Advancing Nursing Data Integration through a Nursing Minimum Data Set - Conceptual and Technical Development of a "Fall" Data Module

Sarah Milkov, Antonia Schmidt, Niklas Tschorn, Marcel Klötgen, Wolfgang Deiters, Christian Potthoff, Kirsten Neveling, Yvonne Weber, Daniela Holle

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Abstract

Background: In ageing populations, the demand for care, including care delivery in long-term care facilities, is increasing. This situation highlights the need to optimize care processes through continuous scientific evaluation. The use of artificial intelligence (AI) has potential for use in nursing research, but it suffers from a lack of standardization and structuring of nursing data. Although solutions such as standardized nursing terminologies exist, their use in practice has thus far not been widespread and is often associated with high documentation costs. This article presents the conceptual and technical development of a nursing minimum data set (NMDS) that focuses on a specific "fall" scenario. It aims to improve data standardization and usability for research and AI-based analysis in long-term care settings.

Methods: The representation of the “fall” use case was developed using literature analyses, co-design workshops and a quantitative survey (n =158). The technical indexing was conducted by translating the results into the technical terminology of the HL7® FHIR® standard.

Results: The "fall" use case was developed as part of a German NMDS for long-term residential care that included fall risk factors, interventions and outcomes. The relevant content, in the sense of a minimum set of items, was identified and prioritized in collaboration with nursing experts and translated into an FHIR® -based implementation guide.
Discussion: The development of the “fall” module demonstrates a method for providing standardized nursing data based on routine care data for AI and research without increasing staff workload. Its co-designed, interoperable approach supports cross-sector data harmonization and offers a transferable model for international nursing contexts.

Conclusion: This approach addresses the lack of structured nursing data for AI and research and can serve as an example for interoperable, cross-sector solutions in global long-term care.

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Advancing Nursing Data Integration through a Nursing Minimum Data Set - Conceptual and Technical Development of a "Fall" Data Module

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Abstract

Background: In ageing populations, the demand for care, including care delivery in long-term care facilities, is increasing. This situation highlights the need to optimize care processes through continuous scientific evaluation. The use of artificial intelligence (AI) has potential for use in nursing research, but it suffers from a lack of standardization and structuring of nursing data. Although solutions such as standardized nursing terminologies exist, their use in practice has thus far not been widespread and is often associated with high documentation costs. This article presents the conceptual and technical development of a nursing minimum data set (NMDS) that focuses on a specific "fall" scenario. It aims to improve data standardization and usability for research and AI-based analysis in long-term care settings.

Methods: The representation of the “fall” use case was developed using literature analyses, co-design workshops and a quantitative survey (n =158). The technical indexing was conducted by translating the results into the technical terminology of the HL7® *FHIR*® standard.

Results: The "fall" use case was developed as part of a German NMDS for long-term residential care that included fall risk factors, interventions and outcomes. The relevant content, in the sense of a minimum set of items, was identified and prioritized in collaboration with nursing

experts and translated into an *FHIR®* -based implementation guide.

Discussion: The development of the “fall” module demonstrates a method for providing standardized nursing data based on routine care data for AI and research without increasing staff workload. Its co-designed, interoperable approach supports cross-sector data harmonization and offers a transferable model for international nursing contexts.

Conclusion: This approach addresses the lack of structured nursing data for AI and research and can serve as an example for interoperable, cross-sector solutions in global long-term care.

Keywords: Nursing, Minimum Data Set, Core Data Set, Fall, Standardization

1 Introduction

1.1. Background

The number of people in need of care is increasing continuously in Germany and Europe due to demographic changes. Many older people suffer from multiple health impairments, and the proportion of people receiving inpatient care in long-term care (LTC) facilities is increasing throughout Europe [1]. One example of a growing health problem in the older population that affects several care sectors is falls, which are highly relevant from several perspectives. For people in need of care, the consequences of falls cause great physical and psychological stress, whereas for care systems, individuals’ likelihood of needing care and hospital treatment increases significantly after a fall [2,3]. The continuous scientific development of nursing processes is essential for improving the quality of care, promoting evidence-based knowledge and further developing nursing practice [4,5].

The application of artificial intelligence (AI) opens new possibilities for nursing research by enabling the efficient analysis of large amounts of care data, recognizing patterns and obtaining scientifically useful insights [6]. This strengthened nursing research makes a significant

contribution to improving and facilitating nursing care as scientific findings can be used to develop evidence-based care strategies [7]. In turn, data from nursing care form the basis for AI-supported analyses [8]. This cycle is depicted in Figure 1.

Underlying this triad is the common need for structured and standardized data. One approach to obtain data for research purposes is the secondary use of existing documentation data from the operative care process, which represents an alternative to traditional prospective studies. In the context of primary surveys, the records of nursing staff can be evaluated with respect to the health status of people in need of care (data collection). One obstacle is access to care data due to the heterogeneous system landscape (data procurement). Furthermore, data harmonization may be a challenge because of different care documentation systems (data harmonization). As a result, documented care data are often not structured or even standardized.

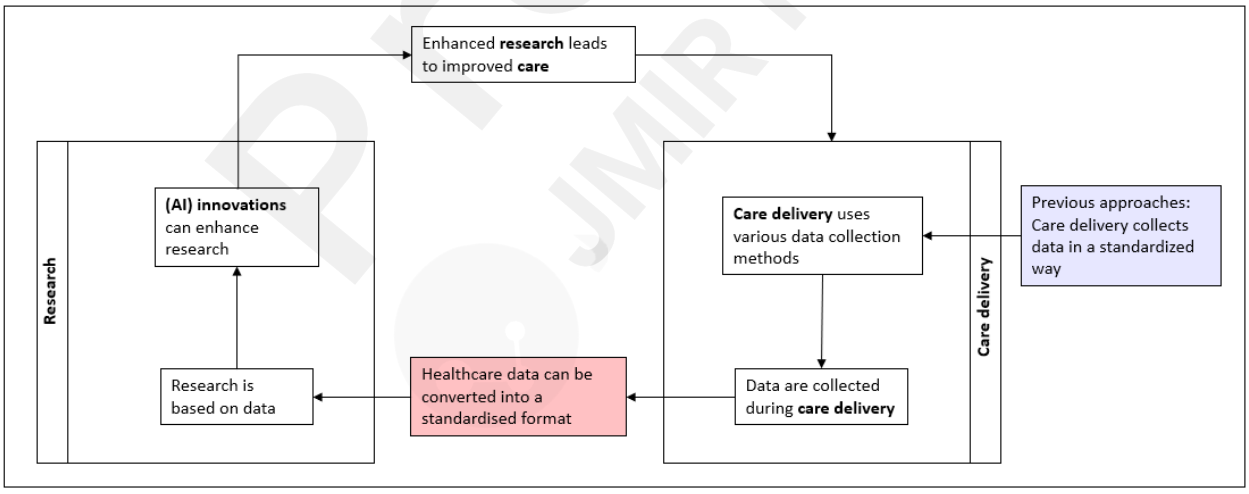

Figure 1: Nursing research, care and AI innovation cycle

Existing solutions, such as internationally recognized nursing terminologies or so-called standardized nursing languages (SNLs), aim to standardize the documentation of nursing data

by specifying certain terms, topics and terminology [9]. However, the use of standardized nursing terminology and specialist languages is not common practice across Europe. The use of structured nursing documentation varies widely between countries, and studies by Thoroddson et al. (2012) and Dos Santos et al. (2024) suggest that nursing diagnoses and interventions are used most frequently [10,11]. The general use of standardized nursing terminology is still lacking, which makes access to nursing data more difficult [10]. A cross-setting study from 2020 in the Netherlands revealed that approximately half of the 667 nurses and assistants surveyed would use standardized terminology in electronic documentation [12]. The reasons for this include burdensome documentation and the predominant use of medical terminology, which neglects the importance of nursing terminology. Other studies in this area also show that complex documentation is inefficient, consumes resources necessary to perform care measures and leads to a considerable documentation burden for nursing staff [11,13–16]. German LTC facilities took a step away from standardization towards more patient-oriented documentation in 2015 with the introduction of a law to reduce bureaucracy in care documentation [17].

Two central problems can therefore be identified: the barely structured and standardized data landscape of LTC in Germany and impracticable solutions to date, both internationally and for German LTC.

In this article, the following research questions are addressed. What conceptual, nursing and technical requirements are necessary to develop an NMDS based on existing nursing care data from routine documentation using the example of the “fall” use case? How can a minimum modular nursing data set contribute to the harmonization and integration of nursing data for cross-sectoral care and data-based research?

The conceptual and technical development of an NMDS according to the definition of an NMDS by Werley et al. (1991) for the context of LTC is presented via the “fall” use case, and its potential is discussed in terms of the challenges mentioned [18]. In addition, a possible practical application in the context of the AI-supported analysis of nursing data is presented.

1.2. Objectives

This article aims to present a new approach to enable the secondary use of nursing data without additional effort in nursing practice. To this end, the following objectives are pursued:

1. Outline the necessary steps to the development of an NMDS based on the use case "fall".
2. Describe the technical approach to systematically record fall risk factors.
3. Provide a perspective on an NMDS for data collection and the harmonization of nursing data for research purposes.

1.3. Related Work

Some related work must be taken into account when addressing the research objectives.

The German research project PFLIP[1] aims to standardize previously collected nursing data to make the data available for research and AI applications and to offer the possibility of harmonizing data across sectors [19]. This project is based on the German Medical Informatics Initiative (MII), which has developed a core medical data set on which the NMDS presented in this article is based. The results discussed here have benefitted from the PFLIP research project. National standards for standardization, fall risk assessments and interoperability were also taken into account [19,20].

With respect to the scientific foundations of fall risk assessment, the “Fall Prevention Expert Standard” guideline served as a foundation for the development of a use case. In Germany, the nursing guideline that defines best practices and quality benchmarks to ensure high standards

[1] „Definition eines Pflege-Kerndatensatzes und den Aufbau eines intersektoralen Pflegedaten-Repository“

of nursing care is called an “expert standard”. In addition to the “fall prevention expert standard”, there are guidelines for other topics, such as “wounds” and “pain management” [2].

With respect to standardization and interoperability, an organization called the “KBV”[2] in Germany publishes relevant healthcare transition documents for interoperable data exchange in a telematic infrastructure. The work of this organization is used as a basis for the development of conceptual and technical use cases [21].

To enable standardized fall data to be used on a broader basis, a suitable data format must be chosen. The *HL7® FHIR® standard* [3] is an internationally recognized framework for the exchange of health information, and its technical terminology is used by healthcare providers, software developers, and governments worldwide to improve interoperability between different systems and facilitate access to health data. The active community of *FHIR®* includes professionals from various healthcare fields who work together to further develop and implement the standard to optimize global healthcare.

2 Approach

2.1. Conceptual Standardization

A co-design approach was used to develop the content of the “fall” use case of an NMDS. Co-design, according to Sanders & Stappers (2008), is an approach that describes collective creativity throughout an entire design process. Designers collaborate to develop innovative solutions by integrating diverse perspectives and skills into the design process [22]. Within this approach, an NMDS structure was developed, and the fall use case was selected and developed in a participatory manner (Section 2.1.1). The development was supplemented by literature and document analyses and a quantitative survey of nursing staff (Section 2.1.2, Section 2.1.3).

[2] „Kassenärztliche Bundesvereinigung“

[3] HL7, FHIR and the FHIR [FLAME DESIGN] are the registered trademarks of Health Level Seven International and their use does not constitute endorsement by HL7.

2.1.1.Co-design Development of a NMDS on the "Fall" Use Case

Initially, a structure for an NMDS was designed on the basis of the MII medical core data set and the German guideline “Expert Standards of Nursing” [20,23]. The “fall” use case was selected because it is relevant to various nursing settings and is important for the LTC setting [2]. This use case was developed in collaboration with nursing staff and was considered particularly suitable as a fall event is extensively documented for insurance-related reasons; therefore, extensive data are available. Through a three-stage, interdisciplinary, participatory process, the contents of the use case were specified, and the initially broad approach was narrowed down to a minimum set of items.

The “fall prevention expert standard” served as the foundation for the use case and was initially evaluated for completeness by nursing staff during a workshop. Its content was visualized for the participants, which allowed them to prioritize the listed fall-related items according to perceived relevance and to suggest additional aspects they considered important in the context of fall prevention. Additionally, patient journey mapping was developed to understand how residents of nursing facilities navigate the nursing system, to illustrate the interfaces in the cross-sectoral documentation of a fall, and to identify additional documentation tools that provide information on the current standard fall documentation. The workshops took place in August 2022. The results were documented and graphically presented by project members. Adjustments to the use case in line with the co-design approach were made throughout the entire project.

2.1.2.Literature and Document Search

Additional international guidelines for fall events were researched on Google Scholar and in national guideline registers. Guidelines that addressed the topic of “falls” in LTC settings and among older adults were included. The guidelines were subsequently analyzed in terms of content (risk factors, interventions, outcomes). As shown in the illustration of the interfaces in

Step 2.1.1, practice documents and legal requirements were evaluated to identify current documentation of falls in nursing care. The documents were searched directly on the website of providers for transfer documents in medicine and nursing care[4] as well as an LTC facility in Germany. Finally, a targeted search for standardized nursing terminology was conducted to incorporate international standards. This included analysis of documents on the International Classification of Nursing Practice (ICNP) [24]. All documents were screened according to criteria for fall events, particularly in the context of LTC settings, with regard to older adults and included risk factors, interventions, or outcomes related to fall documentation.

2.1.3.Quantitative Online Survey

To specify the broad findings in a practice-relevant manner, the findings from Steps 2.1.1 and 2.1.2 were integrated into a quantitative online questionnaire that was created with the software LimeSurvey (Appendix 1) [25]. The aim of the questionnaire was to prioritize “fall” events identified by nursing staff. The questionnaire included demographic questions and a Likert scale on which the participants rated the relevance of various fall-related items (risk factors, interventions, outcomes). The participants also indicated whether the items mentioned had previously been documented in their care facility and, if so, whether they had been documented digitally. The questionnaire was distributed nationwide to care facilities in various settings as well as to nursing staff with different professional backgrounds and experience levels. The survey responses were descriptively analyzed and graphically presented via the software Looker Studio [26].

All participants received written information about the purpose, scope, and procedures of the questionnaire. Participation was entirely voluntary, and informed consent was obtained prior to data collection. Participants were informed that their data would be processed anonymously. No vulnerable patient groups or potentially at-risk individuals were included in the study. All

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participating institutions in the project have given their approval to the study as part of a data protection agreement, with the involvement of data protection experts. The study was conducted in accordance with the principles of the Declaration of Helsinki, the guidelines of the Council for International Organizations of Medical Sciences (CIOMS), the World Health Organization (WHO), the European General Data Protection Regulation (GDPR), the German Federal Data Protection Act (BDSG), and the Data Protection Act of the State of North Rhine-Westphalia (Landesdatenschutzgesetz NRW). As the survey data were fully anonymized and no information was collected that would allow the identification of individual participants, the study does not involve the processing of personal data as defined in Article 4(1) of the EU-GDPR. Since the study aimed to collect opinions and assessments from nurses as experts regarding fictitious fall risks derived from the literature, it does not involve interventional or experimental research on humans.

2.2. Technical Standardization

In the next step, the interim results were translated into the technical terminology of the *HL7® FHIR® standard* and made available for use in digital applications and AI-based systems.

2.2.1. Systematic Capture of Fall Risk Factors and Outcomes

To enable the broader use of the standardized fall data, HL7® *FHIR®* was chosen as a suitable data format. The methodology employed to translate the identified fall parameters into HL7® *FHIR®* involved a series of systematic processes. The focus was initially limited to fall risks that were documented digitally in our cooperating LTC facility and received more than 80% agreement on their relevance for fall detection by the nursing staff, as rated in Section 2.1.3. This restriction, including the deliberate exclusion of interventions, was made to conserve time- and effort-related resources. Initially, a thorough screening of the *FHIR®* base resources was conducted to determine which resources were most suitable to represent the identified fall

risk factors. Subsequently, existing implementation guides (IG) such as the MII core data set were searched for eligible profiles that could be used as a basis for further profiling. Subsequently, fall risk factors and fall outcomes were mapped to appropriate codes in the Systematized Nomenclature of Medicine Clinical Terms (SNOMED) [27] and the International Statistical Classification of Diseases and Related Health Problems (ICD-10) [28] to ensure that each risk factor was accurately represented in a standardized format that can be widely recognized and utilized in the healthcare industry. Finally, *FHIR*® Shorthand was used during the profiling process to create a concise, human-readable, and computable representation of the mapped fall risk factors. This significantly simplified the process of creating and maintaining *FHIR*® resources and profiles.

2.2.2. Perspective on a "Fall" NMDS for Data Collection and Harmonization of Nursing Data for Research Purposes

In addition to the systematic capture of fall risk factors, the definition of the "fall" NMDS is an important part of the reusability of the data and its structure. As discussed in previous sections, this secondary use of data plays an essential role in research on health services. These aspects are also recognized by research data networks such as the German Medical Informatics Initiative (MII), which relies on *FHIR*®. To be compatible with these structures in the future, the NMDS use case "fall" for data collection and the harmonization of nursing data was transformed to *FHIR*®.

An IG was created that provides a detailed, step-by-step manual that effectively communicates how to implement the mapped fall risk factors in *FHIR*®. The IG offers a topic-specific bundled presentation of profiles, value sets and other *FHIR*® data structures. The need for this IG is based on recognition of the complexity of healthcare data and the challenges that can arise when implementing standardized healthcare data models such as *FHIR*®.

Another argument in favor of following the example of existing research data networks is the prospect of being connected to them. Considering and incorporating the *FHIR®*-based CDS of the MII ensures that the collection of fall risk factors can be included in the research data network and made available to researchers.

3 Results

3.1. Conceptual Standardization

3.1.1. Co-design Development of a NMDS on the "Fall" Use Case

A structure was developed for an NMDS on the basis of the MII core data set. The basic modules represent items that are typically collected from all nursing home residents. The extension modules include nursing-specific events and are oriented towards “expert standards of nursing”, including the “fall” use case module (Fig. 2).

Twelve participants from the fields of management, quality management, technical application support, nursing service management, department management and members of the PFLIP research project attended the co-design workshops. Experts from the field of nursing science also played a key role in developing patient journey mapping. During this process, participants observed that while the expert standard provides valuable insights, it could be further enriched by considering additional factors to capture the full complexity of falls, leading to an expansion of the topic in Step 3.1.2. Patient journey mapping helps to identify critical interfaces, relevant documentation, and transfer forms that are essential for a comprehensive representation of fall-related processes. On this basis, a search for these documents was initiated to incorporate them into the development of the use case.

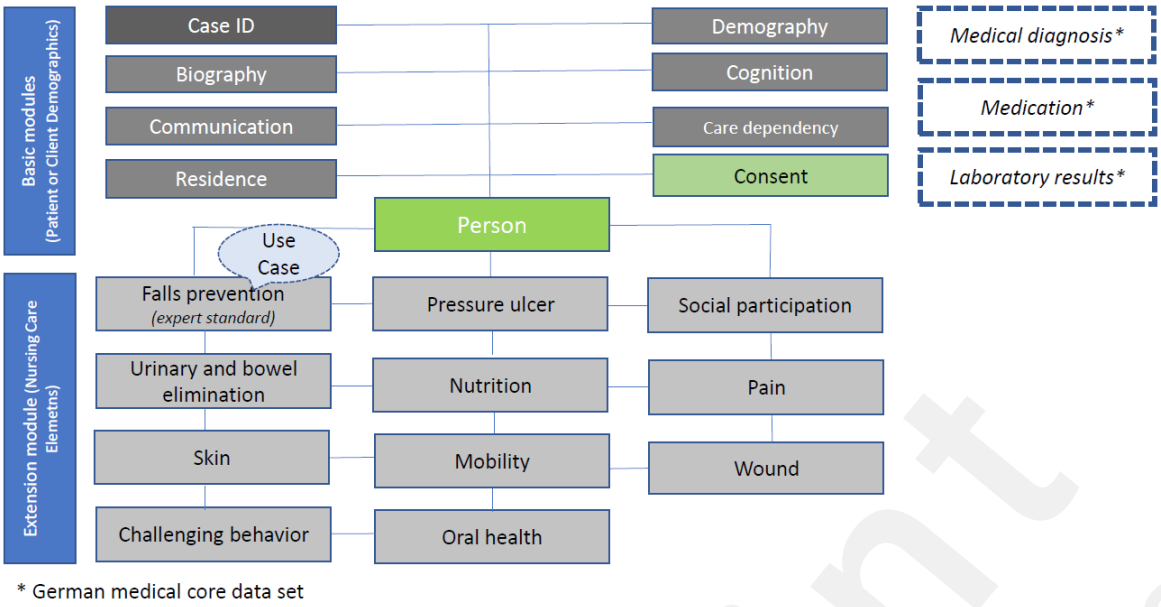

Figure 2: Draft of the Structure of a Nursing Minimum Data Set

3.1.2.Literature and Document Search

As part of the literature analysis, four additional international fall guidelines, five documents that are routinely applied in German LTC practice, six documents from a provider of transfer documents in Germany, six transfer documents from a selected LTC facility in Germany and the ICNP falls catalogue were included. Many of these documents depict fall events rather generally. Thus far, no document has comprehensively addressed falls along with associated nursing-relevant risk factors and intervention possibilities.

3.1.3.Quantitative Survey

A quantitative online survey was conducted from March 17, 2023, to July 30, 2023, with a total of 158 participants, 117 of whom identified as female. Of these participants, 63.3% were directly involved in nursing care. The participants had an average of 24.86 years of professional experience, ranging from 0.5 to 45 years. Most respondents (63 participants) worked in LTC at the time of the survey, followed by home care (37 participants) and hospital settings (14 participants).

Risk factors were identified as items in the following categories: diseases, disease-related

changes, environment, medications, and other factors. As interventions, items were identified in the following categories: physical measures, clothing adjustment measures, environmental adjustment measures, training and counselling measures, measures involving other professional groups, measures for the use of assistive devices for fall and injury prevention, the use of technology-based measures, and additional nursing measures. As outcomes, items were identified in the category of information about fall events. The results, including the identified content of the “fall” use case, are presented in Fig. 3.

"Fall" Use-Case									
Fall riskfactors									
General personal data									
Age	Gender	Fracture history	Fall history	Other					
Diseases									
Condotion after Stroke	Parkinson's Disease	Osteoporosis	Multiple Sclerosis	Mulitmorbidity	Incontinence	Cardiac Arrythmia	Overall average of diseases	Diabetes	Depression
Alcohol/ Drug/ Nicotine abuse	Dementia	Delirium (State of confusion)	COPD	Blood sugar fluctuations	Blood pressure fluctuations	Osteoarthritis	Other		
Disease-related changes									
Overweight	Confusion	Need for Support in Daily Tasks	Sensorimotor Impairment (Difficulties in Fine Motor Coordination)	Visual Impairment	Dizziness (Vertigo)	Difficulty with Multitasking	Pain	Sleep Disorder	Movement Restriction
Musculoskeletal Impairment	Cognitive Impairment	Cachexia/Malnutrition/Underweight	Hearing Impairment	Limb Amputation	Overall Average of Disease-Related Changes		Joint Paresis (Paralysis)	Gait Instability	Other
Environmental factors									
Tripping Hazards	Assistive Devices (e.g., Walker)	Inappropriate Footwear	Structural Factors (e.g., Door Thresholds)	Average Environmental Factors	Restrictive Measures	Social Environment (Relatives, Network)	Other		
Medications									
Antidepressants	Polypharmacy (Multiple Medications)	Psychotropic Drugs (Affecting the Psyche)	Average Medication Use	Antihypertensives (Blood Pressure-Lowering Medications)	Anticonvulsants (Preventing Epileptic Seizures)	Antiarrhythmic Drugs (For Treating Cardiac Arrhythmias)	Antidiabetic Medications	Diuretics (Diuretic Medications)	Other
Other Factors									
Overestimation of Abilities	Fear of falling	Inadequate Activities	Wandering Behavior	Compliance (Willingness to participate in therapeutic measures)					
Fall Prevention Interventions									
Measures for the Use of Assistive Devices									
Alarm and Sensor Systems	Low Beds	Walking Aid	Protectors						
Clothing Adjustment Measures									
Adjustment/Consultation on Footwear		Non-Slip Socks							
Environmental Adjustment Measures									
Lighting Conditions	Seating Furniture & Beds	Toilet/Shower/Bathtub	Handrails	Use of Non-Slip Materials in Wet Areas	Orientation Measures				
Training and Counseling Measures									
Training and Counseling for the Person at Risk of Falling		Encouraging Participation in Fall Prevention Programs							
Measures for Involving Other Professional Groups									
Medication Review	Vision Assessment	Nutritional Assessment	Podiatric Measures						
Use of Technology-Based Measures									
Telemedicine	Exergames	Cognitive Games	Socialized Training	Smart Home Systems	Non-Conventional Balance Training				
Other									
Documented Fall Outcomes									
Activity Before the Fall	Health Condition Before the Fall	Date	Location	Time	Immediate Cognitive Consequences	Immediate Physical Consequences	Immediate Psychological Consequences		

	> 80 % agreement on the relevance and current documentation in our cooperating LTC facility - Fall risk factors
	> 80% agreement on the relevance but currently not part of documentation in our cooperating LTC facility
	> 80 % agreement on the relevance - Interventions for fall prevention & outcomes

Figure 3: NMDS Use Case “Fall”

3.2. Technical Standardization

3.2.1. Systematic Capture of Fall Risk Factors

An overview of the risk factors considered for translation into *FHIR®* can be found in Figure 3. The objectives marked in green were considered because these received more than 80% agreement on relevance and were currently documented in our cooperating LTC facility.

When the risk factors were translated into appropriate *FHIR®* resources and existing profiles were screened, 13% of the risk factors could be mapped to the MII medication profile. With respect to risk factors that included the diagnosis of a disease, it was necessary to differentiate between a medical and a nursing diagnosis as the term “diagnosis” is protected and relevant for billing purposes in the German healthcare system. For 49% of the risk factors, the differentiation of an MII condition into a nursing diagnosis and a medical diagnosis was sufficient for representation. For 23% of the risk factors, the nursing observation profile was created, which can be used to describe an occurrence during normal nursing activities. More specific profiles were created for the remaining 15% of the risk factors, as they had more precise requirements and required differentiation. For example, the risk factor for incontinence was divided into fecal and urinary incontinence, and the necessity of a decision was included for measures involving deprivation of liberty.

3.2.2. Perspective on a “fall” NMDS for data collection and harmonization of nursing data for research purposes

At the heart of the developed IG is a questionnaire, represented by the *FHIR®* resources questionnaire and questionnaire response, which was specifically designed for the “fall” use case. The guide serves as an essential tool for ensuring consistency and accuracy in the implementation process across different systems and platforms. The response form composed of these two *FHIR®* resources allows for the systematic documentation of all fall-relevant risk factors. The IG offers a collection of *FHIR®* resources to capture previously identified risk

factors for a fall. In addition to profiles designed solely for one or a few other risk factors, three more comprehensive profiles were developed that can depict a multitude of risk factors (Table 1,2) [29].

HL7 *FHIR*® Basic Resource	**Profile Designation**
Bundle	• Multi-Morbidity (*org. Multimorbidität*)
Condition	• Medical-Diagnosis (*org. Medizinische-Diagnose*) • Nursing-Diagnosis (*org. Pflege-Diagnose*)
Observation	• Nursing-Observation (*org. Pflege-Beobachtung*) • Nursing-Observation-Urinary-Incontinence (*org. Pflege-Beobachtung-Harn-Inkontinenz*) • Nursing-Observation-Faecal-Incontinence (*org. Pflege-Beobachtung-Stuhl-Inkontinenz*) • Survey-Fall-History-6-Months (*org. Erhebung-Sturzhistorie-6-Monate*) • Deprivation-of-Liberty (*org. Freiheitsentziehende-Maßnahme*)
Device	• Aids (*org. Hilfsmittel*)
List	• Multi-Medication (*org. Multimedikation*)
Questionnaire	• Risk-Assessment (*org. Risikoermittlung*)
QuestionnaireResponse	• Risk-Assessment-Fall (*org. Risikoermittlung-Sturz*)
Patient	• Resident-Pseudonymized (*org. BewohnerIn-Pseudonymisiert*)

Table 1: Self-Defined Profiles in the PFLIP Implementation Guide

Name	**Context of Use**
VoluntaryConsentExists (*org. FreiwilligeEinwilligungLiegtVor*)	Deprivation-of-Liberty (*org. Freiheitsentziehende-Maßnahme*)
CourtOrderExists (*org. RichterlicheAnordnungLiegtVor*)	Deprivation-of-Liberty (*org. Freiheitsentziehende-Maßnahme*)
DateOfBirth_mm_yyyy (*org. Geburtstag_mm_yyyy*)	Resident-Pseudonymized (*org. BewohnerIn-Pseudonymisiert*)
FullSurveyPeriod	Survey-Fall-History-6-Months

(*org. VollständigerErhebungszeitraum*)	(*org. Erhebung-Sturzhistorie-6-Monate*)

Table 2: Extensions within the PFLIP Implementation Guide

4 Practical Application Example - An AI-Based NDSS System

An AI-based nursing decision support system (NDSS) for elderly people to predict falls in nursing homes can be used as an example of an application of the content and technology developed for our NMDS.

Developed in a user-centered design process based on ISO 9241-210-2019, the NDSS covers routinely documented aspects of falls in German nursing homes and reflects the most relevant fall-related factors from the literature and practice [30]. Nursing staff with different levels of education and specialized training, administrative employees from an outpatient care facility and day care, and people who worked in the field of nursing science were asked about the practical suitability of the proposed NDSS in four workshops. On the basis of the workshop results, the NDSS was improved iteratively. The decision support system is designed to predict the risk of falling using a five-step scale and focuses on the interpretability of AI so that predictions are comprehensible and transparent for users. Therefore, the NDSS can provide information about recognized risk factors that are responsible for corresponding fall risk. The proposed decision support system also suggests prophylaxis to reduce the risk of falling and show the progression of this risk over several months.

5 Discussion

5.1. Principal Results

The previous sections showed how a German NMDS for LTC was developed for the “fall” use case in a participatory manner and with consideration of nursing science. This NMDS was then transferred to a technical concept that can be harmonized with other systems.

The developed use case can benefit nursing research by making standardized, documented

data available for secondary use and enabling AI-supported analyses. Since the data set is based on routine documentation in nursing facilities and standardizes already documented data, it has the potential to support problems that have arisen thus far in efforts to standardize care documentation, such as a lack of manageability and the effort of documentation by nursing staff [13–16]. However, it should be noted that the data set does not automatically ensure that documented data are also transferred to standards (such as *FHIR®*). Data that are documented in other facilities and care documentation systems are not always automatically available in *FHIR®* and may be in different formats. To counteract this limitation, a system solution, such as a data repository, is needed to automatically standardize routine data. Standardization of content and technology will also facilitate the exchange of data between sectors and professions. In addition, the structural orientation towards an existing medical core data set represents a step towards harmonizing nursing and medical data. This can support the need to give nursing terminology equivalent weight in documentation as medical terminology and integrate them instead of overwriting them [9,20].

The co-design approach chosen to develop the use case indicates a way of standardizing nursing data while maintaining a high degree of user centricity. This gives this NMDS an advantage over previous NMDSs and assessment instruments. In the future, a person-centered approach can be ensured by broadening the perspective to include affected persons, i.e., residents of LTC facilities. The results in the NMDS table (Fig. 2) illustrate the differences between risk factors that are perceived as relevant by practitioners and the scientific literature and those that are documented in a German geriatric care facility. This can indicate which important fall risk factors have not yet been mapped in routine documentation, such as “environmental factors” in this case. This information highlights the need for further research.

Although the results were collected nationally, findings from other European countries demonstrate difficulties in introducing standardized care documentation systems and

standardization. This approach can serve as a model for the development of NMDSs for other countries [13–15].

The *FHIR*® translation makes the data usable for AI applications that can assess and predict falls. The IG thus serves as a valuable resource for healthcare providers and researchers alike and provides a structured and standardized approach to capturing and analyzing fall risk factors. It is hoped that the future application of this guide will contribute to the development of more effective and personalized fall prevention strategies and ultimately improve patient outcomes. The developed IG also provides a methodological basis for expanding the minimum data set to include other nursing topics in addition to falls as well as other care sectors and is internationally applicable.

5.2. Limitations

The results have several limitations. For reasons of feasibility, we focused on only one use case. In this use case, we initially focused on a limited number of risk factors that were technically implemented. In the future, we plan to expand the core data set thematically. To date, only aspects of inpatient LTC have been –examined, but we plan to extend the findings to different settings.

It can be assumed that both the participants in the co-design workshops and the participants in the quantitative survey showed a certain level of interest in and affinity for the topic. As participation was voluntary, it is possible that less-interested participants did not take part due to a participation bias.

The results are also oriented towards national standards, practical procedures and documentation in German LTC facilities. However, the procedure and methodology can be applied internationally.

6 Conclusion

The “fall” use case developed for a German NMDS in LTC shows how nursing data can be recorded in a standardized and user-centric way. The use of previously documented routine data reduces the documentation burden for nursing staff and facilitates cross-sector data exchange. This concept creates a valuable basis for nursing research by providing high-quality, structured data for secondary use. It also offers the potential for international application and can serve as a model for the development of nursing data sets in other subject areas, particularly through *FHIR®* translation for use in AI-based applications.

The IG and the profiles it contains are to be submitted for an HL7 *FHIR®* balloting. This structured mechanism is designed to solicit feedback from members of the HL7 community to ensure quality and relevance. The suggestions for changes and improvements collected in this process can be evaluated during further efforts and, if approved, can be integrated into the IG to promote the joint creation and further development of the NMDS.

6.1. Competing Interests

The authors declare that they have no competing interests.

6.2. Funding

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6.3. Authors’ Contributions

S.M. and A.S. wrote the main manuscript text. N.T. contributed to the writing of the manuscript. D.H., A.B., M.K., W.D., A.S and S.M. were involved in the conception and design of the submission as well as the substantial revision of the manuscript. C.P., K.N., Y.W., D.H., A.B., W.D., A.S., N.T., M.K. and S.M. were involved in the acquisition, analysis, or interpretation of the data. All authors approved the submission of the manuscript.

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8 Acronyms

AI	Artificial Intelligence
CDS	Core Data Set

FHIR	Fast Healthcare Interoperability Resources
ICNP	International Classification of Nursing Practice
IG	Implementation Guide
LTC	Long-Term Care
MII	Medical Informatics Initiative
NDSS	Nursing Decision-Support-System
NMDS	Nursing Minimum Data Set
PFLIP	Definition eines **Pfl**ege-Kerndatensatzes und den Aufbau eines **i**ntersektoralen **P**flegedaten-Repository
SNOMED	Systematized Nomenclature of Medicine Clinical Terms
ICD-10	International Statistical Classification of Diseases and Related Health Problems