable and unavoidable transfers.*** QI opportunities related to avoidable transfers were earlier detection of new signs/symptoms; discussions of resident/family preference; advance directive/hospice care; better communication about condition; and condition could have been managed in the NH. Three factors related to unavoidable transfers were bleeding, nausea/vomiting, and resident/family preference for hospitalization.
35	Saliba et al. (2000)	USA	A structured	458 residents transferred from the SNF	SNF - ED/hospital	Structured implicit review (SIR)	***1) Percentage of appropriate transfers.***

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
			implicit review (SIR) of medical records. Retrospective.	to the ED or hospital.			Assuming no directive limits care: two reviewers agreed that 36% of ED transfers and 40% of hospital admissions are inappropriate. They also agreed that 48% of ED and 49% of hospital admissions are appropriate. Considering advance directives: two reviewers agreed that 44% of ED transfers and 45% of hospital admissions are inappropriate. They also agreed that 41% of ED and 44% of hospital admissions are appropriate.
36	Schwab et al. (2018)	France	Patient data from a monocentric, retrospective, matched, case-control study using the	438 patients, who experienced an unscheduled readmission within 30 days after the index discharge. The control group consisted of elderly	1. Unplanned readmission (AED visit or readmission) or death during the 12-month follow-up period 2. Unplanned readmission	1. The 80+ score 2. The LACE index 3. The HOSPITAL score 4. The TRS	***1) Score results.*** Using a t-test, the means of the scores were compared between cases and controls (table 4). The 80+ score, the LACE index and the HOSPITAL score had p-values of 0.87, 0.24 and 0.60, respectively, meaning that there was no significant difference between cases and controls. In contrast, for the TRST, the mean score of the cases was significantly different from the mean score of the controls.

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
			clinical data warehouse of a French university hospital.	patients who had not had any unscheduled readmissions during the 30 days after the index discharge.	to hospital or death within 30 days of discharge 3. 30 day potentially avoidable readmission 4. AED visit, hospital admission or nursing home admission at 30 and 120 days.		
37	Shams et al. (2015)	USA	Retrospective cohort study.	5,600 eligible admissions. Inpatient	30 day avoidable readmissions	Potentially Avoidable Readmission (PAR) algorithm	***1) 30-day avoidable readmission.*** PAR rate is found to be 11.77 %.

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
				administrative records gathered from four medical facilities were analysed. 7200 records that correspond to 2985 distinct adult patients.			
38	Soria-Aledo et al. (2012)	Spain	A retrospective pre- and post-intervention study	1450 histories (725 belonging to the control group and 725 to the intervention group).	Transition from emergencies, consultation, home or other centres to the hospital	AEP (Appropriateness Evaluation Protocol) Spanish version	***1) Inappropriate admissions.*** Comparing control and intervention groups, inappropriateness of admission in the control group was 7.4% (54 patients), whereas in the intervention group it was significantly reduced to 3.2% (23 patients). ***2) Inappropriate stays.***

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
							Comparing control and intervention groups, the percentage of inappropriate stays was 24.6% (334 patients) in the control group and 10.4% (137 patients) in the intervention group. ***3) Cost of inappropriateness.*** The cost of the days considered inappropriate in the study sample, taking into account the mean cost per patient, clinical service and day, was 147,044 euros in the control group and 66,462 euros in the intervention group.
39	Stadler et al. (2019)	USA	Prospective cohort, pre/post study	216 residents. 3 SNFs.	SNF-hospital/ED	RAFT (Reducing Avoidable Facility Transfers) model	***1) ED transfers and hospitalizations for SNF residents overall, and for post-acute care (PAC) and long-term care (LTC) subgroups.*** Mean monthly ED transfers decreased from 24.8 (6.5) at baseline to 15.9 (3.0) post intervention, representing a 35.8% reduction. Mean monthly LTC ED transfers reduced from 11.1 (3.9) at baseline to 4.2 (2.3) post intervention, representing a 61.9% reduction. Mean monthly

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
							ED transfers of PAC patients did not change significantly post intervention. Mean monthly hospitalizations decreased by 30.5% from 15.8 (6.2) to 10.9 (3.7) post intervention. LTC hospitalizations decreased from a monthly average of 6.5 (2.9) at baseline to 2.4 (1.5) post intervention, a 62.4% reduction. PAC average monthly hospitalizations decreased slightly from 9.3 (4.8) at baseline to 8.5 (3.0) post intervention, representing an 8.1% reduction. ***2) Advanced care planning status, hospital charges, and standard Minimum Data Set (MDS) quality metrics.*** Key characteristics that could potentially influence ED and hospital utilization were measured. These included reported MDS quality measures, staffing ratio and case mix. No significant changes in any of these factors during the intervention period when compared to previous years were observed.
40	Stiell et al. (2017)	Canada	Prospective observatio	1100 patients, with shortness of breath due	ED admissions (but also	Ottawa Heart Failure Risk Scale (OHFRS)	***1) SAE (serious adverse events).***

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
			nal cohort study	to acute heart failure, either admitted to the hospital or discharged from the ED.	discharge decisions)		The overall SAE rate was 15.5%, 19.4% for patients admitted, 10.2% for those discharged from the ED, and 17.4% for those with NT-proBNP values. ***2) Physician accuracy in interpretation, acceptability to the physicians, and potential impact on disposition decisions.*** Risk category (i.e., low, medium, etc.) classification of the physicians to the criterion interpretation was compared. Overall agreement of 59.2% for the exact category and 94.7% for the exact category +- 1 was found. Issues identified were not completing the walk test, not having the NT-proBNP values available clinically, and too many criteria. In 11.9% of cases, physicians indicated that they would be “uncomfortable” or “very uncomfortable” in using OHFRS to make disposition decisions for that patient. Commonly expressed concerns were unavailability of NT-proBNP values and forgetting to arrange for a walk test.

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
41	Stiell et al. (2018)	Canada	Prospective cohort study	1415 patients, who presented to the emergency department with acute shortness of breath or respiratory distress caused by exacerbation of COPD and who might be considered well enough to be discharged by the	ED admissions and discharges	The Ottawa COPD (chronic obstructive pulmonary disease) Risk Scale (OCRS)	***1) Short-term serious outcomes.*** Among the 1415 participants who were enrolled (Table 2), there were 135 (9.5%) short-term serious outcomes, with higher rates in those admitted compared with those discharged from the emergency department (11.0% v. 8.3%, $p < 0.01$). ***2) Physicians answering the following question, "How comfortable would you be using this scale to assist making a disposition decision for this patient?"*** On the 5-point scale of comfort in using OCRS, the physicians indicated that they would be uncomfortable or very uncomfortable in only 13.4% of cases.

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
				attending physician.			
42	Subbe et al. (2001)	UK	Prospective cohort study	673 medical emergency admissions.	Admission to HDU or ICU	Modified Early Warning Score (MEWS)	***1) HDU and ICU admission, attendance of the cardiac arrest team at a cardiorespiratory emergency and death at 60 days.*** During follow-up, 7 patients were admitted to ICU, 23 to HDU, 4 were resuscitated by the cardiopulmonary arrest and 56 died.
43	Teh and Janus (2018)	Australia	Prospective study	781 patients.	30 day hospital readmissions	Revised LACE index	***1) Readmission rates for those who had revised LACE index scores of 8 and above, and those with scores below 8, and also between those who participated vs. those who chose not to participate in RAPT intervention.*** Median revised LACE index score for all admission episodes was 7 [IQR 4, 8], with 358 (41.0%) admission episodes classified as high risk of early readmission. Revised LACE index scores were equivalent for readmission vs. non-readmission episodes (7 [IQR 5, 8] vs. 7 [IQR 4, 8]), although there was a trend toward scores of 8 and above being more frequent among readmission vs. non- readmission episodes. Of the 358 admission episodes identified as high risk, 133 (37.2%) received RAPT

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
							intervention, and 53 (14.8%) formally declined. Among the 133 admission episodes that received RAPT intervention, there were 19 (14.3%) subsequent early readmissions and 114 (85.7%) were not readmitted. Early readmission rates were equivalent for those who received vs. those who did not receive RAPT intervention (14.3 vs. 14.7%). The readmission rate was 10.5% for those who received specialist clinic appointments, 17.8% for HARP referrals, and 20.0% for IRS referrals. Among those who declined RAPT intervention, the readmission rate was 22.6% for those who failed to attend or cancelled their clinic appointment and 16.7% for those who refused clinic during their inpatient stay.
44	Uhlmann et al. (2017)	Switzerland	Retrospective study	6729 hospital stays.	Potentially avoidable readmission (PARA)	1. LACE index 2. HOSPITAL score 3. Risk prediction model for PARAs	***1) PARA.*** 777 stays were followed by a PARA; 5952 patients were not readmitted.
45	Unroe et al. (2015)	USA	Prospective study	4,035 long-stay nursing-home residents	Avoidable hospitalizations	Root cause analysis (INTERACT QI Acute care transfers (ACT) tool)	***1) Avoidable hospitalizations.*** Of the 910 transfers that the RNs evaluated, 28% were judged to be avoidable, 57% were unavoidable, and 15% had no response coded,

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							because information was missing or the RN could not reach a conclusion.
46	Velasco Díaz et al. (2005)	Spain	Retrospective and descriptive study	Medical records of 622 patients admitted to medical services from the ED.	Unnecessary emergency admissions	Appropriateness evaluation protocol Spanish version (AEP)	***1) Appropriateness of admissions.*** Of the 622 admissions reviewed, 63 (10.1%) were considered inappropriate. ***2) Appropriateness of stays***. Unnecessary admissions generated 78.2% of unnecessary stays, and the appropriate admissions generated 24.8% of unnecessary stays.
47	Wright et al. (2014)	UK	Pre- and post-retrospective cohort study	Comparison of 5,416 emergency geriatric admissions in the 12 months preceding TREAT with	Unplanned hospital admissions	Triage and Rapid Elderly Assessment Team (TREAT). (Includes Comprehensive Geriatric Assessment)	***1) Same-day discharge rate as a percentage of admissions (an inverse measure of admission rate).*** After the introduction of TREAT, the percentage of admissions resulting in same-day discharges increased from 12.26 to 16.23% for TREAT-matching Admissions, but for the residual population fell from 15.01 to 9.77%.

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
				the 5,370 emergency geriatric admissions in the 12 months following			***2) LOS (Length of Stay).*** After the introduction of TREAT, the median LOS for TREAT-matching admissions reduced by 2 days, and mean LOS by 18.16%. For the residual admissions, the median was unchanged, and mean LOS reduced by 1.08%. For all Emergency Geriatric Admissions population, median LOS reduced by 1 day, and the mean LOS by 11.65%.
48	Zerah et al. (2022)	Switzerland, The Netherlands, Belgium, Ireland	Retrospective study using data from the OPERAM (OPtimising thERapy to prevent Avoidable hospital admissions in	832 patients, 4 medical centres from 4 countries.	Drug related hospital admissions	1) Standardised chart review 2) Standardised chart review with revised trigger tool	***1) ADE (adverse drug event), DRA (drug related admission), preventable DRAs.*** 673 hospitalizations (55%) had at least one identified ADE and 518 were adjudicated as DRAs (42%; Figure 1). Of the 518 DRAs identified, 219 (42%) could be considered as preventable (due in whole or in part to overuse [N=55, 11%], underuse [N=135, 26%] and/or misuse [N=45, 9%]).

#	Authors publication year	Country	Method/Design	Sample/Study population and number	Care transition	Assessment tool reported	Outcome
			Multimorbid older people) trial.				
49	Zúñiga et al. (2022)	Switzerland	Multicenter nonrandomized stepped-wedge design within a hybrid type-2 effectiveness study	11 NHs in German-speaking Switzerland. 942 residents.	NH - hospital/ED	INTERCARE nurse-led model (Includes Comprehensive Geriatric Assessment)	***1) Unplanned hospitalizations.*** Raw rates for unplanned transfers per 10000 resident days were 0.41 for the three baseline months and subsequently 0.84 (intervention start=T1), 0.85 (3 months after T1), 0.64 (6 months after T1), 0.79 (9 months after T1), and 0.42 (12 months after T1) unplanned transfers/10000 resident days per quarterly period after baseline. During the 3-month baseline and 18-month intervention study periods, 367 hospital transfers occurred, of which 303 transfers (82.6%) were unplanned (primary outcome) and 64 transfers (17.4%) planned. At the resident level, 225 residents (23.9%) were transferred to a hospital at least once for an unplanned reason.

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Supplementary file 3: Characteristics of the tools

Summary

The supplementary file is structured into 36 sections with a total of 48 tables. Each section represents a family of tools and tables represent a particular assessment tool. For example, section 1 represents a family of INTERACT tools, with 4 tables representing its variations.

List of abbreviations

Y: Yes

N: No

NI: No Information

1. INTERACT tools and their variations

Table 1. INTERACT tools (with focus on care paths only)

Tool name (reported in (1-5))	
INTERACT tools with focus on decision support tools.	
Concept/components covered	
Decision support tools (include care paths for 10 conditions) for Home health care (INTERACT version 1.0 tools), Assisted living (INTERACT version 2.0 tools), Skilled nursing (INTERACT version 4.5 tools) : Acute mental status change, Change in behaviour: evaluation of medical causes of new or worsening behavioural symptoms, Dehydration, Fever, Gastrointestinal symptoms, Shortness of breath, Symptoms of congestive heart failure, Symptoms of lower respiratory infection, Symptoms of urinary tract infection, Fall. (6).	
What the tool measures/does	
Determine which residents could be safely managed in the nursing home. 1-5 (6).	
Objectivity	
Process	Y. Self explaining (6).
Evaluation	Y. For example signs of increased confusion, new or worsened memory loss, unrelieved pain, difficult or laboured breathing that is

	out of proportion to the patient's level of physical activity, depending on a care path (6).
Interpretation	Y. Care paths are in the form of flow charts. Depending on situation/input information there is clear guidance on how to act next (6).
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	Y. Depending on a care path, may require some specific data. For example X-ray, blood work, ECG, stool specimen for occult blood (6).
Specific training required	Y. INTERACT as a whole may require specific training and appropriate implementation in NHs. Interact website also includes an implementation guide, implementation check-list to assist NHs in getting started and monitor implementation process. Web site also offers a "Contact Us" feature for questions to be answered by the INTERACT team (4). For website, refer to: (6). Each participating NH appointed a team responsible for attending the learning sessions (relates to the whole intervention). (5)
Who completed the tool?	
Care paths for home health care: all home health licensed staff (6). Care paths for assisted living: all assisted living licensed nursing staff and primary care clinicians (6). Care paths for skilled nursing: all skilled nursing facility/nursing facility licensed nursing staff and primary care clinicians (6).	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In NH, when a resident is evaluated by a nurse, after change in resident´s status was noted (6). Likely prospective use.	

Language	Tool can be seen/accessed in:
English (6)	Website with INTERACT tools: (6)

Table 2. QI review tool (from project INTERACT II)

Tool name (reported in (7))	
Quality improvement (QI) review tool (from project INTERACT II)	
Concept/components covered	
Consists of four sections: resident information; hospital transfer information, including symptoms or change in condition that precipitated the transfer; actions taken by staff before the transfer; and analysis of factors that may have influenced the transfer decision and rating of the transfer as avoidable, possibly avoidable, or not avoidable. (7)	
What the tool measures/does	
Assists NH staff in understanding the reasons for the transfer and identifies opportunities to improve identification and management of changes in resident status and reduce acute care transfers. (7)	
Objectivity	
Process	NI
Evaluation	NI
Interpretation	NI
Reliability	
Inter-rater	Interrater reliability was calculated for a subset of 50 forms. Percentage raw agreement of all three raters was 78%. Agreement between each set of two raters ranged from 78% to 88%. (7)
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	NI

Specific training required	Y. Initial collaborative calls focused on training and logistics associated with implementing INTERACT II tools (7).
Who completed the tool?	
Registered nurses, licensed practical nurse, nurse manager, nurse educator, social workers (7).	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In NH, QI was applied retrospectively on every hospital transfer (7).	
Language	**Tool can be seen/accessed in:**
Likely to be in English	Tool not found.

Table 3. INTERACT II tools (with focus on care paths only)

Tool name (reported in (8))	
INTERACT II tools with focus on care paths (subset of tools from INTERACT II).	
Concept/components covered	
Care paths for Mental status change, Fever, Symptoms of lower respiratory infection, Symptoms of congestive heart failure, Symptoms of urinary tract infection, Dehydration. (8)	
What the tool measures/does	
Determine which residents could be safely managed in the nursing home. (8)	
Objectivity	
Process	NI
Evaluation	NI
Interpretation	NI
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI

Specific input data required	NI
Specific training required	Y. NH staff was educated prior to intervention (8).
Who completed the tool?	
NH staff (8).	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In NH (8). Likely prospective use.	
Language	**Tool can be seen/accessed in:**
Likely to be in English	Tool not found.

Table 4. Root cause analysis (INTERACT QI Acute care transfers (ACT) tool)

Tool name (reported in (9, 10))	
Root cause analysis (INTERACT QI Acute care transfers (ACT) tool)	
Concept/components covered	
Broad ACT categories include (1) Resident characteristics and risk factors for hospitalization; (2) acute change in condition and other non-clinical factors that contributed to the transfer; (3) action(s) taken to evaluate and manage the change in condition before transfer; (4) description of the hospital transfer; and (5) opportunities for improvement. (9)	
What the tool measures/does	
Describes common clinical and non-clinical factors that help clinical staff understand reasons for the transfer and for process improvement considerations to avoid future transfers. (9)	
Objectivity	
Process	NI However, described the ACT QI procedures: "(1) monthly review of all ACTs by a team composed of the APRN, project coordinator, and APRN supervisor; (2) identification of resident and NH factors contributing to the transfer; and (3)

	agreement by the team on the question "Was the transfer potentially preventable (avoidable)?" using the QI technique "Five Why's." This technique is an iterative interrogative approach to exploring cause and effect and was used by the team to assure root causes of transfers were considered when establishing agreement on which transfer were deemed avoidable vs unavoidable." (9)
Evaluation	NI
Interpretation	Y. "Agreement by the team on the question "Was the transfer potentially preventable (avoidable)?" using the QI technique "Five Why's." (9)
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	Slightly longer than 30 min. (10)
Specific input data required	NI
Specific training required	RNs (registered nurses) completed facility staff trainings on several INTERACT tools, including root cause analysis of hospital transfers. (10)
Who completed the tool?	
Advanced practice registered nurses. (9)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In NH, retrospectively applied with regard to hospital transfers. (9) After discharge from hospital back to nursing home / nursing home / likely retrospective. (10)	
Language	**Tool can be seen/accessed in:**
Likely to be in English	Tool not found.

2. ACE service model / The Aged Care Emergency (ACE) program

Table 5. ACE model (with focus on evidence-based algorithms only)

Tool name (reported in (11, 12))	
ACE service model / The Aged Care Emergency (ACE) program with focus on evidence-based algorithms (for clinical use).	
Concept/components covered	
Some of the algorithms for the following conditions also include further related sub-sections: Allergic Reactions/Anaphylaxis, Assaults, Cardiology, Cellulitis, Dental and Oral Health, Diabetes, Falls, Gastroenterology, Neurology, Nosebleeds (Epistaxis), Pain, Palliative Care and Last Days of Life Care, Polypharmacy and high-risk medications in RACFs, Respiratory, Subcutaneous Fluid Administration, Urology, Wound Care. (13, 14)	
What the tool measures/does	
Determine which residents could be safely managed in the nursing home. (11-14)	
Objectivity	
Process	Y. Self-explaining.
Evaluation	Y. Depending on algorithm. For example measuring pain level (13), although it can be measured with other specifically designed tools, pain measurement by nature may still be subjective to some extent.
Interpretation	Y. Algorithms frequently in the form of flow charts (some are in text form or table form). Depending on input information/situation, there is a guidance on how to act next (13).
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI

Specific input data required	Y. Depending on algorithm, may require specific data. For example test for blood glucose level (BGL), testing of urine for culture and sensitivity, imaging (CT head or MRI) (13).
Specific training required	Y. May require some training. Education resources are also provided on the ACE website here: (15).
Who completed the tool?	
The manual of algorithms guides and supports RACF staff to manage acutely unwell residents in situ and is used as a reference source by RNs, AINs, PCAs, GPs and ED staff (12).	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In the RACF. Algorithms were used to manage acutely unwell residents in situ (12). Likely prospective use.	
Language	**Tool can be seen/accessed in:**
English (13).	Algorithms can be accesses on a website (they are presented separately). Username is "aged" and password is "care": (13), or in the form of generic ACE manual, which contains all algorithms and other ACE model components: (14).

3. **A complex intervention (BHiRCH-NH) to reduce avoidable hospital admissions in nursing homes**

Table 6. A complex intervention (BHiRCH-NH) to reduce avoidable hospital admissions in nursing homes (with focus on care pathway only)

Tool name (reported in (16, 17))
A complex intervention (BHiRCH-NH) to reduce avoidable hospital admissions in nursing homes with focus on care a pathway.
Concept/components covered
Care pathway is a clinical guidance and decision-support system for 4 ACSCs: dehydration, deterioration of congestive heart failure, lower respiratory tract infection, urinary tract infection. (16, 18)

What the tool measures/does	
Determine which residents could be safely managed in the nursing home. (16, 18)	
Objectivity	
Process	Y. Self-explaining (18).
Evaluation	Y. Some elements of a care pathway may seem subjective by nature. For example when checking for lower UTI symptoms (i.e. discomfort on passing urine, lower abdominal discomfort/pain) (18).
Interpretation	N. Following the use of the care pathway, the nurse will make a clinical decision about the next course of action which will include one or more of the following actions: further general monitoring using S&W tool or direct monitoring for specific symptoms of the resident´s condition, initiate treatment in a care home, in case of potential diagnosis/immediate concern about resident´s condition communicate with primary care using SBAR tool (18).
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	Y. May require specific data, for example testing for UTI, lower respiratory tract infection (18).
Specific training required	Y. Some training may be required. It was reported that a workshop, introductory meetings and telephone coaching were provided. However, this training was on the whole intervention (care pathway is part of this intervention) (16).
Who completed the tool?	
By a nurse (18).	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In NH. Applied when a change in resident´s condition was noted (18). Likely prospective use.	

Language	Tool can be seen/accessed in:
English (18)	Care pathway can be accessed in Appendix 12: (18)

4. Novel Decision Guide "Go to the Hospital or Stay Here?"

Table 7. Novel Decision Guide "Go to the Hospital or Stay Here?"

Tool name (reported in (19))	
Novel Decision Guide "Go to the Hospital or Stay Here?"	
Concept/components covered	
Change in condition, what to expect in different situations, how to get involved in a decision, pros and cons of being treated in a hospital or in the NH, FAQs, decision tree, what residents family and caregivers say and more. (20)	
What the tool measures/does	
To guide residents, families, friends, caregivers on a decision-making whether to go to a hospital or stay in a nursing home. (19, 20)	
Objectivity	
Process	Y. Self-explaining (20)
Evaluation	Y. Decision guide provides information in the form of text, frequently asked questions, and also provides a decision tree. A decision tree has some parts that may seem subjective in nature, for example assessing how sick a person is with 3 options: mild, moderate, very sick. (20)
Interpretation	Y. When talking about a decision tree (which is part of the decision guide), it has a clear guidance on how to arrive at a certain conclusion depending on situation/input data.
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	

Time to completion	NI
Specific input data required	Y. When talking about a decision tree (part of the decision guide), it may require some tests, but specific tests are not mentioned (20) (we assume because the guide is for use by patients/caregivers, and not be used by care professionals).
Specific training required	Y. Member of the research team reviewed the contents of the Guide with participants and answered any questions that arose. (19) Educational material & resources for residents/families and for care professionals are available here: (20)
Who completed the tool?	
For NH residents, families, friends, caregivers	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In NH, when an acute change in resident´s condition occurs (20). Prospective use?	
Language	**Tool can be seen/accessed in:**
English, Spanish, French, Filipino, Creole, Chinese (20)	Decision guide can be accessed from (in booklet or in trifold form): (20)

5. **ACI-TIPI acute cardiac ischemia time-insensitive predictive instrument**

Table 8. ACI-TIPI acute cardiac ischemia time-insensitive predictive instrument

Tool name (reported in (21))
ACI-TIPI acute cardiac ischemia time-insensitive predictive instrument
Concept/components covered
Software based tool.
What the tool measures/does
Calculates probability of acute ischemia.
Objectivity

Process	Y. Sort of “software” tool.
Evaluation	N. Automatically computed by the electrocardiograph.
Interpretation	Y. On presentation to the emergency department, each patient's ACI-TIPI probability of acute ischemia was automatically computed by the electrocardiograph. During intervention periods, the probability was automatically printed on the electro-cardiogram header, with an indication that it was "to supplement, not replace physician judgment," along with the standard electrocardiogram interpretive header text.
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	Both manufacturers' ACI-TIPI electrocardiographs had ROC areas of 0.78.
Costs	
Time to completion	Instant (computed by the electrocardiograph)
Specific input data required	N. To acquire the ACI-TIPI probability in clinical use, the user enters the patient's age and sex and indicates whether chest or left arm pain is the primary symptom; the electrocardiograph then directly measures the wave-forms and computes and prints the probability of acute ischemia on the electrocardiogram header for the physician's immediate use.
Specific training required	NI
Who completed the tool?	
Physician.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In ED. On presentation of a patient to the emergency department. (21) Likely prospective use.	
Language	**Tool can be seen/accessed in:**
English	Tool described in the study. (21)

6. Appropriateness Evaluation Protocol (AEP) and its sub-types

Table 9. AEP (with focus on criteria of appropriateness of admission only)

Tool name (reported in (22))	
AEP with focus on criteria of appropriateness of admission.	
Concept/components covered	
18 criteria of appropriateness of hospital admission, of which 11 are related to severity of illness and patient condition, and 7 related to health care requirements or intensity of services.	
What the tool measures/does	
Appropriateness of hospital admissions.	
Objectivity	
Process	Y. Self-explaining.
Evaluation	Y. Has some parts, which may be subjective. For example, acute or progressive sensory, motor, circulatory or respiratory embarrassment sufficient to incapacitate the patient (does not include back pain).
Interpretation	Y. Admission is considered to be appropriate when any of the 18 criteria of the appropriateness of hospital admission is fulfilled. When none of the criteria are fulfilled, hospital admission is considered inappropriate.
Reliability	
Inter-rater	Independent application by 2 physicians on random sample of 85 registers of hospital discharges from which corresponding medical records were obtained. Overall agreement rate, the specific degree of agreement and the kappa index were calculated. Overall agreement rate: 89%. Specific concordance: 40%. Kappa index: 0.5
Intra-rater	NI

Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	Y. For example, data on electrolyte (Na, K) or blood gas (CO2, arterial pH), electrocardiographic data.
Specific training required	NI
Who completed the tool?	
Physicians	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In the study authors did a retrospective application using patient´s medical records. However, application of AEP during patient´s hospitalization could also be possible, but study authors note it would be more appropriate for retrospective use.	
Language	**Tool can be seen/accessed in:**
English	Annexe 1: (22)

Table 10. AEPf (French version)

Tool name (reported in (23-26))	
AEPf (French version)	
Concept/components covered	
16 criteria in total. 10 criteria on clinical severity, 6 criteria on delivery of care. (24)	
What the tool measures/does	
Appropriateness of hospital admissions. (24)	
Objectivity	
Process	Y. Self-explaining. (24)
Evaluation	Y. Has some parts, which may be subjective. For example, sudden impairment of essential functions (moving, eating, breathing, urinating, etc.) except for a chronic manifestation with no new facts. (24)

Interpretation	Y. If one of 16 criteria is present, the admission is considered appropriate. (23)
Reliability	
Inter-rater	The degree of agreement between two observers were assessed by the concordance and the Kappa coefficient. The reproducibility of the instrument was high (Kappa: 0.81). (24)
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	Data were gathered from the patients themselves most of the time. It was easy to get the information from the record when necessary, most of the time in less than 5 min.(24)
Specific input data required	Y. For example, data on electrolyte (Na, K), ECG. (24)
Specific training required	NI
Who completed the tool?	
Can be used by non-experts. AEPf was used by a physician and nurse (24). Also was used by gerontologists and epidemiologists (26).	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In ED, prospective use. (24) Retrospective use. (23)	
Language	**Tool can be seen/accessed in:**
French (24)	Annexe: (24)

Table 11. AEPg (geriatric adaptation of AEP)

Tool name (reported in (23))
AEPg (geriatric adaptation of AEP)
Concept/components covered
17 criteria in total. 11 criteria on clinical severity, 6 criteria on delivery of care.

What the tool measures/does	
Appropriateness of hospital admissions.	
Objectivity	
Process	Y. Self- explaining.
Evaluation	Y. Some parts may be subjective. For example, sudden impairment of essential functions (moving, eating, breathing, urinating, etc.) except for a chronic manifestation with no new facts.
Interpretation	Y. If one criteria is present, admission is considered appropriate.
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	Y. For example, data on electrolyte (Na, K), ECG
Specific training required	NI
Who completed the tool?	
Geriatricians and a geriatric psychiatrist	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In NH. Likely retrospective use.	
Language	**Tool can be seen/accessed in:**
French	Table 2: (23)

Table 12. Adapted AEP

Tool name (reported in (27))
Adapted AEP
Concept/components covered

NI	
What the tool measures/does	
Appropriateness of hospital admissions.	
Objectivity	
Process	NI
Evaluation	NI
Interpretation	NI
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	NI
Specific training required	Y. Reported that 2 reviewers were previously trained to use the protocol (i.e. adapted AEP).
Who completed the tool?	
NI Reported just on reviewers.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Hospital. Likely retrospective use.	
Language	**Tool can be seen/accessed in:**
NI. Likely to be in Portuguese	Tool not found.

Table 13. AEP Italian version

Tool name (reported in (28))
AEP Italian version

Concept/components covered	
NI	
What the tool measures/does	
Appropriateness of hospital admissions.	
Objectivity	
Process	NI
Evaluation	NI
Interpretation	NI
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	NI
Specific training required	Y. Reviewers were given thorough preparation for the study using the literature on the subject and doing practice runs involving vast sample of medical records.
Who completed the tool?	
Reviewers: Qualified doctors.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Hospital, concurrent method was used as opposed to longitudinal retrospective.	
Language	**Tool can be seen/accessed in:**
Likely Italian	Tool not found.

Table 14. AEP Spanish version

Tool name (reported in (29, 30))

AEP Spanish version	
Concept/components covered	
NI	
What the tool measures/does	
Appropriateness of hospital admissions. (29, 30)	
Objectivity	
Process	NI
Evaluation	NI
Interpretation	Y. Inappropriate admission is considered when on the day of admission the patient does not meet any criteria for hospitalization according to the AEP.(29)
Reliability	
Inter-rater	The degree of concordance by the three assessors following a short training period is kappa value of 0.31 for appropriate admissions.(29) The reviewers, four physicians participating in the study, reached an inter-observer agreement of more than 85% with a reviewer expert in the use of the AEP. (30)
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	NI
Specific training required	Y. By way of training the assessors were given a theoretical and practical course on the use of the AEP.(29)
Who completed the tool?	
Internal resident doctor and ward nurses (29) and physicians (30).	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In hospital, retrospective use of AEP using medical records of patients admitted to the hospital. (29)	

Language	Tool can be seen/accessed in:
Likely to be in Spanish (29)	Tool not found.

Table 15. Modified Italian AEP

Tool name (reported in (31))	
Modified Italian AEP	
Concept/components covered	
Criteria of appropriateness of hospital admission divided in two subsets pertaining to severity of illness and patient conditions (n=11) and health care requirements or clinical services (n=7). (32)	
What the tool measures/does	
Appropriateness of hospital admissions. (31)	
Objectivity	
Process	NI
Evaluation	NI
Interpretation	Y. The admission to hospital is considered as appropriate when at least an established criterion is met. (31)
Reliability	
Inter-rater	Inter-rater agreement and the k statistic for the assessment of admission were always higher than 85% and 0.82. (32)
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	NI
Specific training required	NI
Who completed the tool?	
Likely study authors (31)	

When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
at admission / in hospital / retrospective (31)	
Language	**Tool can be seen/accessed in:**
Italian (32)	Tool not found.

7. CURB-65 score

Table 16. CURB-65 score

Tool name (reported in (33, 34))	
CURB-65 score (available for hospital setting and slight adaptation for community setting)	
Concept/components covered	
5 clinical and laboratory characteristics (confusion, blood urea nitrogen, respiratory rate, blood pressure, and age >= 65 years). For community setting, blood urea nitrogen is absent. (33-35)	
What the tool measures/does	
Mortality risk, assessment of severity in community acquired pneumonia. (33-35)	
Objectivity	
Process	Y. Self-explaining. (35)
Evaluation	Y. One element may be subjective by nature. In particular, assessment of confusion (measured by a mental test, or new disorientation in person, place or time). (35)
Interpretation	Y. Available for 2 settings (hospital and community). For hospital setting has max. score of 5, for community setting max. score is 4. Score of 1 is given for every element present. For hospital setting: scores 0-1, 2, 3-5 indicate low, intermediate and high risk for mortality respectively. For community setting: scores 0, 1-2, 3-4 indicate low, intermediate and high risk for mortality respectively. (35)
Reliability	
Inter-rater	NI

Intra-rater	NI
Validity	
Convergent	The positive predictive value of the CURB-65 as an indicator of inappropriate hospitalization was determined by calculating the proportion of patients with CURB-65 score 0 and 1 in whom we were unable to find any justification for hospitalization, out of the total number of inpatients with a score 0 and 1, that is, by dividing the number of outpatients or unjustified patients who had been admitted to the hospital by the total number of patients with score 0 and 1. The calculated positive predictive value of the CURB-65 score as a sole indicator for inappropriate hospitalization was 52%. (33). The sensitivity and specificity of the CURB-65 score of 2 or more—in the derivation cohort was 92.8% and 49.2%, respectively (with PPV and NPV in %: 16.2 and 98.5). Corresponding values in the validation cohort were 100% and 46.4% (with PPV and NPV in %: 16.1 and 100). (35)
Costs	
Time to completion	NI
Specific input data required	Y. For hospital setting, blood urea testing is needed. (35)
Specific training required	NI However, easy to use. "The CURB-65 score has been recommended by the British Thoracic Society, and because of its ease of use" (34)
Who completed the tool?	
One infectious diseases, one internist and three pulmonary specialists (33)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Can be used in hospital or community setting. Likely prospective use. (35) Emergency room, retrospective by using patient´s records. (33) Retrospective use, using clinical records of patients admitted to ED. (34)	
Language	**Tool can be seen/accessed in:**
English. (35)	Figures 2 & 3: (35)

8. **Risk Nomogram**

Table 17. Risk Nomogram

Tool name (reported in (36))	
Risk Nomogram	
Concept/components covered	
Prior number attendances, age, gender, polypharmacy, SIS cognition score, malignancy, CCT intervention, depression Hx.	
What the tool measures/does	
Probability of having no unplanned revisit during the 28 days after discharge.	
Objectivity	
Process	Y. Self-explaining.
Evaluation	Y. For example, component on depression (includes patient self-reporting of significant depressive syndromes).
Interpretation	Y. The final score is used to calculate the probability of having no unplanned revisit during the 28 days after discharge (where 1 is the probability of no attendance).
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	The ROC for the nomogram is shown in Fig.3, with an area under the curve of 0.65.
Costs	
Time to completion	NI
Specific input data required	N. Mostly data from medical record verified with patient interview.

Specific training required	Y. Research nurses trained for the study recruited patients and used patient interview in conjunction with the medical record and hospital electronic patient tracking systems to determine whether each of these factors were present.
Who completed the tool?	
Research nurses.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Prospective use, patients assessed in the ED and designated for discharge back to the community.	
Language	**Tool can be seen/accessed in:**
English	Figure 1 and table 1: (36)

9. HOSPITAL score and its sub-type

Table 18. HOSPITAL score

Tool name (reported in (37-44))	
HOSPITAL score	
Concept/components covered	
The HOSPITAL score is a predictor model using seven clinical variables at discharge. Haemoglobin level at discharge, Discharge from an Oncology unit, Sodium level at discharge, Procedures during hospital stay, Index admission type, Number of hospital admissions during the previous year, Length of hospitalisation. (41)	
What the tool measures/does	
Risk of 30-day potentially avoidable hospital readmissions. (41)	
Objectivity	
Process	Y. Self-explaining. (41)
Evaluation	N. Does not include subjective elements. Some elements relate to laboratory testing data, like haemoglobin, sodium level. Other relate to ICD-9 coded procedure, admission type, number of admissions, LOS, discharge from an oncology service. (41)
Interpretation	Y. The scoring system ranges from 0 to 13 points with

	higher scores connoting higher risk of readmission. These risks were further categorized into 3 groups: low risk (up to 4 points); intermediate risk (5–6 points); and high risk (7 or more points), roughly corresponding to 5%, 10%, and 20% risk of potentially preventable 30-day readmissions, respectively. (40)
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	The cross-validated C statistic was 0.69 in the derivation set and 0.71 in the validation set. When the HOSPITAL score was applied to the complete cohort before exclusion of unavoidable readmissions (n = 10 731), the cross-validated C statistic was 0.67. (41) Sensitivity: 21% Specificity: 80% (37) Across all 4 diagnoses, the HOSPITAL score had very good accuracy (Brier score = 0.11) good discrimination [c-statistic = 0.68 (95%CI, 0.66–0.70)], and very good calibration (Hosmer-Lemeshow goodness-of-fit P= 0.77). The expected and observed readmission rates were very similar within each risk subgroup: low risk (9.1% expected, 9.6% observed), moderate risk (11.3% expected, 11.0% observed), and high risk (18.0% expected, 18.1% observed). Within diagnoses, accuracy and discrimination were similar (Brier score, 0.10–0.12; c-statistic, 0.67–0.71), although calibration was better for pneumonia and COPD (P= 0.76 and 0.81, respectively) than for acute MI or HF (P= 0.16 and 0.17, respectively—Table 3). (40) The HOSPITAL score had a C statistic of 0.72 (95%CI, 0.72-0.72). The Brier score was 0.08. In US hospitals, the C statistic was 0.72 (95% CI, 0.71-0.72); Canada, 0.78 (95% CI, 0.76-0.80); Israel, 0.68 (95% CI, 0.67-0.69); and Switzerland, 0.68 (95% CI, 0.66-0.71).

	In terms of calibration, the estimated risk of potentially avoidable readmission calculated with the HOSPITAL score matched the observed proportion of potentially avoidable readmissions in each risk group: 5.8% for the low risk group; 11.9%,intermediate; and 22.8%, high risk (Table 3). This is also reflected by an excellent Pearson χ2 test with a P value of 0.89. When calibration is analysed for each individual point score, calibration remains excellent except at the extreme ends of the range (low [0 points] and high [≥11 points]). (42)
Costs	
Time to completion	NI
Specific input data required	Y. Laboratory testing (haemoglobin, sodium level) (41)
Specific training required	NI However reported to be easy to use (42)
Who completed the tool?	
Physicians. (41)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Can be used in hospital, prospective use, before discharge. (41) Retrospective using electronic health records. (40)	
Language	**Tool can be seen/accessed in:**
English	Table 3: (41)

Table 19. Simplified HOSPITAL score

Tool name (reported in (39))
Simplified HOSPITAL score
Concept/components covered

The HOSPITAL score is a predictor model using six clinical variables at discharge. Haemoglobin level at discharge, Cancer diagnosis or discharge from an Oncology unit, Sodium level at discharge, Index admission type, Number of hospital admissions during the previous year, Length of hospitalisation.	
What the tool measures/does	
Risk of 30-day potentially avoidable hospital readmissions.	
Objectivity	
Process	Y. Self-explaining.
Evaluation	N. Does not include subjective elements.
Interpretation	Y. Scoring system, max. score is 12. Unlikely to be readmitted if 0-4 point(s), and likely to be readmitted if 5 points or more. These categories were created for ease of interpretation, roughly corresponding to a risk of potentially avoidable readmission of more than 15% in the "likely" category.
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	1. Brier score of 0.08. 2. C-statistic of 0.69 (95%CI 0.68-0.69). The negative predictive value of the simplified HOSPITAL score was 94%, and its specificity 73%. 3. The calibration was excellent with predicted rates matching exactly the observed rates, as shown in Table 3a.
Costs	
Time to completion	NI
Specific input data required	Y. Laboratory testing (haemoglobin, sodium level)
Specific training required	NI. Reported to be easier to calculate as opposed to original HOSPITAL score.
Who completed the tool?	
Study authors.	

When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In hospital, retrospective use. Can be used before discharge.	
Language	**Tool can be seen/accessed in:**
English	Table 1: (39)

10. LACE index and its sub-type

Table 20. LACE index

Tool name (reported in (37, 44, 45))	
LACE index	
Concept/components covered	
Length of hospitalisation, Acuteness of the admission, Comorbidities of patients, AED admissions. (37, 45, 46)	
What the tool measures/does	
Expected probability of death or hospital readmission within 30 days of discharge. (37, 45, 46)	
Objectivity	
Process	Y. Self-explaining. (46)
Evaluation	Y. Component "acuity of admission" may involve some subjective judgement. (46)
Interpretation	Y. Scoring system, max. points is 19. Table 4 in the original study ((46)) provides the expected probability of death or readmission within 30 days of discharge. Score of 0 and 19 correspond to 2% and 43.7% expected probability of death or readmission respectively. (46) A patient with a score greater than 10 is considered at high risk for unplanned hospital readmission.(37)
Reliability	
Inter-rater	NI
Intra-rater	NI

Validity	
Convergent	The LACE index had moderate discrimination for early death or readmission. The C statistic (95% CI) in the derivation was 0.7114 (0.6736–0.7491). In the validation, it was 0.6935 (0.6548–07321), and in the entire cohort, it was 0.7025 (0.6755–0.7295). (46) Sensitivity (cut-off > 10): 0.61 Specificity (cut-off > 10): 0.44 PPV (cut-off > 10): 0.52 NPV (cut-off > 10): 0.54 Discrimination: AUC (i.e. c-statistic) = 0.534 Calibration (Hosmer-Lemeshow χ2 test): χ2 = 23.58, degrees of freedom = 23, P-value = 0.43 (37) The optimal cut-off for the LACE index is a score of 7 or more with sensitivity of 0.752 and specificity of 0.564. AUC (c-statistic) is 0.658. (45)
Costs	
Time to completion	NI
Specific input data required	Y. Calculation of another index to measure comorbidity (using Charlson comorbidity index).(46)
Specific training required	NI
Who completed the tool?	
Study authors (37)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In hospital, retrospective using medical records. (37)	
Language	**Tool can be seen/accessed in:**

English(46)	Tool in Table 3, conversation of a score to % expected probability of death or readmission is in Table 4: (46)

Table 21. Revised LACE index

Tool name (reported in (47))	
Revised LACE index (LOS component was omitted as compared with original LACE)	
Concept/components covered	
Acuteness of the admission, Comorbidities of patients, AED admissions.	
What the tool measures/does	
Risk of hospital readmission within 30 days of discharge.	
Objectivity	
Process	NI However likely to be same as in original LACE.
Evaluation	NI However likely to be same as in original LACE.
Interpretation	NI Max. possible score not reported. However, revised LACE score 8 or above is considered as high risk of early readmission.
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	Sensitivity and specificity for the revised LACE index were 0.49 (95% CI 0.39–0.59) and 0.60 (95% CI 0.57–0.64), respectively, with NPV 0.90 (95% CI 0.87–0.92) and PPV 0.15 (95% CI 0.11–0.19).
Costs	
Time to completion	Y. Under 10 min.
Specific input data required	NI However likely to be same as in original LACE.
Specific training required	Y. Only mentioned that researchers were trained in conducting assessment.

Who completed the tool?	
Researchers.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In hospital, prospective use, used at admission of a patient to hospital (as opposed to before discharge in the original LACE).	
Language	**Tool can be seen/accessed in:**
English	Tool not found.

11. **New Zealand version of Patients At Risk of Hospital Readmission (PARR) predictive risk tool**

Table 22. New Zealand version of Patients At Risk of Hospital Readmission (PARR) predictive risk tool

Tool name (reported in (45))	
New Zealand version of Patients At Risk of Hospital Readmission (PARR) predictive risk tool	
Concept/components covered	
Use of admissions data from the New Zealand hospitals. (gender, age, race (Maori, Pacific, Asian, others), cost weight of last admission, code for last submission, diagnoses for last admission and number of acute admissions in the previous 90 days, 180 days and 2 years).	
What the tool measures/does	
Prediction of 30-day hospital readmissions.	
Objectivity	
Process	NI
Evaluation	N. From description in the study, does not seem to include subjective judgement.
Interpretation	NI
Reliability	

Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	The optimal cut-off for PARR index is a score of 0.34 or more with sensitivity of 0.542 and specificity of 0.714. AUC (i.e. c-statistic) = 0.628.
Costs	
Time to completion	NI
Specific input data required	N. From description in the study, does not seem to require specific data (such as laboratory results).
Specific training required	NI
Who completed the tool?	
NI	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Retrospective using admissions data from hospitals.	
Language	**Tool can be seen/accessed in:**
Likely to be in English	Tool not found.

12. PAR-Risk Score

Table 23. PAR-Risk Score

Tool name (reported in (48))
PAR-Risk Score
Concept/components covered
The PAR Risk Score assigns points to the following 12 predictors: length of stay longer than four days, admission in previous six months, anaemia, hypertension, hyperkalaemia, opioid prescription during hospital stay, comorbidities such as heart failure, acute

myocardial infarction, chronic ischemic heart disease, diabetes with organ damage, cancer, and metastatic carcinoma.	
What the tool measures/does	
Risk of 30-day potentially avoidable readmissions.	
Objectivity	
Process	Y. Self-explaining.
Evaluation	N. Does not include subjective judgement. Requires data on administrative characteristics, comorbidities, medications and lab results.
Interpretation	Y. Low, medium, and high risk based on the raw PAR-Risk Score values using the original threshold levels of <3, 3–10, and>10, respectively. Adapted threshold levels for the three risk categories low, medium, and high risk were PAR-Risk Score values of <12, 12 to 25, and >25, respectively.
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	The overall PAR-Risk Scores showed C statistic of 0.605, 95% -CI 0.575–0.635. The Brier score was 0.053. The calibration plot indicated a lack of fit (Fig3), which was also supported by the goodness-of-fit test with a p-value of <0.01. A summary of the goodness-of-fit test statistics provided in the supplement (S3Table). **Original threshold:** Positive Predictive Value (%): low vs. medium 4.3; low vs. high 7.5 Negative Predictive Value (%): low vs. medium 97.0 ; low vs. high 97.0. Sensitivity (%): low vs. medium 93.4; low vs. high 95.8

	Specificity (%): low vs. medium 9.4; low vs. high 10.4 **Adapted threshold:** Positive Predictive Value (%): low vs. medium 6.0 ; low vs. high 7.9 Negative Predictive Value (%): low vs. medium 96.6 ; low vs. high 96.6 Sensitivity (%): low vs. medium 61.7; low vs. high 67.9 Specificity (%): low vs. medium 52.9; low vs. high 53.4
Costs	
Time to completion	NI
Specific input data required	Y. For example, lab results on hyperkalaemia.
Specific training required	NI
Who completed the tool?	
Study authors.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Retrospective using data from hospitalisations.	
Language	**Tool can be seen/accessed in:**
English	S1 table: (48)

13. EOL care pathway

Table 24. EOL care pathway

Tool name (reported in (49))
EOL care pathway
Concept/components covered
The EOL care pathway used in the Good Death project had five main sections: (i) commencing a pathway; (ii) medical interventions and advance care planning; (iii) care

staff interventions, including care management, daily comfort care chart and further care action sheet; (iv) multidisciplinary communication sheet; and (v) after-death care. (49, 50)	
What the tool measures/does	
Provides guidance on different aspects of terminal care. (49, 50)	
Objectivity	
Process	Y. Self-explaining. (50)
Evaluation	Y. Some components may be subjective. For example, profound weakness, becoming semi-conscious with lapses into unconsciousness, changes in breathing patterns. (50)
Interpretation	N. Does not seem to provide a certain final judgement. This is a guide to providing care for residents in RACFs during last days of their lives. The entire document (pathway) forms part of the resident´s medical record. (50)
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI However, the pathway is a 12 page document, which may take some time to complete it. (50)
Specific input data required	Y. Some data may be seen as specific, for example Advance care planning (if not yet completed). Also, further data may be needed via discussion with the resident or his/her representative. However, some data may already be documented in the resident´s chart and taken from there. (50)
Specific training required	NI
Who completed the tool?	
GPs, nurses. (50)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In RACF, prospective use. (50)	
Language	**Tool can be seen/accessed in:**

English (50)	Pathway can be found on this page: (50). Direct link to the PDF file: https://metrosouth.health.qld.gov.au/sites/default/files/content/raceolcp_watermark.pdf

14. The Identification of Seniors at Risk (ISAR) scale

Table 25. The Identification of Seniors at Risk (ISAR) scale

Tool name (reported in (51))	
The Identification of Seniors at Risk (ISAR) scale	
Concept/components covered	
Takes into account function (premorbid and post-acute change), polypharmacy, cognitive and visual impairment, and recent hospitalizations. (51, 52)	
What the tool measures/does	
Predicts high acute care hospital utilization and adverse health outcomes during the 6 months after the ED visit/after home discharge. (51, 52)	
Objectivity	
Process	Y. Self-explaining. (52)
Evaluation	Y. First, the tool can be filled by a patient too, which may already be subjective. Second, it includes questions which may also include subjective judgement, like “in general, do you see well?”, or “in general, do you have serious problems with your memory?”. (52)
Interpretation	Y. 6 question tool, max. 6 points. ISAR score of 2 or higher, indicating an increased risk of adverse health outcomes. (52)
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	Y. The AUC for the ISAR scale was 0.68 overall. (52).

	Using ROC (combined) curves, ISAR showed the best prediction among other variables, although predictive value was poor (AUC=0.62 (0.53-0.71) for ISAR>3 and AUC=0.65 (0.57-0.74) for continuous ISAR). (51).
Costs	
Time to completion	Y. Can be quickly and easily administered. (52)
Specific input data required	N. Questions can also be answered by a patient. (52)
Specific training required	NI However, reported to be easy to use, can be used by patients. (52)
Who completed the tool?	
Can be self-completed by many patients or informants. (52)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In ED setting. Can be used at admission or discharge from the ED. Prospective use. (52)	
Language	**Tool can be seen/accessed in:**
English (52)	Figure 1: (52)

15. The Silver Code

Table 26. The Silver Code

Tool name (reported in (51))	
The Silver Code	
Concept/components covered	
Combines demographics, polypharmacy, comorbidities, and previous hospitalizations. (51, 53)	
What the tool measures/does	
Predicts 1-year mortality, hospital admission, ED readmissions. (51, 53)	
Objectivity	
Process	Y. Self-explaining. (53)

Evaluation	N. With the SC, a score is assigned to age, sex, marital status, admission to a day hospital, admission to regular ward with corresponding discharge diagnosis, and polypharmacy, 3–6 months prior to the index ED visit. (53)
Interpretation	Y. Max. 30 points. 4 classes of increasing risk score (0–3, 4–6, 7–10, and 11+). (53) Score 0 - 30, best - worst (51)
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	Y. Area under the receiver-operating characteristic curve in predicting hospital admission (SC: 0.63) and mortality (SC: 0.70). (53) AUC (combined) for Silver Code: 0.56 (95% CI, 0.46-0.65) AUC (combined) for Silver Code > 11: 0.53 (95% CI, 0.44-0.62) (51)
Costs	
Time to completion	NI
Specific input data required	N. It is based on administrative data (53)
Specific training required	NI
Who completed the tool?	
Expert physicians or nurses (51)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Used retrospectively using administrative data from the ED. However, can also be used prospectively if data is available. It is based on administrative data, which would be virtually available even before patients access the ED. (53)	
Language	**Tool can be seen/accessed in:**
English (53)	Table 1: (53)

16. The Walter indicator

Table 27. The Walter indicator

Tool name (reported in (51))	
The Walter indicator	
Concept/components covered	
Combines demographics, clinical aspects (heart failure, cancer with or without metastases), and laboratory testing (albumin, creatinine). (51, 54)	
What the tool measures/does	
Predicts 1-year mortality after hospital discharge. (51, 54)	
Objectivity	
Process	Y. Self-explaining. (54)
Evaluation	N. Does not have elements requiring subjective judgement. Includes demographic characteristics, activities of daily living (ADL) dependency, comorbid conditions, length of hospital stay, and laboratory measurements. (54)
Interpretation	Y. Scoring system. Max. score 20. Lowest-risk group (0-1 point). Group with 2-3 points Group with 4-6 points Highest risk group with more than 6 points. In the validation cohort, 1-year mortality was 4% in the lowest-risk group, 19% in the group with 2 or 3 points, 34% in the group with 4 to 6 points, and 64% in the highest-risk group. (54)
Reliability	
Inter-rater	NI

Intra-rater	NI
Validity	
Convergent	The area under the receiver operating characteristic curve for the point system was 0.75 in the derivation cohort and 0.79 in the validation cohort. (54) AUC (combined) for Walter indicator: 0.64 (95% CI, 0.55-0.73) AUC (combined) for Walter indicator > 6: 0.55 (95% CI, 0.45-0.65) (51)
Costs	
Time to completion	NI
Specific input data required	Y. Lab results (creatinine, albumin) (54)
Specific training required	NI However, the tool has a simple additive point system. (54)
Who completed the tool?	
Study authors. Can also be used by clinicians.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In hospital, at discharge. Prospective use (validated prospectively). Tool uses data that should be available at discharge. (54)	
Language	**Tool can be seen/accessed in:**
English (54)	Table 3: (54)

17. Preventability Assessment Tool (PAT)

Table 28. Preventability Assessment Tool (PAT)

Tool name (reported in (55))
Preventability Assessment Tool (PAT)
Concept/components covered

Includes several factors (with corresponding sub-sections) that may have been related to a patient admission. Patient factors, self-care, primary care factors, coordination of care, access to care (clinical and non-clinical), hospital admission characteristics, other factors.	
What the tool measures/does	
Assessment of preventability of unplanned hospital admissions for chronic conditions.	
Objectivity	
Process	Y. Self-explaining.
Evaluation	Y. A section of the tool asks the extent to which some factors in the previous 3 months may have been related to a patient´s unplanned admission. Some factors may seem subjective when making judgement on them. For example, patient factors (includes, but not limited to: cognitive function, mental health problems).
Interpretation	N. The tool does not have a specific rule to judge how preventable an admission was. Instead, the tool asks how preventable an admission was, considering all that has happened to a patient in the last 3 months (within the context of the study definition of preventability; definition given in the tool).
Reliability	
Inter-rater	Agreement between the assessments of the hospital doctors and nurses regarding which admissions were deemed preventable were (K = 0.21; 95% CI = 0.09–0.34). The agreement between hospital nurses and hospital doctors for admissions being preventable was 18%, agreement for non-preventable admissions (including admissions assessed as not preventable and those unclassifiable) was higher at 46%. Overall disagreement between the hospital nurses and hospital doctors was 36%.
Intra-rater	NI
Validity	
Convergent	There was very low agreement between the Expert Panels and the hospital nurse regarding the assessment of the preventability of individual admissions (K = 0.17; 95% CI = 0.05–0.28) (see Table 3). Of the 119 admissions assessed as preventable by Expert Panel, only 53 (45%) were assessed as preventable by the hospital nurses. Similarly, there was very low agreement between the Expert Panel

	and the hospital doctor regarding the assessment of the preventability of individual admissions (K = 0.13; 95% CI = 0.01–0.25). Of the 119 admissions assessed as preventable by Expert Panel, only 51 (45%) were assessed as preventable by the hospital doctors.
Costs	
Time to completion	Y. About 5 min. to complete
Specific input data required	N. Does not require laboratory testing results. However, observer would require data on several components, like data on patient factors, self-care factors, primary care factors, etc.
Specific training required	Y. The research nurse provided brief explanations of how to use the PAT to assess admissions within the context of the study definition of preventability, and was available to answer questions.
Who completed the tool?	
Hospital clinicians (doctor or nurse caring for the patient).	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In hospital, prospective use, during admission.	
Language	**Tool can be seen/accessed in:**
English	Supplement 1. (55) Direct link to the Supplement 1: Link

18. Quality assessment instrument

Table 29. Quality assessment instrument

Tool name (reported in (56))
Quality assessment instrument
Concept/components covered
Patient, clinician, and system factors.
What the tool measures/does
Classifies the preventability of hospitalization in terms of patient, clinician, or system factors.

Objectivity	
Process	Y. Self-explaining.
Evaluation	Y. Some elements may include subjective judgement. For example. Part 1 asks to select 1 primary reason out of 6 reasons for admission. Part 2 asks if an admission was preventable, and if yes, it asks to choose 1 of 13 reasons that could have prevented an admission.
Interpretation	N. Does not have a specific rule/guidance to judge if an admission was preventable. Tool provides a set of reasons and asks to choose one of them. In determining the reason for admission (one of six categories) and the reason for preventable admissions (one of 13 categories), a simple majority rule was applied.
Reliability	
Inter-rater	Agreement of preventability of readmissions was 74%, K= 0.43 (95% CI 0.36, 0.50).
Intra-rater	Agreement for the assessment of preventability of readmissions was 96%, K= 0.89 (95% CI 0.68, 1.0).
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	N. Does not require specific input data, such as laboratory testing results. However, assessor should have access to some data (can be available from medical records). For example, in the study authors retrieved data from medical records on: outpatient notes for the 1 month period before readmission, ED note or clinic note on the day of admission, all records of admission histories and physical examinations, admitting nursing evaluation, admitting orders, any laboratory or radiologic information that was available within 24 hours of admission.
Specific training required	Y. Panellists received 45 min. of instructions, during which the rating form (tool) was reviewed and examples of each type of preventable hospitalization were discussed.
Who completed the tool?	

A panel of 10 board certified internists, 8 had administrative responsibility for the ambulatory practice in hospitals, all practiced clinical medicine.
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)
In hospital, retrospective using medical records.

Language	Tool can be seen/accessed in:
English	Appendix: (56)

19. SIR (structured implicit record review)

Table 30. SIR (structured implicit record review)

Tool name (reported in (5, 57))
SIR (structured implicit record review)
Concept/components covered
Series of items about the resident and circumstances surrounding the hospitalization. These relate to residents´ baseline health status, advance directives, potential benefits of acute transfer, and the care provided in the NH when the residents' status changed. In particular, the following factors were identified as affecting the transfer decision: (1) the resident's baseline state, including demographic characteristics and care preferences; (2) characteristics of the acute illness, including the severity of the acute illness, the existence of known interventions for the illness, the urgency of the need for examination and the response to SNF based treatments; (3) clinical care resources necessary and typically available to manage the acute illness, including physician services, SNF based services and services typically available only outside of the SNF; and (4) the quality of acute care in the SNF. (5, 57)
What the tool measures/does
Assessment of inappropriateness of ED transfers and hospital admissions and factors related to inappropriateness. (5, 57)
Objectivity

Process	Y. Reviewers required to answer SIR questions, and after responding to SIR questions, the reviewer was asked: ''Was this hospitalization avoidable?'' Response categories included the following: definitely

	not avoidable, probably not avoidable, probably avoidable, and definitely avoidable. (5) **However, complete tool not found.** SIR has questions (addressed as SIR questions) which seem to guide reviewers in completing the SIR. A framework for SIR Form was shown in the study (57), however the actual SIR questions could not be found. The framework for SIR Form shows items addressed in SIR Form grouped into overarching general topics. (57).
Evaluation	Y. Some items addressed in SIR Form may be subjective. For example items on: pain, probability of death/pain. (57) **However, complete tool not found.**
Interpretation	Y. Reviewers were instructed to rate a transfer or admission appropriate when no lower level of care would suffice to deliver safely the services the resident required. (57) **However, complete tool not found.**
Reliability	
Inter-rater	Information about resident's preferences or AD, if any, had little or no effect on agreement or interrater reliability. When rating the appropriateness of ED transfer, the two independent physician reviewers agreed with each other 84% of time (kappa .68) when excluding consideration of preferences, and 85% of the time (kappa .70) when considering preferences. Interrater reliability was even higher for hospital transfers. When rating the appropriateness of hospital admission, the reviewers agreed with each other 89% of the time (kappa .78) whether or not preferences were considered. (57)
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	Y. Data from SNF, ED and hospital records were used to complete SIR. For example, data from SNF record included information on

	nursing and physician notes, laboratory and radiology reports, and more. (57)
Specific training required	Y. The reviewers received 2 days of training. Before the training, each reviewer received a 34-page instruction manual explaining the SIR questions. (57)
Who completed the tool?	
Physicians. (57) Experts in nursing home care and experienced practicing long-term care clinicians. (5)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Physicians used SIR to review SNF and hospital records. Likely retrospective use. (57).	
Language	**Tool can be seen/accessed in:**
English (57)	See Table 1 for Framework for SIR Form: (57)

20. Rectal bleeding admission guide and algorithm

Table 31. Rectal bleeding admission guide and algorithm

Tool name (reported in (58))	
Rectal bleeding admission guide and algorithm	
Concept/components covered	
Haemoglobin (Hb) > 13 g/dl; Systolic blood pressure (SBP) > 115 mmHg; Patient not on anticoagulant/antiplatelet therapy.	
What the tool measures/does	
Identifies patients with acute LGIB (lower gastrointestinal bleeding) who can be safely managed in primary care.	
Objectivity	
Process	Y. Self-explaining.
Evaluation	N. Includes the following elements 1. Haemoglobin (Hb) > 13 g/dl; 2. Systolic blood pressure (SBP) > 115 mmHg; 3. Patient not on anticoagulant/antiplatelet therapy
Interpretation	Y. If ALL 3 criteria are true, patient will not usually require admission.

Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	Y. Laboratory testing, haemoglobin.
Specific training required	Y. This new, simple risk assessment tool was adapted into a clinical algorithm and promoted with posters and education of staff in the surgical admissions ward and ED (Fig. 1). This (i.e. criteria/instrument) was implemented with education of primary and secondary care staff, access to an emergency clinic and provision of patient information.
Who completed the tool?	
ED clinicians and general practitioners (GPs).	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In surgical admissions ward and ED. On admission. Likely prospective use. Hospital setting, Acute setting. Useful in community referrals.	
Language	**Tool can be seen/accessed in:**
English	Figure 1. (58)

21. Potentially Avoidable Readmission (PAR) algorithm

Table 32. Potentially Avoidable Readmission (PAR) algorithm

Tool name (reported in (59))
Potentially Avoidable Readmission (PAR) algorithm
Concept/components covered

Sort of mathematical methods. Authors proposed a new readmission metric to identify potentially avoidable readmissions, and a tree-based classification method to estimate the predicted probability of readmission that can directly incorporate patient's history of readmission and risk factors changes over time.	
What the tool measures/does	
Identifies potentially avoidable readmissions, estimates the predicted probability of readmission.	
Objectivity	
Process	Sort of mathematical algorithm (phase-type survival forest = tree based method).
Evaluation	N. Does not seem to involve subjective judgement. Method incorporates patient's history of readmission and risk factors changes over time.
Interpretation	It seems that final judgement is produced by this method/algorithm in the form of predicted probability of readmission (i.e. potentially avoidable readmission).
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	In the **baseline model,** the c-statistics was 0.793. In the **calibrated model**, the c-statistics was 0.836. **Model validation**. The calibrated model was used and its **internal validity** (also called reproducibility) was studied, based on the same population underlying the sample. The average c-statistics for the seven runs of training sets reached 0.839 and for the test sets, it was 0.821. Hence, there exists an "optimism" of 0.018 in the mean area under the ROCs for the training and testing splits, and as a result, the internally validated (or optimism corrected) c-statistics is estimated as 0.818.

	To provide more robust evidence of validity, **external (in fact: spatial) validation** (also called generalizability) was conducted with a new sample of 478 patients admitted. The c-statistics in the external sample decreased to 0.809 (a decrease of 0.027) which is slightly more than results from internal validation (a decrease of 0.018). However, **both internal and external validations** confirm the superiority of our proposal over the cur-rent approaches in terms of discrimination power and stability. **Comparisons with other approaches.** The comparison results are summarized in Table7 and Fig.4. **As shown, the proposal works better than other alternatives in all predictive criteria.**
Costs	
Time to completion	NI The risk prediction model works real-time. This may imply that result can be available immediately.
Specific input data required	N. The method directly incorporates patient's history of readmission and risk factors changes over time. The study is limited to administrative data (that are regularly available to all health plans) and it does not have laboratory test results and vital signs such as haemoglobin or serum level at discharge, which may affect the risk of unnecessary readmission.
Specific training required	NI
Who completed the tool?	
Likely study authors.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Likely in hospital. Likely prospective use.	
Language	**Tool can be seen/accessed in:**
English	The algorithm, phase-type survival forest, is described in text (pages 3-7) and in box "Algorithm 1" (page 7): (59)

22. RAFT (Reducing Avoidable Facility Transfers) model

Table 33. RAFT (Reducing Avoidable Facility Transfers) model

Tool name (reported in (60))	
RAFT (Reducing Avoidable Facility Transfers) model	
Concept/components covered	
RAFT consists of the following components: 1. Small team of providers who manage longitudinal care and after-hours call. 2. Systematic elicitation of advance care plans including acute care preferences 3. Increased engagement of the provider during an acute care event 4. Case Review.	
What the tool measures/does	
Provides sort of plan for action, with 3 distinct phases: before, during and after acute event.	
Objectivity	
Process	Y. Visualisation of the RAFT intervention in Figure 1 is self-explaining. Further intervention details are also described in the study.
Evaluation	Y. For example, component on informed decision making: "providers are aware of Advance Directives during acute event and make recommendations in this context." We think that making recommendations in the context of AD could involve subjective judgement.
Interpretation	The RAFT model is an intervention with 3 distinct sections: before, during and after acute event. Unlike other interventions, the focus was not on whether the transfer was clinically indicated, but rather what the team might have reasonably and safely done differently to change the outcome.
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI

Costs	
Time to completion	NI
Specific input data required	Y. As part of an intervention, completion of advance care plans and Provider Orders for Life Sustaining Treatment (POLST) form were required.
Specific training required	Y. As part of an intervention, a nurse-led education session was held with all nursing staff to explain the benefits of engaging the provider early.
Who completed the tool?	
Physicians, nurse practitioners, physician´s assistant.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In SNF, prospective use.	
Language	**Tool can be seen/accessed in:**
English	Visual representation of the RAFT intervention can be seen in Figure 1: (60)

23. Ottawa Heart Failure Risk Scale (OHFRS)

Table 34. Ottawa Heart Failure Risk Scale (OHFRS)

Tool name (reported in (61))
Ottawa Heart Failure Risk Scale (OHFRS)
Concept/components covered
10 criteria grouped into 3 sections: initial assessment, investigations, walk test after ED treatment.
What the tool measures/does
Identifies ED patients with acute heart failure at high risk for serious adverse events.

Objectivity	
Process	Y. Self-explaining.
Evaluation	N. Tool is composed of simple bedside variables. Clinical and laboratory results from the electronic patient records including standardized variables from the history, clinical examination, routine laboratory values, cardiac, chest x-ray, and initial and repeat ECG, and a 3 minute walk test.
Interpretation	Y. Scoring system, max. score is 15. Provides a table on how to convert a total score into %-risk or risk category (low, medium, high, very high). Presented in Figure 1 of the study.
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	**Performance of OHFRS Without NT-proBNP** The most useful threshold scores appear to be >1 (optimal sensitivity) and >2 (decreased admissions). Compared to actual practice, using an admission threshold of OHFRS score >1 would have increased sensitivity (71.8% vs.91.8%) but increased admissions (57.2% vs. 77.6%). Using a threshold >2 would have led to a similar sensitivity (71.8% vs. 71.2%) but reduced admission rates (57.2% vs. 48.3%). **Performance of OHFRS With NT-proBNP** Compared to actual practice, using an admission threshold of OHFRS score >1 would have significantly increased sensitivity (69.8% vs. 95.8%) while increasing admissions (60.8% vs. 88.0%). Using a threshold >2 would have led to better sensitivity (69.8% vs.79.8%) but with similar admission rates (60.8% vs.63.0%). **Conclusions** Compared to current practice, an OHFRS score threshold of >1 would significantly improve sensitivity but would require more admissions. Alternately, a threshold of >2 would offer similar

	sensitivity to current practice but reduce admissions. NT-proBNP values were available for about 60% of patients and their incorporation into the OHFRS scores led to better sensitivity.
Costs	
Time to completion	NI
Specific input data required	Y. For example, ECG, Urea, Serum, Troponin.
Specific training required	Y. When tool was completed by supervised residents in emergency medicine training programs.
Who completed the tool?	
ED physicians or supervised residents in emergency medicine training programs, who were trained by means of a 1-hour practical session.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In ED, prospective use.	
Language	**Tool can be seen/accessed in:**
English	Figure 1: (61)

24. Ottawa COPD (chronic obstructive pulmonary disease) Risk Scale (OCRS)

Table 35. The Ottawa COPD (chronic obstructive pulmonary disease) Risk Scale (OCRS)

Tool name (reported in (62))
The Ottawa COPD (chronic obstructive pulmonary disease) Risk Scale (OCRS)
Concept/components covered
10 items grouped into 3 sections: initial assessment, investigations, re-assessment after ED treatment.
What the tool measures/does
Identifies ED patients with acute COPD who are at high risk for short-term serious outcomes.
Objectivity
Process Y. Self-explaining.

Evaluation	N. A scale comprising 10 items from history, physical examination and bedside tests.
Interpretation	Y. Scoring system, max. score is 16. Has a table for conversion of a total score to a %-risk and risk class (low, medium, high, very high)
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	Choosing total point scores of 1 or 2 as the threshold for admission would be associated with sensitivities for a short-term serious outcome of 79.3% or 71.9%, respectively. These theoretical admission thresholds would lead to absolute admission rates of 56.6% or 47.9%, respectively, compared with the observed admission rate of 45.0% at the study hospitals. **Conclusions** Compared with current practice, an OCRS score threshold of 1 or more would increase sensitivity by 50% but would require 25% more admissions. Alternately, a threshold of 2 or more would improve sensitivity by 38% while leading to only a slight increase in admissions.
Costs	
Time to completion	NI
Specific input data required	Y. For example, ECG, Chest X-ray, Haemoglobin, Urea, Serum
Specific training required	Y. Attending physicians and residents in emergency medicine were trained locally.
Who completed the tool?	
Physicians, residents in emergency medicine.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In ED. Likely prospective use.	
Language	**Tool can be seen/accessed in:**

English	Figure 1: (62)

25. **Comprehensive Geriatric Assessment (was reported as a component in 2 studies/interventions)**

Table 36. 1. A&E-based geriatric admission-avoidance system: Triage and Rapid Elderly Assessment Team (TREAT) (with focus on CGA only).

2. INTERCARE nurse-led model (with focus on CGA only)

Tool name (reported in (63-65))	
1. A&E-based geriatric admission-avoidance system: Triage and Rapid Elderly Assessment Team (TREAT) **(with focus on CGA only) (63).** 2. INTERCARE nurse-led model **(with focus on CGA only) (64, 65).**	
Concept/components covered	
The CGA includes the following dimensions: Physical dimension, Functional dimension, Social dimension, Economic dimension, Mental dimension. (65)	
What the tool measures/does	
Helps to identify unknown geriatric syndromes or problems, thus helping to manage patients. (66)	
Objectivity	
Process	NI CGA is rather a set of components or dimensions that guide an assessment. For each dimension/component a specific assessment instrument is required. (65, 66). The INTERCARE nurse collaborates with the leadership and/or interprofessional team to discuss and define which assessment instrument they work with, for each of the 5 CGA dimensions in their institution. (65)
Evaluation	NI
Interpretation	NI
Reliability	
Inter-rater	NI
Intra-rater	NI

Validity	
Convergent	NI
Costs	
Time to completion	Y. CGA is a time-consuming process, which may be problematic in ED. It takes around 25 min. to complete. (66).
Specific input data required	Y. For CGA it is required to use another assessment instruments to assess each CGA dimension/component. (65, 66)
Specific training required	Y. The INTERCARE nurse provides information and guidance to the care team about the 5 different dimensions and can suggest how each dimension can be assessed and evaluated (65).
Who completed the tool?	
Any care staff can be involved in the 5 dimensions of the CGA, corresponding to their degree of training and experience. (65). Physicians (66). Consultant geriatrician (63).	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In NHs, Comprehensive geriatric assessment of residents initiated by INTERCARE nurses when a change in condition was observed (65). Accident and Emergency (A&E) department of a hospital, the consultant geriatrician selected patients for TREAT from the A&E admissions, performing a CGA in A&E for these patients (63). In ED, CGA is useful for identifying unknown geriatric syndromes or problems, in order to help ED physicians manage such patients (66). Likely prospective use.	
Language	**Tool can be seen/accessed in:**
English (65, 66)	CGA dimensions are presented in Table S1: (65) CGA components are presented in Table 1: (66)

26. Standardised chart review method and its sub-types

Table 37. Standardised chart review method with ORIGINAL trigger tool

Tool name (reported in (32))	
Standardised chart review method with ORIGINAL trigger tool	
Concept/components covered	
Has 3 steps: (i) data abstraction, (ii) screening for triggered events using the newly developed trigger tool, screening for non-triggered events using two screening questions and (iii) adjudication in terms of ADE causality and contribution to hospital admission (DRA). Original trigger tool from (ii) includes 26 triggers classified into 3 categories: diagnoses triggers - 13 laboratory values triggers - 10 other triggers - 3	
What the tool measures/does	
Identifies drug related hospital admissions (DRAs).	
Objectivity	
Process	Y. Self-explaining. Further details on the standardised chart review method is given in the study. For each trigger, a list of potentially causative drugs or potential causes for drug underuse was provided. A trigger was positive when the situation and a potential causative drug (or drug lacking in case of underuse) were both present. The whole process followed by the adjudication committee was considered to be the gold standard to define an ADE and a DRA. The adjudication committee recorded the following data in the Electronic Case Report Forms: presence/absence of(a) each of the 26 triggers, associated ADE for each positive trigger (using WHO causality criteria [20]), medication involved when an ADE was recorded, associated DRA (main reason or contributory reason) and medications involved in each DRA; (b) non-triggered events, associated ADE, associated DRA and type of event(s) and medication(s)involved. Finally, each hospitalisation classified as DRA was also classified by type: adverse drug reactions, overuse, misuse

	or underuse. Each adjudicated hospitalisation could have more than one trigger, ADE or non-triggered event.
Evaluation	Y. For example, in one of the triggers (for heart failure exacerbation) there is a question that may involve some subjective judgement when answering it: "use of any drugs (*provided list of drugs*) that could precipitate heart failure exacerbation?".
Interpretation	Y. In the three-step standardised chart review procedure it is written that "DRA judged to be due to a medication error is considered preventable".
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	The overall PPV value [CI 95%] of the tool for detecting DRAs was 0.66 [0.62–0.69]. The tool's overall PPV value for detecting preventable DRAs was 0.28 [0.25–0.32]. The tool's overall PPV value for detecting ADEs was 0.87 [0.84–0.89].
Costs	
Time to completion	Y. The trigger tool remains time-consuming.
Specific input data required	Y. In the three-step standardised chart review procedure a section on "data abstraction" lists necessary data, including but not limited to: laboratory values, medication lists, previous falls, past medical history, and more.
Specific training required	NI
Who completed the tool?	
Experienced pharmacists and physicians.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In medical centres, retrospective using patient records.	
Language	**Tool can be seen/accessed in:**
English	Appendix 1: (67)

Table 38. Standardised chart review method with REVISED trigger tool

Tool name (reported in (67))	
Standardised chart review method with REVISED trigger tool.	
Concept/components covered	
Has 3 steps: (i) data abstraction, (ii) screening for triggered events using the newly developed trigger tool, screening for non-triggered events using two screening questions and (iii) adjudication in terms of ADE causality and contribution to hospital admission (DRA). REVISED trigger tool consists of 21 triggers (step ii of method): diagnoses triggers – 16, laboratory values triggers – 3, other triggers – 2.	
What the tool measures/does	
Identifies drug-related hospital admissions (DRAs).	
Objectivity	
Process	Y. Self-explaining. Further details on the standardised chart review method is given in the study. Logic how the three-step standardised chart review with the revised trigger tool works is the same as in the three-step standardised chart review with the original trigger tool.
Evaluation	Y. For example, in one of the triggers (for heart failure exacerbation) there is a question that may involve some subjective judgement when answering it: "use of any drugs (*provided list of drugs*) that could precipitate heart failure exacerbation?".
Interpretation	Y. In the three-step standardised chart review procedure it is written that "DRA judged to be due to a medication error is considered preventable".
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	

Time to completion	Y. The revised trigger tool seems to be less time-consuming as compared to the original trigger tool. The trigger tool remains time-consuming, so we also developed a user-friendly version that could help clinicians to identify DRAs more effectively.
Specific input data required	Y. In the three-step standardised chart review procedure, step 1 on "data abstraction" lists necessary data, including but not limited to: laboratory values, medication lists, previous falls, past medical history, and more.
Specific training required	NI
Who completed the tool?	
Revised trigger tool was just proposed based on study results. However, it can be also used by clinicians.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In medical centres, retrospective using patient records.	
Language	**Tool can be seen/accessed in:**
English	Revised trigger tool is shown in Table 3. Clinical adaptation of the revised trigger tool is shown in Table 4. For comparison of Original and Revised trigger tools, see Appendix 6. (67)

27. Tool on appropriate referrals by Bermejo Higuera et al.

Table 39. Tool on appropriate referrals by Bermejo Higuera et al

Tool name (reported in (68))
Tool on appropriate referrals by Bermejo Higuera et al
Concept/components covered
Tool has 3 criteria relating to duration of observation in a hospital, whether a patient needed to see a specialist and/or needed special diagnostic tests, whether a patient needed special treatment.
What the tool measures/does

Identifies appropriate or relevant hospital admissions.	
Objectivity	
Process	Y. Self explaining.
Evaluation	N. Does not seem to include a subjective judgement. Tool has 3 criteria relating to duration of observation in a hospital, whether a patient needed to see a specialist and/or needed special diagnostic tests, whether a patient needed special treatment.
Interpretation	Y. Referrals are considered appropriate or relevant to be those that meet one of the following criteria: 1. the patient was admitted to hospital or stayed in observation for more than 24 hours 2. the patient had to be seen by a specialist and/or required diagnostic tests not available in the nursing home 3. the patient required treatment not available in the nursing home
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	N. Since data required relates to duration of observation in a hospital, whether a patient needed to see a specialist and/or needed special diagnostic tests, whether a patient needed special treatment.
Specific training required	NI
Who completed the tool?	
Likely study authors.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In NH, retrospective using medical records.	
Language	**Tool can be seen/accessed in:**

Study was in Spanish language.	Page 2, in text: (68)

28. Tool by Codde et al. List of Exclusion criteria and potentially avoidable reasons for emergency department (ED) presentation

Table 40. Tool by Codde et al. List of Exclusion criteria and potentially avoidable reasons for emergency department (ED) presentation

Tool name (reported in (69))	
Tool by Codde et al. List of Exclusion criteria and potentially avoidable reasons for emergency department (ED) presentation	
Concept/components covered	
1. Exclusion criteria (11) for potentially avoidable ED presentations. Criteria justifying ED presentation. 2. Criteria (11) for potentially avoidable ED presentations. Criteria NOT justifying ED presentation (I.e. criteria indicating potentially avoidable ED presentations).	
What the tool measures/does	
Provides list of exclusion criteria and potentially avoidable reasons for emergency department (ED) presentation.	
Objectivity	
Process	Y. Self-explaining.
Evaluation	Y. Some elements may seem subjective in judgement. For example, assessing for “significant neurological changes” or “increasing confusion with no signs of UTI”.
Interpretation	Y. To determine avoidable presentations, we developed a list of 10 exclusion criteria based on the clinical presentation or other factors such as family request for transfer (see Table 1). From Table 1 we noticed/understood the following: 1. They presented exclusion criteria (we counted 11) for potentially avoidable ED presentations. We understood these criteria as justifying ED presentation.

	2. They also listed criteria (we counted 11) for potentially avoidable ED presentations. We understood these criteria as NOT justifying ED presentation (I.e. criteria indicating potentially avoidable ED presentations).
Reliability	
Inter-rater	Analysis of the interrater reliability of a subset of 54 cases demonstrated agreement of intraclass correlation coefficient 0.414 (95% CI 0.277–0.560) between the four raters. In 28 of 54 cases, all raters assessed the case identically. From these 54 cases, the emergency medicine specialist identified 54% as potentially avoidable, the GP 70%, and the two ED nurses 71% and 74%. This equates to a range of 24–33% of all transfers being avoidable.
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	N. Data can be taken from medical records. In this study authors gathered data from ED Information System and Hospital Morbidity Data System.
Specific training required	NI
Who completed the tool?	
Single experienced ED nurse.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Retrospective using medical records. Authors analysed data from a single tertiary hospital ED patient database.	
Language	**Tool can be seen/accessed in:**
English	Table 1: (69)

29. **A prediction rule to identify low-risk patients with community-acquired pneumonia (Pneumonia Severity Index, PSI)**

Table 41. A prediction rule to identify low-risk patients with community-acquired pneumonia

Tool name (reported in (31, 70))	
A prediction rule to identify low-risk patients with community-acquired pneumonia (Pneumonia Severity Index, PSI)	
Concept/components covered	
Covers items such as demographic factors, health conditions, physical examination findings, nursing home residency, laboratory and radiographic findings.	
What the tool measures/does	
Identifies low-risk patients with community-acquired pneumonia (CAP).	
Objectivity	
Process	Y. Self –explaining.
Evaluation	N. Required data relates to demographic factors, coexisting illnesses, physical examination findings, laboratory and radiographic findings.
Interpretation	Y. A tool has 2 steps which are administered to assign a patient to one of risk classes out of 5 in total: 1. Step 1 is a flow chart form, used to identify whether a patient can be assigned to risk class I. Figure 1. 2. Step 2 is a table form, a point based system to identify whether a patient can be assigned to risk classes from II to V. Table 2. Points calculated from table 2 are then classified into classes from II to V according to table 3. Transformation of points into risk classes according to table 3: II (<=70) III (71-90) IV (91-130) V (>130)
Reliability	

Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	There was no significant difference (P = 0.15) in the area under the receiver-operating-characteristic curves between the MedisGroups derivation cohort (0.84) and the MedisGroups validation cohort (0.83). Although the area under the curve was significantly greater in the Pneumonia PORT cohort (0.89) than in either of the MedisGroups cohorts (P=0.001), the absolute differences in area were minimal.
Costs	
Time to completion	NI
Specific input data required	Y. For example, laboratory and radiographic data.
Specific training required	NI
Who completed the tool?	
Can be used by physicians.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Authors validated the tool using a database and also using data from prospective cohort study (patient followed prospectively) using chart review and patient interviews (prospective tool use). Can be used at the time of patient presentation to hospital, but also can be used in outpatients. Likely prospective and retrospective use.	
Language	**Tool can be seen/accessed in:**
English	Figure 1, table 2 & 3: (70)

30. **Tool by Gozalo et al. on Three types of transitions that were classified as being potentially burdensome**

Table 42. Tool by Gozalo et al. on three types of transitions that were classified as being potentially burdensome.

Tool name (reported in (71))	
Tool by Gozalo et al. on three types of transitions that were classified as being potentially burdensome.	
Concept/components covered	
Three types of transitions were classified as being potentially burdensome. These types relate to end-of-life transitions, lack of continuity of nursing home facilities, multiple hospitalizations.	
What the tool measures/does	
Classifies transitions as being potentially burdensome.	
Objectivity	
Process	Y. Self-explaining.
Evaluation	Y. For example, one element refers to "any transfer in the last 3 days of life" may involve subjective judgement (i.e. time to death)
Interpretation	Y. 3 types of transitions classified as potentially burdensome: 1. any transfer in the last 3 days of life, 2. a lack of continuity of nursing home facilities before and after a hospitalization in the last 90 days of life (i.e., going from nursing home A to the hospital and then to nursing home B), 3. and multiple hospitalizations in the last 90 days of life. A burdensome-transition score was created (range, 0 to 3) on the basis of the occurrence of any event in each category during the last 90 days of life.
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI

Specific input data required	NI Specific data is not required by the instrument. However, access to some data (for example data on ADLs, cognitive impairment) may be needed to make necessary judgements.
Specific training required	NI
Who completed the tool?	
Likely study authors.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Retrospective using MDS data on all NS residents in the USA and Medicare claims data.	
Language	**Tool can be seen/accessed in:**
English	Page 2 in text: (71)

31. Tool by Ong et al., on time to death as an indication of the inappropriateness of admissions

Table 43. Tool by Ong et al., on time to death as an indication of the inappropriateness of admissions

Tool name (reported in (72))	
Tool by Ong et al., on time to death as an indication of the inappropriateness of admissions	
Concept/components covered	
Assessment based on time to death.	
What the tool measures/does	
Indicates appropriateness of hospitalizations based on time to death.	
Objectivity	
Process	Y. Self-explaining.
Evaluation	Y. Assessment is based on time to death, and judgement on time to death may be subjective.

Interpretation	Y. Depending on time to death, a patient could be managed either in a care home or in an acute medical setting. Deaths were then categorized as incurable or likely to be manageable in the care home (deaths occurring within 3 days of index admission), potentially predictable (within 4–7 days of admission) and likely to be appropriate for acute medical intervention (death after 7 days).
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI
Costs	
Time to completion	NI
Specific input data required	Y. Specific data is not required by the instrument. However, access to some data may be required to make necessary judgements. This study was retrospective and they recorded total number of admissions, cause of death, and the number of days to death from the index admission.
Specific training required	NI
Who completed the tool?	
Likely study authors.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Retrospective use by reviewing hospital admissions from care homes to a hospital.	
Language	**Tool can be seen/accessed in:**
English	Page 2 in text: (72)

32. Modified Early Warning Score (MEWS)

Table 44. Modified Early Warning Score (MEWS).

Tool name (reported in (73))	
Modified Early Warning Score (MEWS).	
Concept/components covered	
Systolic blood pressure, pulse rate, respiratory rate, temperature and AVPU score (73)	
What the tool measures/does	
Identifies patients at risk of deterioration who require increased levels of care in the HDU or ICU. (73)	
Objectivity	
Process	Y. Self-explaining.
Evaluation	N. Assessment is made based on systolic blood pressure, pulse rate, respiratory rate, temperature and AVPU score (73)
Interpretation	Y. Scoring system. Total score of 4 or more was considered as a ward alert by nurses. Patients with a MEWS of 3 or 4 in the preoperative evaluation or at operating room discharge were transferred to HDU, whereas a MEWS score of 5 or more was considered a criteria for ICU admission. In case of a total MEWS of 3 calculated only on neurological status (subscore = 3) the patient was admitted to the ICU, as well as in case of a patient with a total MEWS of 2 (made by subscore of 2 in heart rate or by subscore of 2 in respiratory rate) in which the HDU was chosen instead of the surgical ward. (74) Total points calculated, then MEWS crore of 5 or more is judged as a "critical score". (73)
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	NI

Costs	
Time to completion	NI
Specific input data required	N. The instrument is for bedside evaluation based on 5 physiological parameters. (74)
Specific training required	Y. Following the internal protocol for emergency and not-scheduled surgical patients, nurses of the surgical ward and HDU were trained in MEWS collection during the patient´s routine evaluation. (74) Appropriate training was provided to nursing staff. (73)
Who completed the tool?	
Anaesthetist, surgical ward nurses. (74) Nursing staff. (73)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Prospective use, tool used before surgical procedure and before discharge from operating room. Likely in surgical ward or HDU. (74) At admission / hospital / prospective (73)	
Language	**Tool can be seen/accessed in:**
English	Table 1: (73)

33. The 80+ score

Table 45. The 80+ score

Tool name (reported in (37))
The 80+ score
Concept/components covered
The 80+ score includes the following 7 items: Estimated glomerular filtration rate (eGFR), Level of social support, Pulmonary disease (asthma or chronic obstruction pulmonary disease), Malignant disease, Prescription of a drug for peptic ulcer or gastro-oesophageal reflux disease, Prescription of an opioid drug, Prescription of an antidepressant drug (except tricyclic antidepressant). (75)

What the tool measures/does	
Prediction of risk of rehospitalisation and mortality in hospital patients. (75)	
Objectivity	
Process	Y. Self-explaining. (75)
Evaluation	N. Clinical and drug variables were included. See table 1. (75)
Interpretation	Y. Scoring system. Table 4 provides estimate of risk for each point total. (75)
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	The goodness-of-fit of the 80+ score was good and is illustrated in figure 1. This was confirmed by the Grønnesby-Borgan test (p=0.49). The 80+ score demonstrated a satisfying discriminatory ability of the outcome, with a C-statistic of 0.715 (figure 2). The optimism was 0.001, rendering an optimism-corrected C-statistic of 0.714 for the 80+ score. This means that a patient with an event (revisit to the hospital or death) had a 71% probability of being given a higher risk score than a patient with no event. When tested in the control group only, the 80+ score had a C-statistic of 0.71, which is similar to the value for the group as a whole. The 80+ risks core has a higher discriminatory ability for risk of rehospitalisation and mortality than most other prediction models of today (75). Discrimination: The 80+ score had the lowest AUC (0.506). Calibration: (Hosmer-Lemeshow χ2 test): 80+ score: $X^2 = 7.89$, degree of freedom = 8, p-value = 0.44. (37)
Costs	
Time to completion	Y. A simple and user-friendly point score system like this can quickly and easily identify high-risk patients. (75)
Specific input data required	Y. For example, renal function (estimated glomerular filtration rate (eGFR)). (75)

Specific training required	NI However, seems that no specific training required, as the instrument is simple and user-friendly. (75)
Who completed the tool?	
Intended for use by clinicians. (75)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
Retrospective using medical records. Likely in hospital. (37). Likely prospective use. (75).	
Language	**Tool can be seen/accessed in:**
English (75)	Tool with its scoring system is in Table 1, and a conversion table (estimate of risk for each point total) is in Table 4: (75)

34. The TRST

Table 46. The TRST

Tool name (reported in (37))	
The TRST	
Concept/components covered	
The TRST is a 5 item clinical prediction: History of cognitive impairment, Difficulty walking/transferring or recent falls, Taking five or more medications, ED use in previous 30 days or hospitalisation in previous 90 days, RN (registered nurse) professional recommendation. (76)	
What the tool measures/does	
Identifies emergency department (ED) patients at risk for ED revisits, hospitalization, or nursing home (NH) placement within 30 and 120 days following ED discharge. (76)	
Objectivity	
Process	Y. Self-explaining. (76)
Evaluation	Y. The element "RN professional recommendation" is explained in the study as: "Emergency department (ED) nurse (RN) concern for elder abuse/neglect, substance abuse, medication noncompliance, problems meeting instrumental activities of daily living, or other."

	This element of an instrument is based on nurse´s recommendation, which may involve subjective judgement. (76)
Interpretation	Y. A 5-item tool. Risk factors were assessed categorically (yes/no for the items cognitive impairment, difficulty walking/transferring, and professional recommendation; and yes/no/unable to determine for the remaining items: polypharmacy, and recent ED use or hospitalization). The number of risk factors present were summed. Subjects were considered to be a high-risk cohort, a priori, if they had cognitive impairment alone, or the presence of two or more TRST risk factors. (76)
Reliability	
Inter-rater	For the purpose of studying reliability, TRST surveys were completed for 37 patients by two different surveyors. There was one discrepancy out of 222 questions (37 screens using the six TRST items). Kappa was 1.0 for all items except for a single discrepancy regarding professional recommendation (kappa = 0.94). (76)
Intra-rater	NI
Validity	
Convergent	Logistic regression modelling revealed that a summed, un-weighted five-item TRST (sans lives alone), with a cut-off score of 2, produced nearly as good a fit (AUC=0.64) in predicting the composite outcome. For the individual outcome hospitalization, the AUC was 0.72 at 30 days and 0.65 at 120 days. Three hundred ten subjects had both APN and TRST classifications of high- or low-risk recorded. The APN and TRST classifications had 70% agreement (kappa, 0.38; 95% CI¼0.28 to 0.49). Sensitivity and specificity of the TRST to predict 30-and 120-day composite outcomes are shown in Table3. **30-day Composite Outcome** **Sensitivity** (cut-off > 2)**:** 0.64 **Specificity** (cut-off > 2)**:** 0.63 **120-day Composite Outcome**

	Sensitivity (cut-off > 2)**:** 0.55 **Specificity** (cut-off > 2)**:** 0.66 The TRST cut-off score was designed to be fairly sensitive in detecting at-risk elders and was initially weighted toward cognitive impairment. However, 99% of high-risk elders were positive for at least two TRST items and a simplified cut-off score of 2 would detect this group. (76) --- **Discrimination:** AUC for TRST was 0.589 (0.524–0.654) **Calibration** (Hosmer-Lemeshow χ2 test.): TRST χ2= 3.44; degrees of freedom= 4; p-value= 0.49 **Sensitivity** (cut-off > 2)**:** 0.37 (0.31–0.43) **Specificity** (cut-off > 2)**:** 0.74 (0.68–0.80) **PPV** (cut-off > 2): 0.59 (0.50–0.67) **NPV** (cut-off > 2): 0.54 (0.48–0.60) (37)
Costs	
Time to completion	Y. 1 to 2 minutes to complete. (76)
Specific input data required	N. Does not seem to require specific data. (76)
Specific training required	Y. May require some educational sessions, however, minimal instructions are sufficient. (37, 76) The TRST was standardized and educational sessions were conducted for all nursing personnel prior to initiating the study. Nursing personnel need minimal instruction in its use. (76)
Who completed the tool?	
ED staff nurses. (76)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
In ED, prospective use. (76)	
Language	**Tool can be seen/accessed in:**
English (76)	Figure 1: (76)

35. ERA index

Table 47. ERA index

Tool name (reported in (43))	
ERA index	
Concept/components covered	
Age, marital status, length of hospital stay, history of diabetes, heart disease, stroke, chronic obstructive pulmonary disease (COPD), neoplasia and dementia. (77)	
What the tool measures/does	
Risk of visits, emergency room visits/hospital admissions and hospital stay. (43)	
Objectivity	
Process	Y. Self-explaining. (77)
Evaluation	N. Does not involve subjective judgement. (77)
Interpretation	Y. Total score calculated based on 10 components. The range of the score varies from -7 to 32, patients with a score ≥ 16 have the highest risk of visits, emergency room visits/hospital admissions and hospital stay. (43) Table 3 guides how to transform total score to relative risk of emergency room visits and hospital visits. (77)
Reliability	
Inter-rater	NI
Intra-rater	NI
Validity	
Convergent	The area under the curve (AUC) for the primary outcome of combined hospitalizations and emergency room visits was 0.678. For hospital visits only, the AUC was 0.705. For emergency room visits only, the AUC was 0.640. (77)
Costs	
Time to completion	NI

Specific input data required	N. No specific data required. (77)
Specific training required	NI
Who completed the tool?	
Likely study authors. (43)	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
no data / likely in hospital / retrospectively (43)	
Language	**Tool can be seen/accessed in:**
English (77)	Table 1. Table 3 guides how to transform total score to relative risk of emergency room visits and hospital visits: (77)

36. Risk prediction model for PARAs

Table 48. Risk prediction model for PARAs

Tool name (reported in (44))	
Risk prediction model for PARAs	
Concept/components covered	
At least one hospitalisation in the 12 months preceding the index admission, cancer diagnosis, blood sodium <135 mmol/, Charlson score >1, length of stay >11 days, and the prescription of at least 15 different medications during the stay.	
What the tool measures/does	
Assessment of 30 day risk of PARA.	
Objectivity	
Process	Y. Self-explaining.
Evaluation	N. Does not involve subjective judgement.
Interpretation	Y. Scoring system, ranges from 0 to 10.5 points. Total points then transformed into three risk categories of PARA: low (0–1.5 points), intermediate (1.5–5 points), high (>5 points).
Reliability	
Inter-rater	NI

Intra-rater	NI
Validity	
Convergent	Area under the ROC curve of 0.696. The p-value of the Hosmer-Lemeshow goodness-of-fit statistic was 0.69. The C statistic for the level of risk was at 0.65.
Costs	
Time to completion	NI
Specific input data required	Y. Requires specific data, laboratory analysis for blood sodium level.
Specific training required	NI
Who completed the tool?	
Likely study authors.	
When/where/how tool was/can be completed? (for example: at discharge/at admission, in hospital/in nursing home, retrospective/prospective)	
At discharge (last data available before discharge, extracted from hospital data system) / in hospital / retrospective	
Language	**Tool can be seen/accessed in:**
English	Table 3 shows components with associated points. Rule to transform total points to risk classes is shown in text on page 4: (44)

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Supplementary file 4: RoB table

Author Year	Experimental	Comparator	Outcome	Weight	D1	D2	D3	D4	D5	Overall
Hullick et al. 2016	ACE service model	Control RACFS with usual care	ED presentations	1	-	!	-	+	!	-
Hullick et al. 2021	ACE program	Usual care	Hospital admissions	1	-	!	+	+	!	-
Kane et al. 2017	INTERACT NHs	Control NHs	Avoidable hospitalizations	1	+	!	-	+	+	-
Selker et al. 1998	ACI-TIPI group	Control group	Unnecessary hospital admissions	1	-	+	+	+	!	-
Tappen et al. 2020	Intervention group (Guide)	Control group (regular care)	Transfers to acute care	1	!	!	+	+	!	!
Sampson et al. 2020	BHiRCH-NH	Treatment as usual	Avoidable hospital admissions	1	+	!	+	+	+	!

+	Low risk
!	Some concerns
-	High risk
D1	Randomisation process
D2	Deviations from the intended interventions
D3	Missing outcome data
D4	Measurement of the outcome
D5	Selection of the reported result

Supplementary file 5: List of excluded studies

#	Studies Category 1	Reason for exclusion
1	Lewin G, Jiwa M. Prevention of avoidable hospital admissions of older people living at home in Western Australia: a pilot randomized control trial. https://trialsearchwhoint/Trial2aspx?TrialID=ACTRN12613000907741. 2013.	Study registration record.
2	Adam L, Moutzouri E, Baumgartner C, Loewe AL, Feller M, M'Rabet-Bensalah K, et al. Rationale and design of OPtimising thERapy to prevent Avoidable hospital admissions in Multimorbid older people (OPERAM): a cluster randomised controlled trial. BMJ Open. 2019;9(6):e026769.	Study protocol.
3	Alonso Bouzón C, Petidier Torregrossa R, Marín Larraín PP, Rodriguez Mañas L. [Effectiveness of reevaluation of admission of patients with poor functional status]. Rev Esp Geriatr Gerontol. 2010;45(1):19-21.	Wrong study design. No assessment tool reported.
4	Bourke R, Rice C, McMahon G, Cunningham C, Kenny RA, Briggs R. 304 ED-FASU: A Novel 'Front Door' Multidisciplinary Service Assessing Patients with Falls and Syncope in the Emergency Department...67th Annual & Scientific Meeting of the Irish Gerontological Society, Innovation, Advances and Excellence in Ageing, 26–28 September 2019, Cork, Ireland. Age & Ageing. 2019;48:iii17-iii65.	Poster presentation. No assessment tool reported.
5	Brühmann BA, Reese C, Kaier K, Ott M, Maurer C, Kunert S, et al. A complex health services intervention to improve medical care in long-term care homes: study protocol of the controlled coordinated medical care (CoCare) study. BMC Health Serv Res. 2019;19(1):332.	Study protocol.
6	Carter HE, Lee XJ, Farrington A, Shield C, Graves N, Cyarto EV, et al. A stepped-wedge randomised controlled trial assessing the implementation, effectiveness and cost-consequences of the EDDIE+ hospital avoidance program in 12 residential aged care homes: study protocol. BMC Geriatrics. 2021;21(1):347-.	Study protocol.

7	Connolly MJ, Boyd M, Broad JB, Kerse N, Lumley T, Whitehead N, et al. The Aged Residential Care Healthcare Utilization Study (ARCHUS): a multidisciplinary, cluster randomized controlled trial designed to reduce acute avoidable hospitalizations from long-term care facilities. J Am Med Dir Assoc. 2015;16(1):49-55.	No assessment tool reported.
8	Connolly MJ, Broad JB, Boyd M, Kerse N, Foster S, Lumley T, et al. Randomised controlled trial of packaged "evidenced" interventions for reducing hospitalisations from residential aged care (RAC): first results from the ARCHUS study. European Geriatric Medicine. 2013;4:S171-.	Poster presentation. No full text.
9	Connolly MJ, Broad JB, Boyd M, Kerse N, Foster S, Lumley T, et al. CLUSTER-RANDOMISED CONTROLLED TRIAL (RCT) OF A MULTIDISCIPLINARY INTERVENTION PACKAGE FOR REDUCING DISEASE-SPECIFIC HOSPITALISATIONS FROM LONG TERM CARE (LTC). Age & Ageing. 2014;43(suppl_2):ii19-ii.	Poster presentation. No assessment tool reported.
10	Crowley EK, Sallevelt BTGM, Huibers CJA, Murphy KD, Spruit M, Shen Z, et al. Intervention protocol: OPtimising thERapy to prevent avoidable hospital Admission in the Multi-morbid elderly (OPERAM): a structured medication review with support of a computerised decision support system. BMC Health Services Research. 2020;20(1):1-12.	Study protocol.
11	Foster SJ, Boyd M, Broad JB, Whitehead N, Kerse N, Lumley T, et al. Aged Residential Care Health Utilisation Study (ARCHUS): a randomised controlled trial to reduce acute hospitalisations from residential aged care. BMC Geriatr. 2012;12:54.	Study protocol.
12	Fournaise A, Lauridsen JT, Bech M, Wiil UK, Rasmussen JB, Kidholm K, et al. Prevention of AcuTe admIssioN algorithm (PATINA): study protocol of a stepped wedge randomized controlled trial. BMC Geriatr. 2021;21(1):146.	Study protocol.

13	Freund T, Peters-Klimm F, Rochon J, Mahler C, Gensichen J, Erler A, et al. Primary care practice-based care management for chronically ill patients (PraCMan): study protocol for a cluster randomized controlled trial. Trials. 2011;12:163.	Study protocol.
14	Hullick C, Conway J, Hall A, Murdoch W, Cole J, Hewitt J, et al. Video-telehealth to support clinical assessment and management of acutely unwell older people in Residential Aged Care: a pre-post intervention study. BMC Geriatr. 2022;22(1):40.	No assessment tool reported.
15	Downs M. The better health in residents in care homes study: Pilot study. https://trialsearchwhoint/Trial2aspx?TrialID=ISRCTN74109734. 2017.	Study registration record.
16	Blighe A. Feasibility study to reduce avoidable hospitalisations and promote Better Health in Residents in Care Homes (BHiRCH). https://trialsearchwhoint/Trial2aspx?TrialID=ISRCTN86811077. 2017.	Study registration record.
17	Lamppu P, Finne-Soveri H, Laakkonen ML, Laurila J, Pitkala K. Educating nursing home staff in palliative care to improve end-oflife care and to reduce burdensome hospitalisations: baseline findings and feasibility of a randomised, controlled trial. European Geriatric Medicine. 2018;9:S42-.	Poster presentation. No full text.
18	Mendes A. Multimorbidity, optimising treatment and preventing hospital admissions in older people...Blum M, Sallevelt B, Spinewine A, et al. Optimizing Therapy to Prevent Avoidable Hospital Admissions in Multimorbid Older Adults (OPERAM): cluster randomised controlled trial. BMJ. 2021; 374: n1585. Journal of Prescribing Practice. 2021;3(9):344-5.	Wrong study design. No assessment tool reported.

19	Noel K, Yagudayev S, Messina C, Schoenfeld E, Hou W, Kelly G. Tele-transitions of care. A 12-month, parallel-group, superiority randomized controlled trial protocol, evaluating the use of telehealth versus standard transitions of care in the prevention of avoidable hospital readmissions. Contemp Clin Trials Commun. 2018;12:9-16.	No assessment tool reported.
20	Huibers CJAL. OPtimising thERapy to prevent Avoidable hospital admissions in the Multimorbid elderly. https://trialsearchwhoint/Trial2aspx?TrialID=NTR6012. 2016.	Study registration record.
21	Ouslander JG, Reyes B, Yang Z, Engstrom G, Tappen R, Newman D, et al. Nursing home performance in a trial to reduce hospitalizations: Implications for future trials. J Am Geriatr Soc. 2021;69(8):2316-26.	Wrong study design. No assessment tool reported.
22	Palacholla RS, Fischer NC, Agboola S, Nikolova-Simons M, Odametey S, Golas SB, et al. Evaluating the Impact of a Web-Based Risk Assessment System (CareSage) and Tailored Interventions on Health Care Utilization: Protocol for a Randomized Controlled Trial. JMIR Res Protoc. 2018;7(5):e10045.	Study protocol.
23	Piotrowski A, Meyer M, Burkholder I, Renaud D, Müller MA, Lehr T, et al. Effect of an interprofessional care concept on the hospitalization of nursing home residents: study protocol for a cluster-randomized controlled trial. Trials. 2020;21(1):411.	Study protocol.
24	Sampson EL, Feast A, Blighe A, Froggatt K, Hunter R, Marston L, et al. Evidence-based intervention to reduce avoidable hospital admissions in care home residents (the Better Health in Residents in Care Homes (BHiRCH) study): protocol for a pilot cluster randomised trial. BMJ Open. 2019;9(5):e026510.	Study protocol.

25	Jia H, Chuang H, Wu SS, Wang X, Chumbler NR. Long-term effect of home telehealth services on preventable hospitalization use. Journal of Rehabilitation Research & Development. 2009;46(5):557-66.	No assessment tool reported.
26	Stop and watch tool reduces avoidable hospital readmissions. Remington Report. 2011;19(3):36-8.	No full text.
27	Vogelsmeier A, Popejoy L, Kist S, Shumate S, Pritchett A, Mueller J, et al. Reducing Avoidable Hospitalizations for Nursing Home Residents: Role of the Missouri Quality Initiative Intervention Support Team. J Nurs Care Qual. 2020;35(1):1-5.	Wrong study design. No assessment tool reported.

#	Studies Category 2	Reason for exclusion
1	Stop and watch tool reduces avoidable hospital readmissions. Remington Report. 2011;19(3):36-8.	No full text.
2	Lewin G, Jiwa M. Prevention of avoidable hospital admissions of older people living at home in Western Australia: a pilot randomized control trial. https://trialsearchwhoint/Trial2aspx?TrialID=ACTRN12613000907741. 2013.	Study registration record.
3	Allen BR, Simpson GG, Zeinali I, Freitas JT, Chapa JJ, Rawson LJ, et al. Incorporation of the HEART Score Into a Low-risk Chest Pain Pathway to Safely Decrease Admissions. Crit Pathw Cardiol. 2018;17(4):184-90.	Wrong study population.

4	Alonso Bouzón C, Petidier Torregrossa R, Marín Larraín PP, Rodriguez Mañas L. [Effectiveness of reevaluation of admission of patients with poor functional status]. Rev Esp Geriatr Gerontol. 2010;45(1):19-21.	No assessment tool reported.
5	Avigni N, Ippoliti M, Muccinelli M, Kubbajeh M, Zanotti C, Tonioli M, et al. [Chest pain in the emergency department: benefits of a management model modified from the ANMCO-SIMEU recommendations]. G Ital Cardiol (Rome). 2011;12(5):365-73.	No assessment tool reported.
6	Bonner A, Tappen R, Herndon L, Ouslander J. The INTERACT Institute: Observations on Dissemination of the INTERACT Quality Improvement Program Using Certified INTERACT Trainers. Gerontologist. 2015;55(6):1050-7.	Wrong study design.
7	Briggs R, McDonough A, Ellis G, Bennett K, O'Neill D, Robinson D. Comprehensive Geriatric Assessment for community-dwelling, high-risk, frail, older people. Cochrane Database of Systematic Reviews. 2022(5).	Wrong study design.
8	Broman KK, Poulose BK, Phillips SE, Ehrenfeld JM, Sharp KW, Pierce RA, et al. Unnecessary Transfers for Acute Surgical Care: Who and Why? Am Surg. 2016;82(8):672-8.	No assessment tool reported.
9	Buitrago I, Seidl KL, Gingold DB, Marcozzi D. Analysis of Readmissions in a Mobile Integrated Health Transitional Care Program Using Root Cause Analysis and Common Cause Analysis. Journal for Healthcare Quality: Promoting Excellence in Healthcare. 2022;44(3):169-77.	No assessment tool reported.
10	Carnessale G, Staniscia T, Matarrese D, Seccia G, Schioppa F, Di Giovanni P, et al. [Appropriateness of hospitalization in the teaching hospital of Chieti using the P.R.U.O. approach]. Ann Ig. 2003;15(2):117-22.	Wrong study population.
11	Collins G. Implementation of an integrated, multidisciplinary team model of screening, assessment and intervention for the elderly population in a medical assessment unit in Galway University Hospital, Ireland. International Journal of Integrated Care (IJIC). 2017;17:1-.	Poster presentation.

12	Downs M, Blighe A, Carpenter R, Feast A, Froggatt K, Gordon S, et al. Programme Grants for Applied Research. A complex intervention to reduce avoidable hospital admissions in nursing homes: a research programme including the BHiRCH-NH pilot cluster RCT. 2021.	Excluded here, because already included in Category 1.
13	Engel L, Hwang K, Panayiotou A, Watts JJ, Mihalopoulos C, Temple J, et al. Identifying patterns of potentially preventable hospitalisations in people living with dementia. BMC Health Serv Res. 2022;22(1):794.	No assessment tool reported.
14	Falvey JR, Burke RE, Levy CR, Gustavson AM, Price L, Forster JE, et al. Impaired Physical Performance Predicts Hospitalization Risk for Participants in the Program of All-Inclusive Care for the Elderly. Phys Ther. 2019;99(1):28-36.	No assessment tool reported.
15	Fluitman KS, van Galen LS, Merten H, Rombach SM, Brabrand M, Cooksley T, et al. Exploring the preventable causes of unplanned readmissions using root cause analysis: Coordination of care is the weakest link. Eur J Intern Med. 2016;30:18-24.	No assessment tool reported.
16	Franks S. Transitional Care to Reduce 30-day Heart Failure Readmissions Among the Long-Term Care Elderly Population...28th Annual Scientific Session, June 2-6, 2017, Baltimore, Maryland. Nursing Research. 2016;65(2):E37-E8.	Poster presentation.
17	Fried RA, Main DS, Calonge BN. Appropriateness of hospital use by family physicians. J Am Board Fam Pract. 1994;7(3):229-35.	Wrong study population.
18	Gujral S, Bell CR, Dare L, Smith PJ, Persad RA, Gujral S, et al. A prospective evaluation of the management of acute pyelonephritis in adults referred to urologists. International Journal of Clinical Practice. 2003;57(3):238-40.	No assessment tool reported. Wrong study population.
19	Handler SM, Sharkey SS, Hudak S, Ouslander JG. Incorporating INTERACT II Clinical Decision Support Tools into Nursing Home Health Information Technology. Ann Longterm Care. 2011;19(11):23-6.	Wrong study design

20	Harriss LR, Thompson F, Lawson K, O'Loughlin M, McDermott R. Preventable hospitalisations in regional Queensland: potential for primary health? Australian Health Review. 2019;43(4):371-81.	No assessment tool reported. Wrong study population.
21	Jackson AH, Fireman E, Feigenbaum P, Neuwirth E, Kipnis P, Bellows J. Manual and automated methods for identifying potentially preventable readmissions: a comparison in a large healthcare system. BMC Med Inform Decis Mak. 2014;14:28.	No assessment tool reported.
22	Jiménez-Puente A, García-Alegría J, Gómez-Aracena J, Hidalgo-Rojas L, Lorenzo-Nogueiras L, Fernández-Crehuet-Navajas J. [Analysis of the causes and potential avoidability of readmissions in an acute patients' hospital]. Med Clin (Barc). 2002;118(13):500-5.	Wrong study population.
23	Johnson PC, Xiao Y, Wong RL, D'Arpino S, Moran SMC, Lage DE, et al. Potentially Avoidable Hospital Readmissions in Patients With Advanced Cancer. J Oncol Pract. 2019;15(5):e420-e7.	No assessment tool reported.
24	Keawpugdee J, Silpasuwan P, Viwatwongkasem C, Boonyamalik P, Amnatsatsue K. Hospital Readmission Risks Screening for Older Adult with Stroke: Tools Development and Validation of a Prediction. Inquiry. 2021;58:469580211018285.	Wrong study population..
25	Knighton A, Martin G, Sounderajah V, Warren L, Markiewicz O, Riga C, et al. Avoidable 30-day readmissions in patients undergoing vascular surgery. BJS Open. 2019;3(6):759-66.	No assessment tool reported.
26	Knox S, Downer B, Haas A, Middleton A, Ottenbacher KJ. Dementia Severity Associated With Increased Risk of Potentially Preventable Readmissions During Home Health Care. J Am Med Dir Assoc. 2020;21(4):519-24.e3.	No assessment tool reported.
27	Krolak-Salmon P, Roubaud C, Finne-Soveri H, Riolacci-Dhoyen N, Richard G, Rouch I, et al. Evaluation of a mobile team dedicated to behavioural disorders as recommended by the Alzheimer Cooperative Valuation in Europe joint action: observational cohort study. Eur J Neurol. 2016;23(5):979-88.	No assessment tool reported.

28	Lagoe RJ, Nanno DS, Luziani ME. Quantitative tools for addressing hospital readmissions. BMC Res Notes. 2012;5:620.	No assessment tool reported.
29	Latus J, Schwab M, Tacconelli E, Pieper FM, Wegener D, Rettenmaier B, et al. Acute kidney injury and tools for risk-stratification in 456 patients with hantavirus-induced nephropathia epidemica. Nephrol Dial Transplant. 2015;30(2):245-51.	Wrong study population.
30	Leendertse AJ, Van Den Bemt PM, Poolman JB, Stoker LJ, Egberts AC, Postma MJ. Preventable hospital admissions related to medication (HARM): cost analysis of the HARM study. Value Health. 2011;14(1):34-40.	No assessment tool reported.
31	Liang JW, Cifrese L, Ostojic LV, Shah SO, Dhamoon MS. Preventable Readmissions and Predictors of Readmission After Subarachnoid Hemorrhage. Neurocritical Care. 2018;29(3):336-43.	No assessment tool reported.
32	Lledó R, Martín E, Jiménez C, Roca R, Gil A, Godoy E, et al. Characteristics of elderly inpatients at high risk of needing supportive social and health care services. Eur J Epidemiol. 1997;13(8):903-7.	No assessment tool reported.
33	Lohman MC, Scherer EA, Whiteman KL, Greenberg RL, Bruce ML. Factors Associated With Accelerated Hospitalization and Re-hospitalization Among Medicare Home Health Patients. Journals of Gerontology Series A: Biological Sciences & Medical Sciences. 2018;73(9):1280-6.	No assessment tool reported.
34	Martin C, Hinkley N, Stockman K, Campbell D. Capitated Telehealth Coaching Hospital Readmission Service in Australia: Pragmatic Controlled Evaluation. J Med Internet Res. 2020;22(12):e18046.	No assessment tool reported.
35	Martin C, Hinkley N, Stockman K, Campbell D. Potentially preventable hospitalizations—The 'pre-hospital syndrome': Retrospective observations from the MonashWatch self-reported health journey study in Victoria, Australia. Journal of Evaluation in Clinical Practice. 2021;27(2):228-35.	No assessment tool reported.
36	Maust DT, Kim HM, Chiang C, Langa KM, Kales HC. Predicting Risk of Potentially Preventable Hospitalization in Older Adults with Dementia. J Am Geriatr Soc. 2019;67(10):2077-84.	No assessment tool reported.

37	McAna JF, Crawford AG, Novinger BW, Sidorov J, Din FM, Maio V, et al. A predictive model of hospitalization risk among disabled medicaid enrollees. Am J Manag Care. 2013;19(5):e166-74.	No assessment tool reported. Wrong study population.
38	McAuliffe LH, Zullo AR, Dapaah-Afriyie R, Berard-Collins C. Development and validation of a transitions-of-care pharmacist tool to predict potentially avoidable 30-day readmissions. Am J Health Syst Pharm. 2018;75(3):111-9.	Wrong study population.
39	Mi R, Hollander MM, Jones CMC, DuGoff EH, Caprio TV, Cushman JT, et al. A randomized controlled trial testing the effectiveness of a paramedic-delivered care transitions intervention to reduce emergency department revisits. BMC Geriatr. 2018;18(1):104.	No assessment tool reported.
40	Mihaljevic SE, Howard VM. Incorporating Interprofessional Evidenced-Based Sepsis Simulation Education for Certified Nursing Assistants (CNAs) and Licensed Care Providers Within Long-term Care Settings for Process and Quality Improvement. Crit Care Nurs Q. 2016;39(1):24-33.	No assessment tool reported. Wrong study design.
41	Morris JN, Howard EP, Steel K, Schreiber R, Fries BE, Lipsitz LA, et al. Predicting risk of hospital and emergency department use for home care elderly persons through a secondary analysis of cross-national data. BMC Health Serv Res. 2014;14:519.	No assessment tool reported.
42	Mulder BJ, Tzeng HM, Vecchioni ND. Preventing avoidable rehospitalizations by understanding the characteristics of "frequent fliers". J Nurs Care Qual. 2012;27(1):77-82.	No assessment tool reported.

43	Nct. OPtimising thERapy to Prevent Avoidable Hospital Admissions in the Multimorbid Older People. https://clinicaltrialsgov/show/NCT02986425. 2016.	Study registration record.
44	Olson CH, Dierich M, Westra BL. Automation of a high risk medication regime algorithm in a home health care population. J Biomed Inform. 2014;51:60-71.	No assessment tool reported.
45	O'Malley AS, Reschovsky JD, Saiontz-Martinez C. Interspecialty communication supported by health information technology associated with lower hospitalization rates for ambulatory care-sensitive conditions. J Am Board Fam Med. 2015;28(3):404-17.	No assessment tool reported.
46	O'Riordan Y, Bernard P, Maloney P, Enright A, McGrath C. Safer transitioning Optimising Frail Elderly Patients Care From Hospital to Home. International Journal of Integrated Care (IJIC). 2017;17:1-2.	Poster presentation.
47	Ouslander JG, Handler SM. Consensus-Derived Interventions to Reduce Acute Care Transfer (INTERACT)-Compatible Order Sets for Common Conditions Associated with Potentially Avoidable Hospitalizations. J Am Med Dir Assoc. 2015;16(6):524-6.	Wrong study design.
48	Palacholla RS, Fischer NC, Agboola S, Nikolova-Simons M, Odametey S, Golas SB, et al. Evaluating the Impact of a Web-Based Risk Assessment System (CareSage) and Tailored Interventions on Health Care Utilization: Protocol for a Randomized Controlled Trial. JMIR Res Protoc. 2018;7(5):e10045.	Study protocol.
49	Passey ME, Longman JM, Johnston JJ, Jorm L, Ewald D, Morgan GG, et al. Diagnosing Potentially Preventable Hospitalisations (DaPPHne): protocol for a mixed-methods data-linkage study. BMJ Open. 2015;5(11):e009879.	Study protocol.
50	Patel KK, Vakharia N, Pile J, Howell EH, Rothberg MB. Preventable Admissions on a General Medicine Service: Prevalence, Causes and Comparison with AHRQ Prevention Quality Indicators-A Cross-Sectional Analysis. J Gen Intern Med. 2016;31(6):597-601.	No assessment tool reported.

51	Pérez-Rubio A, Santos S, Luquero FJ, Tamames S, Cantón B, Castrodeza JJ. [Evaluation of the appropriateness of stays in a third level hospital]. An Sist Sanit Navar. 2007;30(1):29-36.	Wrong study population.
52	Peris A, Zagli G, Maccarrone N, Batacchi S, Cammelli R, Cecchi A, et al. The use of Modified Early Warning Score may help anesthesists in postoperative level of care selection in emergency abdominal surgery. Minerva Anestesiol. 2012;78(9):1034-8.	Wrong study population.
53	Pileggi C, Bianco A, Di Stasio SM, Angelillo IF. Inappropriate hospital use by patients needing urgent medical attention in Italy. Public Health. 2004;118(4):284-91.	Wrong study population.
54	Porath A, Schlaeffer F, Lieberman D, Porath A, Schlaeffer F, Lieberman D. Appropriateness of hospitalization of patients with community-acquired pneumonia. Annals of Emergency Medicine. 1996;27(2):176-83.	Wrong study population.
55	Salzman BE, Knuth RV, Cunningham AT, LaNoue MD. Identifying Older Patients at High Risk for Emergency Department Visits and Hospitalization. Popul Health Manag. 2019;22(5):394-8.	No assessment tool reported.
56	Sánchez-García S, Juárez-Cedillo T, Mould-Quevedo JF, García-González JJ, Contreras-Hernández I, Espinel-Bermudez MC, et al. The hospital appropriateness evaluation protocol in elderly patients: a technique to evaluate admission and hospital stay. Scand J Caring Sci. 2008;22(2):306-13.	Wrong study population.
57	Sarmento J, Alves C, Oliveira P, Sebastião R, Santana R. [Characterization and Evolution of Avoidable Admissions in Portugal: The Impact of Two Methodologic Approaches]. Acta Med Port. 2015;28(5):590-600.	Wrong study population.
58	Selker HP, Beshansky JR, Griffith JL, Aufderheide TP, Ballin DS, Bernard SA, et al. Use of the acute cardiac ischemia time-insensitive predictive instrument (ACI-TIPI) to assist with triage of patients with chest pain or other symptoms suggestive of acute cardiac ischemia. A multicenter, controlled clinical trial. Annals of Internal Medicine. 1998;129(11):845-55.	Excluded here because already included in Category 1.

59	Sengupta R, Loftus TM, Doers M, Jandarov RA, Phillips M, Ko J, et al. Resting Borg score as a predictor of safe discharge of chronic obstructive pulmonary disease from the emergency department observation unit. Academic Emergency Medicine. 2020;27(12):1302-11.	Wrong study population.
60	Shanahan TAG, Fuller GW, Sheldon T, Turton E, Quilty FMA, Marincowitz C. External validation of the Dutch prediction model for prehospital triage of trauma patients in South West region of England, United Kingdom. Injury. 2021;52(5):1108-16.	No assessment tool reported. Wrong study population.
61	Stiell IG, Perry JJ, Clement C, Brison RJ, Rowe BH, Aaron S, et al. Creation of the Canadian heart failure risk scale for acute heart failure patients. Academic emergency medicine Conference: 2017 annual meeting of the society for academic emergency medicine, SAEM 2017 United states. 2017;24:S23.	Poster presentation.
62	Stober MJ, Hager K, Rinker G. Assessment and Management Tools for Advancing Disease. Home Healthc Now. 2022;40(3):159-66.	No full text.
63	Sutherland T, David-Kasdan JA, Beloff J, Mueller A, Whang EE, Bleday R, et al. Patient and Provider-Identified Factors Contributing to Surgical Readmission After Colorectal Surgery. J Invest Surg. 2016;29(4):195-201.	No assessment tool reported. Wrong study population.
64	Tinetti ME, Charpentier P, Gottschalk M, Baker DI. Effect of a restorative model of posthospital home care on hospital readmissions. J Am Geriatr Soc. 2012;60(8):1521-6.	No assessment tool reported.
65	Tuso P, Watson HL, Garofalo-Wright L, Lindsay G, Jackson A, Taitano M, et al. Complex case conferences associated with reduced hospital admissions for high-risk patients with multiple comorbidities. Perm J. 2014;18(1):38-42.	No assessment tool reported.
66	Ukert B, David G, Smith-McLallen A, Chawla R, Smith-McLallen A. Do payor-based outreach programs reduce medical cost and utilization? Health Economics. 2020;29(6):671-82.	No assessment tool reported.
67	van der Does AMB, Kneepkens EL, Uitvlugt EB, Jansen SL, Schilder L, Tokmaji G, et al. Preventability of unplanned readmissions within 30 days of discharge. A cross-sectional, single-center study. PLoS One. 2020;15(4):e0229940.	No assessment tool reported.

68	Victor CR, Khakoo AA. Is hospital the right place? A survey of 'inappropriate' admissions to an inner London NHS trust. J Public Health Med. 1994;16(3):286-90.	Wrong study population.
69	Vigod SN, Kurdyak PA, Seitz D, Herrmann N, Fung K, Lin E, et al. READMIT: a clinical risk index to predict 30-day readmission after discharge from acute psychiatric units. J Psychiatr Res. 2015;61:205-13.	No assessment tool reported. Wrong study population.
70	Vogelsmeier A, Popejoy L, Kist S, Shumate S, Pritchett A, Mueller J, et al. Reducing Avoidable Hospitalizations for Nursing Home Residents: Role of the Missouri Quality Initiative Intervention Support Team. J Nurs Care Qual. 2020;35(1):1-5.	No assessment tool reported.
71	Weinberg DS, Kraay MJ, Fitzgerald SJ, Sidagam V, Wera GD. Are Readmissions After THA Preventable? Clin Orthop Relat Res. 2017;475(5):1414-23.	No assessment tool reported.
72	Weiss M, Yakusheva O, Bobay K. Nurse and patient perceptions of discharge readiness in relation to postdischarge utilization. Med Care. 2010;48(5):482-6.	No assessment tool reported.
73	Weissman GE, Kerlin MP, Yuan Y, Kohn R, Anesi GL, Groeneveld PW, et al. Potentially Preventable Intensive Care Unit Admissions in the United States, 2006-2015. Ann Am Thorac Soc. 2020;17(1):81-8.	No assessment tool reported.
74	Zhang Y, Zhang Y, Sholle E, Abedian S, Sharko M, Turchioe MR, et al. Assessing the impact of social determinants of health on predictive models for potentially avoidable 30-day readmission or death. PLoS One. 2020;15(6):e0235064.	Wrong study population.
75	Zografakis-Sfakianakis M, De Bree E, Linardakis M, Messaritaki A, Askitopoulou H, Papaioannou A, et al. The value of the Modified Early Warning Score for unplanned Intensive Care Unit admissions of patients treated in hospital general wards. International Journal of Nursing Practice (John Wiley & Sons, Inc). 2018;24(3):1-.	Wrong study population.

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 1-2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 2
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 2
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 2-3
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 2
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Page 3, Supplementary file_7
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 3
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 3
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 3
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 3
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 3
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	NA
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	NA
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	NA
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	NA
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	NA
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	NA
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	NA

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 4-5
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	NA
Study characteristics	17	Cite each included study and present its characteristics.	Page 4, Supplementary file_2
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Page 5-6, Supplementary file_4.
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Supplementary file_2
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Page 5-6
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	NA
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 10-11
	23b	Discuss any limitations of the evidence included in the review.	Page 11
	23c	Discuss any limitations of the review processes used.	Page 11
	23d	Discuss implications of the results for practice, policy, and future research.	Page 11
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 2, 12
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	We prepared a protocol, but it is not available online/publicly.
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 2, 12
Competing interests	26	Declare any competing interests of review authors.	Page 12

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Supplementary files are available online along with the publication, and contain information on: characteristics of the included studies, characteristics of the tools, list of excluded studies with reasons, search string, data extracted from included studies.

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

Supplementary file 7: Final search string

(("tool" OR "tools" OR "toolkit" OR "toolkits" OR intervention* OR "instrument" OR "instruments" OR guideline OR "guidelines") AND (("avoidable" AND ("transition*" OR "transitions" OR "transfer" OR "transfers" OR "hospitalization" OR "hospitalizations" OR "admission" OR "admissions" OR "readmission" OR "readmissions")) OR "inappropriate transfer" OR "inappropriate transfers" OR "inappropriate hospitalization" OR "inappropriate hospitalizations" OR "inappropriate admission" OR "inappropriate admissions" OR "burdensome transition*" OR "burdensome transitions" OR "preventable hospitalization" OR "preventable hospitalizations" OR "preventable admission" OR "preventable admissions" OR "preventable readmission" OR "preventable readmissions" OR "inadequate transition*" OR "inadequate transfer" OR "inadequate admission" OR "inadequate admissions" OR "unnecessary transition*" OR "unnecessary transitions" OR "unnecessary transfer" OR "unnecessary transfers" OR "unnecessary hospitalization" OR "unnecessary hospitalizations" OR "unnecessary admission" OR "unnecessary admissions" OR "unnecessary readmission" OR "unnecessary readmissions" OR "ineffective transition*" OR "ineffective transitions" OR "ineffective transfer" OR "inefficient transition*" OR "inefficient transfer" OR "inefficient transfers")) AND ("senior" OR "seniors" OR "older adults" OR "elderly" OR "elderlies" OR "aged")

PubMed: No human and time restriction 721 results, 23.06.2022

CINAHL: No expanders (no equivalent subjects): 349 results, 23.06.2022

CENTRAL: No search word variations, 196 results, 23.06.2022

Declarations

(1) I declare that I have not undergone a doctoral procedure or started a doctorate at any other university.
(2) I declare that the information provided is true and that I have not submitted the academic work to any other academic institution for the purpose of obtaining an academic degree.
(3) I declare on oath that I have written the thesis independently and without outside help. All rules of good scientific practice have been observed; no sources and aids other than those specified by me have been used and the passages taken verbatim or in terms of content from the works used have been identified as such.

07.02.2025

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