

LEARNING

FROM

DATA

TO IMPROVE

MEDICAL CARE

IN DUTCH

NURSING HOMES

GARY Y. C. YEUNG

Learning from Data to Improve Medical Care in Dutch Nursing Homes

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VRIJE UNIVERSITEIT

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1

General Introduction

Dutch Nursing Home Context

In the Netherlands, approximately 121,000 people reside in nursing homes with long-term care needs (as of September 2025).¹ The majority of nursing home residents have psychogeriatric conditions (psychogeriatric care) that require constant supervision or functional support in daily living activities and care (eg, bathing, dressing, eating, getting in and out of bed, and moving around). Other nursing home residents require long-term care due to physical impairments caused by various medical conditions (somatic care). In addition to nursing home units for long-term care residents, most nursing homes also have special units that provide short-term care, such as respite care, post-acute hospital care, rehabilitation, or hospice care.

Dutch nursing homes have a unique medical attending position of an elderly care physician.^{2, 3} Elderly care physicians are medical specialists who have completed a 3-year medical residency program focusing solely on community-dwelling older adults and nursing home residents. In 2025, about 2,000 elderly care physicians were registered in the Netherlands.⁴ They provide 24/7 on-site medical care to nursing home residents. Depending on the size and medical staff model of the nursing home organization, they work together in physician groups that can also include nurse practitioners, physician assistants, medical residents in elderly care medicine or family medicine, and/or junior doctors. Hereinafter, they are all referred to as medical practitioners, unless otherwise specified. The medical practitioners are not only responsible for medical care but also coordinate multidisciplinary care for residents. The multidisciplinary care team in nursing homes usually consists of psychologists, dieticians, physical therapists, occupational therapists, speech therapists, social workers, and spiritual counsellors. They all work together to support the residents and care team in providing the best possible care in nursing homes.

The medical staff models in Dutch nursing homes range from elderly care physicians responsible for their nursing home units to elderly care physicians who supervise other medical practitioners and their units. Elderly care physicians also collaborate with the nursing home's board to maintain and improve the facility's quality of medical care.

Quality of Long-Term Care in Nursing Homes

A general definition of quality of care is the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with evidence-based professional knowledge.⁵ While this definition broadly applies across healthcare settings, the way quality of care is assessed can vary depending on the perspective and the purpose of the assessment.⁶⁻⁹ In nursing homes, however, this evaluation is particularly complex.⁹⁻¹¹ Nursing home residents live with a range of medical conditions and functional limitations. They rely not just on healthcare services but also on personal and social care. Consequently, desired outcomes in nursing homes can vary greatly, depending more on each resident's circumstances, expectations, and values than in other healthcare settings, such as acute hospital settings.¹⁰ This requires a person-centered approach to care that focuses on quality of life, which may not fully align with evidence-based professional knowledge.¹² Especially in situations where a trade-off exists between safety standards and quality of life, which can give rise to dilemmas to deliver 'high' quality care.^{6-8, 10, 12} For example, a nursing home resident on anticoagulant therapy who falls (frequently) and has a head injury may not be referred for imaging to rule out intracranial hemorrhage, in order to avoid the burden of a hospital transfer.

These challenges in assessing quality of long-term care were also reflected in the Dutch National Quality Framework for Nursing Home Care introduced in 2017.¹³ This quality framework aimed to strive for high-quality, safe, and meaningful care tailored to each resident's needs and preferences (ie, person-centered care), in a safe environment using a whole-system approach. It also aimed to strengthen the learning capacity within nursing homes. To achieve these aims, the framework defined essential conditions for nursing homes, including adequate and competent staffing; leadership, governance and management; effective and efficient use of resources; transparency; and a culture of continuous learning and quality improvement within care teams. To support nursing homes in learning by sharing of insights, experiences, and/or knowledge between staff members in order to foster mutual understanding and collaborative problem solving (ie, collective learning),¹⁴⁻¹⁶ the quality framework included mandatory quality indicators for nursing homes to collect. Nursing home organizations were required to reflect on their continuous learning and quality improvement processes in an annual quality report.

Since 2024, the Quality Framework has been replaced by the Generic Compass

Working Together on Quality of Existence (in Dutch: 'Het Generiek Kompas: Samen werken aan kwaliteit van bestaan'), which places an even stronger emphasis on quality of life and wellbeing.¹⁷ The Generic Compass encourages evaluating quality of care within each individual's context, focusing on what matters most to them, also in terms of outcomes and the overall contribution to quality of life. The Generic Compass applies not only to individuals with long-term care needs in nursing homes but also to those receiving care at home, regardless of age or specific needs. The Generic Compass outlines key building blocks necessary to help an individual with their care needs. These include understanding the wishes and needs each individual with care needs and creating support networks around them. Other building blocks focus on building professional networks in the community, organizing work, fostering collective learning and development, and gaining insights into quality. The last two building blocks focus especially at structures and processes that empower professionals to keep learning and improving the quality of care they deliver.

With the Generic Compass, nursing home organizations must still report on the quality of care they deliver and reflect on their learning and improvement efforts in an annual quality report (in Dutch: 'Kwaliteitsbeeld'). However, mandatory quality indicators from the previous quality framework are no longer required. As a result, nursing homes now have more flexibility to collect the data they consider most relevant for continuous learning and quality improvement within their local care context.

Learning Health System

In nursing homes, optimizing quality of care through the concept of continuous learning and quality improvement, while leveraging health care data collected in everyday practice (ie, routine healthcare data), has been becoming increasingly important even before the launch of the Generic Compass.¹⁸⁻²³ Although substantial amounts of data are registered by healthcare professionals for clinical care, the reuse of these data for quality improvement, research and policy remains limited.²⁴⁻²⁶ Given the scarcity of medical practitioners and other health care providers in nursing homes,⁴ the idea is that a learning health system can potentially contribute to quality of care by, for example, intelligent automation, positive deviance, predictive models, clinical decision support systems, surveillance systems, and comparative effectiveness research.²⁷

The concept of a learning health system is defined by the Institute of Medicine as

one in which ‘science, informatics, incentives and culture are aligned for continuous improvement, innovation, with best practices seamlessly embedded in the delivery process, [with] patients and families active participants in all elements, and new knowledge captured as an integral by-product of the delivery experience’.²⁸ Building on this definition, different frameworks exist for implementing and evaluating learning health systems in practice. At the core of most frameworks is the learning community with its continuous learning cycle. The learning community is a group of stakeholders who come together to achieve collective improvement.²⁹ Such a community may include patients, clinicians, managers, administrators, researchers, technical staff, and others. Each community member brings distinct perspectives, competencies, and experiences, all of which are crucial for the continuous learning cycle.^{30, 31} The continuous learning cycle itself consists of capturing practice in data, translating those data into knowledge, and applying that knowledge back into practice (Fig. 1).³²



Figure 1. Learning community with its continuous learning cycle (Adapted from Foley and Vale,²⁹ used under CC BY 4.0)

Capturing Practice in Data with Quality Indicators

One way to capture practice in data is with quality indicators. Quality indicators are measures that help identify potential quality gaps by comparing current practice with guideline recommendations or with the performance of other providers. They are defined as measurable elements of practice for which there is evidence or consensus that they can be used to assess and monitor the quality of care delivered.³³ Quality indicators are preferably calculated using electronic routine

care data to minimize the documentation burden for health professionals.³⁴

A widely used framework to categorize quality indicators is the Donabedian model, which distinguishes between structure, process, and outcome indicators.⁶ Structural indicators assess the organizational and resource-related conditions under which care is delivered, such as the presence of treatment protocols for staff or access to diagnostic services like laboratory testing. Process indicators evaluate whether the appropriate clinical actions and decision-making required to achieve a desired outcome are performed. Examples relevant to medical care in nursing homes include timely medication reviews or the documentation of advance care planning conversations. Outcome indicators reflect the effects of care on residents' health and well-being, such as hospitalizations, pressure ulcer prevalence, and symptom burden. However, although these outcome indicators are relevant to nursing home residents, they might offer professionals little guidance on who should act and what specific actions are needed to improve outcomes. In contrast, structural and process indicators offer more direction on which actions need to be taken to improve the indicator, while the effects on health outcomes might be uncertain. These limitations were also observed in the mandatory quality indicators for nursing homes included in the previous Dutch National Quality Framework for Nursing Home Care, of which only a few relate specifically to the work of the medical practitioner (eg, physician treatment orders, medication reviews, and involuntary care).³⁵ Most indicators reflect the functioning of the multidisciplinary care team rather than aspects fully within the medical practitioner's control (eg, pressure ulcers, care plans, nursing home's net promoter score).

Translating Data Into Knowledge for Practice Through Audit and Feedback

A way to systematically translate data into knowledge for practice is through audit and feedback. Audit and feedback involve measuring, for example, quality indicators or other professional performance systematically against explicit criteria or standards (audit) and providing this knowledge to professionals in a structured manner (feedback).³⁶ Audit and feedback have shown small to moderate improvements in quality of care.³⁷ The improvements are greater when (i) baseline performance is low, (ii) feedback is provided by a respected colleague, (iii) it includes clear targets and an action plan for changing practices, and (iv) it is provided regularly both in written reports and verbally. Most of the research on audit and feedback has been conducted outside long-term care settings, and it

is uncertain to what extent the above-mentioned conditions apply to the nursing home setting.³⁸ Studies in Canadian long-term care facilities have so far focused on written feedback delivery and showed mixed results. Physicians who engaged with performance reports showed a greater decrease in psychotropic medication prescriptions,³⁹ whereas for antibiotics, only a reduction in prolonged antibiotic prescriptions was observed.⁴⁰ Yet, another study focusing on various benchmarks and framing of the psychotropic medication feedback message found no significant differences in monthly prescriptions.⁴¹ A promising form to provide feedback is through facilitated group feedback sessions, where recipients actively engage with the feedback through social interaction with the help of a facilitator.⁴²⁻⁴⁴

Learning from Data

In the Netherlands, a national program Learning from Data (in Dutch: ‘Leren van data’) was funded in 2020 by the Ministry of Health, in which the professional association of elderly care physicians Verenso, the national health research institute NIVEL, and the department of medicine for older people at Amsterdam UMC collaborate.²⁵ The Learning from Data program aims to evolve the medical care in Dutch nursing homes into a learning health system by promoting the reuse of routine EHR data. This is achieved by working towards the standardization of routine EHR data and by integrating existing databases to enhance their use for quality improvement, research, and policy.

The existing database available from the start of the Learning from Data program contains routine healthcare data from one of the largest EHR vendors. Additionally, the ‘Registry Learning from Data in Nursing Homes’ has been established, which contains a minimal dataset including routine healthcare data from all active EHR vendors in nursing homes.²¹ The minimal dataset includes data about, for example, nursing home residents’ demographics, diagnoses, and physical and cognitive functioning.

Next to better utilization of existing routine healthcare data, the program also established a Sentinel Surveillance Network of Nursing Homes (hereafter ‘sentinel network’), in which physician groups across the Netherlands record annually in the EHR additional healthcare data on predefined topics.⁴⁵ Appropriate psychotropic prescriptions and appropriate antibiotic prescriptions for lower respiratory tract and urinary tract infections were among the first topics monitored in the network, because of their dominant clinical relevance in nursing homes. Researchers from

the Department of Medicine for Older People at Amsterdam UMC analyzed the sentinel network data to generate performance reports aggregated at the physician group level. The data are measured using national guideline recommendations as a reference and benchmarked against the other nursing homes in the network. For each participating physician group, the research team also organized a physician group feedback session as part of an audit and feedback program.

Overall Aim

The overall aim of this thesis is to investigate how the quality of medical care in Dutch nursing homes can be assessed, evaluated, and improved by using EHR data within the context of a learning health system.

Research Questions

Guided by the learning cycle within the learning health system and with medical practitioners as the main stakeholders, this thesis addresses the following questions:

- 1) Practice to Data: Which quality indicators are, according to medical practitioners, most suitable for assessing the quality of medical care in Dutch nursing homes?
- 2) Data to Knowledge: In what ways can EHR data be used to assess and evaluate the quality of medical care in Dutch nursing homes?
- 3) Knowledge to Practice: How can physician group feedback sessions translate knowledge from EHR data into practice improvements?

Thesis Outline

This thesis is structured to directly address each of the three research questions outlined above.

Chapter 2 addresses the first research question (Practice to Data) by examining which quality indicators medical practitioners consider suitable for assessing the quality of medical care in nursing homes for continuous learning and improvement. This is explored through the compilation of a set of actionable quality indicators in a Delphi study with medical practitioners. The next two chapters address the second research question (Data to Knowledge) by investigating how EHR data can be leveraged to assess and evaluate the quality of medical care. In **Chapter 3**, we used routine EHR data to evaluate the timely documentation of cardiopulmonary resuscitation codes and medical treatment preferences within six weeks of admission.

Indicators related to this were also included in the Delphi study presented in the previous chapter. **Chapter 4** used data registered by medical practitioners for the sentinel network to assess adherence to recommendations in the Dutch national urinary tract infection guideline of elderly care physicians. **Chapter 5** addresses the third research question (Knowledge to Practice) by detailing how the sentinel network feeds data back in physician group feedback sessions and investigating the extent to which physician groups are able to translate such feedback into intentions for improving clinical practice. The study analyzed transcripts of group feedback sessions from the sentinel network and identified lessons to improve future group feedback sessions and enhance collective learning. Finally, **Chapter 6** integrates and discusses the main findings of this thesis, closes the circular relation between the 3 research questions, and provides recommendations for future research and practice to further evolve the learning health system for medical care in nursing homes in the Netherlands.

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Compiling a Set of Actionable Quality Indicators for Medical Practitioners in Dutch Nursing Homes: A Delphi Study

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Abstract

Most quality indicators (QIs) currently used in nursing homes reflect the care delivered by the entire multidisciplinary team and are not specific for medical practitioners. International experts have proposed a set of QIs that specifically reflect the quality of medical care in nursing homes. The objective of the Delphi study described here was to compile a set of actionable QIs tailored for medical practitioners working within Dutch nursing homes. This was achieved through the evaluation of 15 existing national QIs and 35 international QIs by a panel of medical practitioners, comprising medical specialists, nurse practitioners, and physician assistants, who are working in Dutch nursing homes. Panelists rated each QI on (1) level of direct control by medical practitioners and (2) its relevance to the quality of medical care. QIs progressing to subsequent rounds required panel agreement on both direct control ($\geq 70\% \geq 3$ points on a 4-point scale) and relevance ($\geq 70\% \geq 8$ on a 10-point scale). In the last round, each panelist selected the 5 most relevant QIs and arranged them in order of importance. These top 5 rankings were converted into points for an overall final ranking. There was consensus on 42 QIs being under the control of medical practitioners, and 21 of these QIs were considered relevant for quality of care. Most of the 21 QIs originated from the international QI set. This finding supports the transferability of the internationally developed QIs to the Dutch nursing home context and provides opportunities to compare the quality of medical care in nursing homes across countries. In the final ranking, the QI related to new medication prescriptions received the highest rating, followed by 3 QIs related to advance care planning. Future research should focus on evaluating the feasibility of measuring the selected QIs and assessing their measurement properties before implementing them in professional learning and quality improvement initiatives for medical practitioners in nursing homes.

Introduction

One of the purposes of quality indicators (QIs) for physicians, nurse practitioners (NPs), and physician assistants (PAs) (herein collectively referred to as medical practitioners) is to provide feedback on the quality of care medical practitioners deliver. QIs are measurable elements of practice performance for which there is evidence or consensus that they can be used to assess the quality of care provided and monitor changes in quality of care.¹ Quality of care is a complex and multidimensional concept, particularly in the context of nursing homes.² The evaluation of quality of care can vary depending on the perspective and purpose of assessment.³ Katz et al.⁴ introduced a framework offering valuable insight into the quality of care from the perspective of medical practitioners in nursing homes. This framework identifies 3 components for the nursing home specialist: commitment, organizational structure, and nursing home practice competence. Assessing commitment and organizational structure can involve quantifying the extent of medical practitioners' involvement in nursing home organizations and the specific staff model they adopt. Measuring competence, defined as the ability to handle complex medical care within nursing homes through specialized training and experience, can be more challenging. Most QIs currently used in nursing homes offer a limited picture of the specific quality of care provided by medical practitioners but reflect the care delivered to the resident by the whole multidisciplinary team.⁵ For example, percentages of residents with pressure ulcers reflect more on the functioning of the overall team than the individual medical practitioner's competence.^{5,6}

In a previous international RAND Modified Delphi study,⁵ existing QIs were adapted to the AMDA Post-Acute and Long-Term Care Medicine Attending Physician Competencies⁷ and an international expert panel selected 95 QIs that could potentially measure the quality of care provided by medical practitioners in post-acute and long-term care. This set of QIs was further examined by an additional international expert panel and pilot-tested to define, operationalize, and test pragmatically from the medical record to measure the quality of care delivered by medical practitioners.⁸ The researchers retained 10 QIs as specified for collection, feasible to collect, and had good validity. Examples of retained QIs were 'if an individual is admitted to a nursing home, then a quantitative or qualitative pain assessment was completed within 30 days' or 'if an individual is admitted to a nursing home, what percentage had a discussion on goals of care or

an acknowledgment of the discussion within 6 weeks?’

Although relevant work has thus been done, it is unclear to what extent these internationally selected QIs are relevant for medical practitioners in Dutch nursing homes. Dutch nursing homes have a unique medical attending position known as the elderly care physician.⁹ Elderly care physicians are medical specialists that complete a 3-year residency program focusing solely on community-dwelling older adults and nursing home residents.¹⁰ The program is based on the CanMEDS Physician Competency Framework, which has similarities to the AMDA competencies. These medical specialists are not only responsible for the medical care of nursing home residents, and together with NPs and PAs, provide 24/7 on-site medical care in Dutch nursing homes. Elderly care physicians also collaborate with the nursing home’s board in maintaining and improving the facilities’ quality of medical care.⁹ The Dutch professional association of elderly care physicians, Verenso, develops national guidelines and QIs for nursing homes, both independently and in collaboration with other health care organizations.⁹ It is unknown if these existing national QIs are considered specific enough for the quality of care provided by medical practitioners and how relevant the internationally proposed QIs are for medical practitioners in Dutch nursing homes, especially for quality improvement.

Although QIs can serve as a valuable instrument for identifying and monitoring gaps in the quality of care, numerous facilitators and barriers have been identified in the process of quality improvement at various levels.^{11, 12} These include the medical practitioner, the team, the entire organization, and the larger health system.¹³ For example, next to engaged and supportive leadership¹⁴ at all levels,^{13, 15} an important factor that increases the feedback effectiveness is the data (eg, QI) that recipients receive,¹⁴⁻¹⁶ which should not only be clinically meaningful and relevant to the job but also under their influence (ie, actionable for recipients).^{11, 12, 17}

The purpose of this study was to compile a set of actionable QIs specifically suitable for measuring the quality of care delivered by medical practitioners in Dutch nursing homes by evaluating existing national and international QIs. These QIs should be appropriate for use by medical practitioners in quality improvement projects.

Methods

Study Design

A Delphi study consisting of 3 online survey rounds was conducted between October 2022 and February 2023. As reviewed by Boukdedid et al.,¹⁸ the Delphi design is used frequently for selecting QIs. We followed their recommendations for reporting on Delphi studies in this article. Fig. 1 presents an overview of all steps taken in this study. A steering committee was responsible for the daily execution of the study, which included recruiting panelists, designing the questionnaires, analyzing the responses, and formulating the feedback summaries. The committee consisted of G.Y.C.Y. and M.S., both physicians with clinical experience in nursing homes, and K.J.J., an epidemiologist and health scientist. This study was reviewed by the Medical Ethics Review Committee of Amsterdam UMC, which confirmed that the Medical Research Involving Human Subjects Act (WMO) did not apply to this study (reference number 2022.0482). Informed consent was acquired digitally when medical practitioners completed the online registration form.

Selection of Potential QIs

To compile our set of potential QIs we used the following international and national sources:

As the international source we used the previously mentioned internationally selected set of QIs that had been used to operationalize and pilot test medical provider QIs that could be derived from nonexpert review of the medical record. We selected the same 37 QIs that were operationalized for data collection by the researchers for further examination.¹⁹ Our steering committee translated these international QIs into Dutch. Afterward, a professional native English translator performed a backward translation, which was reviewed by G.Y.C.Y. and M.S. to make final adaptations to the translated QIs.

The national sources for QIs in this study were the Dutch professional association of elderly care physicians Verenso²⁰ and the Dutch national quality framework of long-term care.²¹ We extracted all QIs (n = 94) listed in the quality framework or in the guidelines developed and/or endorsed by Verenso. G.Y.C.Y. and M.S. screened these QIs independently on the potential to specifically reflect medical practitioners’ quality of care. Discrepancies were resolved through discussion to reach consensus.

Because the QIs were derived from different sources there was partial overlap

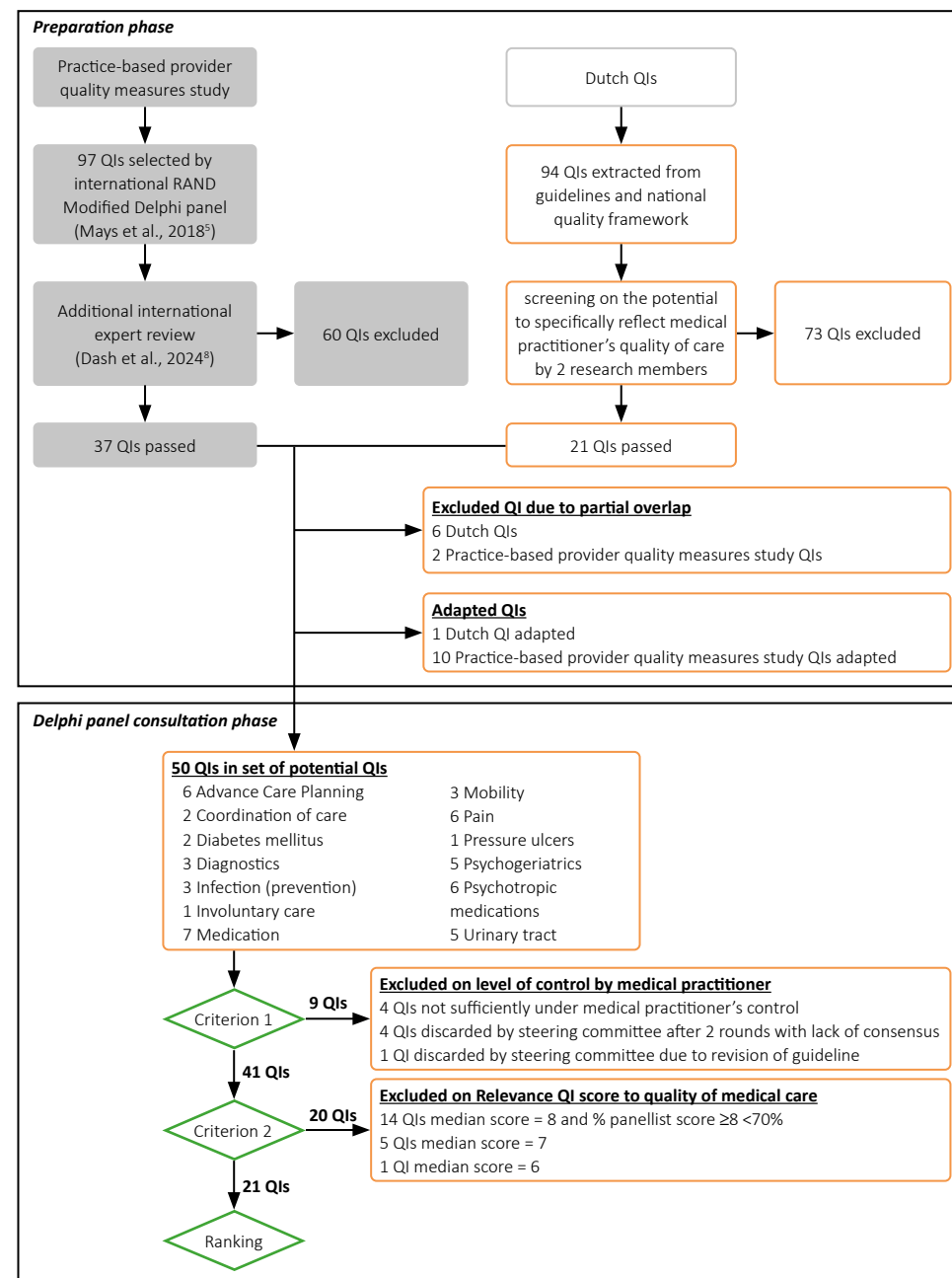


Figure 1. Flow chart Delphi study. In grey, work performed in previous studies.

among QIs. In such cases, G.Y.C.Y. and M.S. adapted these QIs or merged them into a single QI, based on clinical experience. The identified potential QIs fell into one of the following domains: advance care planning (ACP), coordination of care, diabetes mellitus, diagnostics, infection (prevention), involuntary care, medication, mobility, pain, pressure ulcers, psychogeriatrics, psychotropic medications, and urinary tract. A total of 50 potential QIs were selected and evaluated in this study (see Supplementary Material 1 and Supplementary Tables 1 and 2 for more information).

Delphi Panel

A convenience sample of elderly care physicians, NPs, and PAs participated in our Delphi panel. Medical practitioners were required to have worked in a Dutch nursing home within the past 2 years. Those who were at least 1 year in a Dutch training program for elderly care physician, NP, or PA were also invited to participate. The Dutch academic networks in medicine for older people²² and the professional associations of the different medical practitioners supported the recruitment of panelists through digital mailing and social media platforms. The online registration opened 1 month before the first questionnaire round was launched and closed on its final day. The registration form contained screening questions on our eligibility requirements, and only those meeting the requirements could complete the registration form and were invited for round 1. Practitioners who completed round 1 were included as panelists and invited for the subsequent rounds. The members of our research team did not participate in the panel.

Questionnaire Rounds

Each round was open for 21 days. Panelists were offered the possibility of requesting an extended deadline if needed. Between the questionnaire rounds, there was a month for analysis and pilot testing of the next round's questionnaires. Medical practitioners and researchers not involved in the study tested the questionnaires by verbalizing their thoughts as they filled in the questionnaire (ie, thinking-aloud method).²³ Each Delphi round took approximately 40 minutes to complete. In each round, nonresponders received up to 3 reminders per e-mail. Survalyzer (Survalyzer AG) was used to create and distribute the questionnaires. To minimize any bias due to the order in which QIs were presented to panelists, Survalyzer randomized per panelist the order of the QIs (on domain level in the first 2 rounds).

In round 1, we collected demographic data of the panelists (eg, age, gender,

working experience) as background information and asked the panelists to evaluate the level of direct control they had as a medical practitioner over each QI on a 4-point scale (Not-Somewhat-Quite-Completely) as the first criterion. Because we are seeking actionable QIs, it is vital that the panelists believe they have sufficient direct control over the QIs as medical practitioner. Panelists could write down suggestions for rephrasing QIs and propose additional existing QIs to be included in the next round as potentially relevant.

In round 2, we asked panelists to evaluate the second criterion: the relevance of each QI on a 10-point scale from 1 (not relevant) to 10 (very relevant). Relevance was assessed with the question: *As a medical practitioner, how important is a good score on the proposed QI for the quality of medical care?* To assist panelists in rating this second criterion, they were instructed to consider the following sub-questions: *How often does the subject to which the QI relates occur in your daily practice? What is the possible impact on the quality of delivered care for the individual patient if scored well or bad on the QI? What opportunities are available to improve?*

In round 3, we asked panelists to select the 5 most important QIs out of the remaining QIs and rank them in order of importance.

If panelists could not provide an informed professional opinion about a QI, there was an option to answer 'cannot assess' in the first 2 rounds. These responses were not included in the calculation for consensus on the specific QI. Also, in the first 2 rounds, panelists were explicitly instructed not to take measurement feasibility into account, because this could potentially discard important yet unmeasurable QIs.²⁴

Analysis

Consensus on criterion 1 was defined as at least 70% of the panel rating the QI quite or completely under the medical practitioner's control (score ≥ 3). If at least 70% of the panel rated the QI as not or somewhat under their control (score ≤ 2), then the QI was discarded. As there is no clear consensus on the level of consensus that should be reached in Delphi studies,¹⁸ the decision to use 70% as a priori cutoff score was based on previous Delphi studies on QIs that used this cutoff.^{24, 25} If no consensus was reached, the QI returned for reevaluation in round 2 with the rating results and a summary of the supporting and counterarguments of the panel. The steering committee wrote the summaries. For QIs with no consensus on criterion 1 after round 2, the steering committee had the final decision to retain or discard after reviewing all responses.

For the analysis in rounds 2 and 3, we followed a similar approach as described in previous studies.^{26, 27} Consensus on criterion 2 was defined as at least 70% of the panel rating the QI ≥ 8 and less than 30% ≤ 3 . These QIs were retained for round 3. All other QIs were discarded.

For the final ranking in round 3, we used every panelist's top 5 QIs. If a QI was ranked first by a panelist, it received 5 points, the second 4 points, the third 3 points, and so on. QIs that were not listed received 0 points. Next, the total score for each QI was calculated and then the QIs were ranked from highest to lowest.

To determine whether the medical background of the panelists influenced the results, a post hoc analysis was conducted to compare the rating results between the subgroups of professionals, with the NPs and PAs (including those in training) analyzed as the group of advanced practitioners vs the group of physicians.

Analyses were carried out using SPSS 28.0 (IBM Corp).

Results

Panel Composition

Initially, 115 medical practitioners registered to participate in our Delphi study and were invited to round 1. Ninety-two practitioners completed round 1 (80%, 92 of 115) and were invited as panelists for the subsequent rounds. The response rate in round 2 was 74% (68 of 92) and round 3 was 67% (62 of 92) (Supplementary Table 3). Fifty-three panelists completed all 3 rounds (58%; 53 of 92). Table 1 lists the composition of the Delphi panel.

Criterion 1: Level of Direct Control

After 2 rounds, 8 of the 50 QIs were discarded on criterion 1. Four QIs were judged not sufficiently be under the direct control of the medical practitioner (Supplementary Table 4: QID1-4). Arguments provided by the panel indicated that these QIs are driven by the scope of practice of other professionals in the nursing home. For instance regarding the assessment of vision, hearing, and dentition (Supplementary Table 4: QID2), panelists found nursing staff and/or opticians, hearing aid specialists, and dentists more in the lead.

The steering committee discarded 4 QIs after 2 rounds because of a lack of consensus and because the panel provided similar rationales to QIs that had already been discarded (Supplementary Table 4: QID6-9). Panelists remarked for instance that dietitians and psychologists played important roles in treating

Table 1. Delphi panel composition

Characteristics, or response rates	Panelists N=92
Medical background, n (% of N)	
Elderly Care Physician	27 (29)
Elderly Care Physician resident	8 (9)
Nurse practitioner (NP)	28 (30)
NP student	3 (3)
Physician assistant (PA)	25 (27)
PA student	1 (1)
Women, % of N	80
Age, median years (range)	50 (27-70)
Years of experience in NH, median (range)	5 (1-33)
Experience as medical practitioner, % of N	
Psychogeriatric ward	91
Somatic ward	89
Special NH wards	32
Rehabilitation and other short-stay wards	57
Active practitioner in NH, % of N	92
Work hours, median per week (range)	32 (2-40)
Response rates, n (% of N)	
Completed only round 1	15 (16)
Completed round 1 and another round	24 (26)
Completed all 3 rounds	53 (58)

NH = Nursing home; Somatic wards = wards for NH residents with primarily physical health conditions/needs; Special NH wards = wards specialized for NH residents with specific health conditions, for example: Huntington, Korsakoff, or Parkinson.

residents with involuntary weight loss (Supplementary Table 4: QID6) or dementia (Supplementary Table 4: QID8). In addition, because of guideline changes on pressure ulcer treatment,²⁸ the steering committee found one QI to be irrelevant and discarded it after round 1 (Supplementary Table 4: QID5). Thus, in total 9 QIs were discarded.

Following panelists' suggestions in round 1, 2 QIs were rephrased to better align with current practices and panelists were asked to reassess these rephrased QIs on criterion 1 in round 2. The antibiotics in QIR17 were changed to the latest guideline recommendations for catheter-associated urinary tract infection (UTI) and in QIR14 only the forms of involuntary care that, by law, require a medical practitioner's

Table 2. Ranking result of round 3

Domain (Source)	Quality Indicator	Round 1			Round 2			Round 3					
		Criterion 1			Criterion 1			Criterion 2			Final Ranking Score		
		n	%≥3	Result	n	%≥3	Result	n	Median	%≥8	%≤3	Result	Score
Medication (ACOVE-3)	Q1R1. If an NHR is prescribed a drug, then the prescribed drug should have an indication or target symptom clearly stated in the medical record or order	92	87	Retain	-	-	-	68	9	81	1	Retain	115
ACP (ACOVE-3, NH 2004)	Q1R2. If an NHR has documented treatment preferences to withhold or withdraw life-sustaining treatment (eg, DNR order, no tube feeding, no hospital transfer), then these treatment preferences should be followed or the record should document why the treatment preferences were not followed	*			68	96	Retain	68	9	93	1	Retain	92
ACP (NH 2004)	Q1R3. If an NHR has a long stay (≥ to 90 days), then within 6 weeks of admission, the patient's chart should document a discussion regarding preferences for life-sustaining treatments or a reason that discussion did not occur	92	92	Retain	-	-	-	67	9	93	0	Retain	91
ACP (Kwaliteitskader)	Q1R4.† Percentage of clients on the unit for whom treatment preferences regarding the end of life have been recorded in the care file	91	93	Retain	-	-	-	68	10	96	0	Retain	84
Psychogeriatrics (ACOVE-3)	Q1R5. If an NHR has suspected or definite diagnosis of delirium, acute confusional state, or reduced level of consciousness, then there should be a documented attempt to identify a potential etiology	92	97	Retain	-	-	-	68	9	90	1	Retain	74

Table 2. Continued

Domain (Source)	Quality Indicator	Round 1			Round 2			Round 3					
		Criterion 1		Result	Criterion 1		Result	Criterion 2		Result	Final Ranking Score		
		n	%≥3		n	%≥3		n	Median			%≥8	%≤3
Psychotropic medications (AGS Choosing Wisely 2014)	QIR6. If an NHR is prescribed a high-risk psychotropic medication such as an antipsychotic, benzodiazepine, or sedative hypnotic, for insomnia, agitation, or delirium, then there should be documentation that other alternatives including behavioral and environmental interventions have been tried and were not effective	91	90	Retain	-	-	68	8	76	0	Retain	62	
	QIR7. If an adult is admitted to a nursing home, then the PCP should participate in a discussion to establish goals of care within 6 weeks. If neither the resident nor family participates in planning goals of care, then the reason should be clearly documented	88	90	Retain	-	-	66	8	76	3	Retain	58	
Urinary tract (AGS Choosing Wisely 2014)	QIR8. If an NHR has bacteriuria, then antimicrobials should be prescribed only when symptoms of UTI are present	92	91	Retain	-	-	68	9	96	0	Retain	48	
Pain (ACOVE-3; Verenso)	QIR9. ‡ If a nursing home resident with chronic pain has moderate to severe pain (score 6 or higher on a scale of 0-10 or similar measurement), a pain treatment plan should be in place	92	84	Retain	-	-	68	8	79	1	Retain	40	
Coordination of care (ACOVE-3)	QIR10. † If an NHR is discharged from a NH to home, then the discharge summary should be completed and forwarded to the general practitioner within 2 weeks of the discharge	82	84	Retain	-	-	63	9	87	3	Retain	35	
Psychotropic medications (Kwaliteitskader)	QIR11. † Is the use of psychotropic as needed medications evaluated structurally?	91	89	Retain	-	-	68	8	72	1	Retain	35	
Pain (ACOVE-3)	QIR12. If an NHR is started on new opioid therapy for persistent pain, then efficacy and side effects should be assessed within 1 week	92	92	Retain	-	-	68	8	82	0	Retain	33	
Coordination of care (ACOVE-3)	QIR13. ‡ If an NHR is treated at an emergency department or admitted to a hospital, then there should be documentation by the PCP of the outcome within 7 days of the patient's return	89	83	Retain	-	-	67	9	87	1	Retain	33	
Involuntary care (Kwaliteitskader)	QIR14. †, ‡ Percentage of clients on the ward who have undergone 1 or more of the following forms of involuntary care. Subdivided into categories O Administration of fluids, nutrition, and medication, medical procedures, and therapeutic interventions; O Restricting freedom of movement O Seclusion	90	72	Retain\$	67	81	Retain	67	8	76	3	Retain	32
Psychogeriatrics (NH 2004)	QIR15. If an NHR has depression, then he or she should be treated for the depression	92	84	Retain	-	-	67	8	78	4	Retain	23	
ACP (ACOVE-3; NH 2004)	QIR16. If an NHR has an advance directive on admission, then PCP is responsible for documentation in the medical chart upon admission	91	86	Retain	-	-	68	9	81	4	Retain	18	

Table 2. Continued

Domain (Source)	Quality Indicator	Round 1			Round 2			Round 3					
		Criterion 1			Criterion 1			Criterion 2					
		n	%≥3	Result	n	%≥3	Result	n	Median	%≥8	%≤3	Result	Final Ranking Score
Urinary tract (Verenso)	QIR17. † The percentage of patients with indwelling urinary catheters who have a complicated UTI who are given oral Augmentin, co-trimoxazole or ciprofloxacin	85	66	No consensus§	68	90	Retain	68	8	78	1	Retain	15
		91	92	Retain	-	-	-	67	9	82	3	Retain	14
Pain (Verenso)	QIR18. † Percentage of patients with pain who are treated with opioids and have been prescribed laxatives												
Psychogeriatrics (AMDA Choosing Wisely)	QIR19. If an NHR has advanced dementia, then the PCP should not recommend the insertion of a percutaneous feeding tube	90	83	Retain	-	-	-	63	9	71	8	Retain	14
		91	87	Retain	-	-	-	68	8	71	4	Retain	13
Psychotropic medications (AGS Choosing Wisely 2014)	QIR20. If the PCP plans to discontinue high-risk psychotropic medication including benzodiazepines, sedative hypnotics, antipsychotics, then there should be documentation of gradual dose reduction												
Pain (Verenso)	QIR21. † Percentage of patients with pain who receive classic nonsteroidal anti-inflammatory drugs and who have been prescribed a proton pump inhibitor	92	82	Retain	-	-	-	65	8	74	2	Retain	1

ACOVE-3, Assessing Care Of Vulnerable Elders 3 QI 2007²⁹; AGS Choosing Wisely 2014, American Geriatric Society Choosing Wisely 2014³⁰; AMDA Choosing Wisely³¹; Kwaliteitskader, Dutch national quality framework of the long-term care³²; n, number of panelists scored; NH 2002, Nursing Homes Indicator 2002³²; NH 2004, Nursing Homes Indicator 2004³²; NHR, nursing home resident; PCP, medical practitioner; Verenso, QI from Dutch guideline of elderly care physicians^{34,35}; -, not applicable.

* Not scored in round 1, because accidentally omitted in round 1's questionnaire.

† Dutch QI. ‡ QI adapted for this Delphi study. § QIR rephrased after round 1's comments (rephrased QI reported).

involvement were maintained. Thus, after 2 rounds, the panel reached consensus on 41 QIs that were deemed to fall under the direct control of medical practitioners in nursing homes (Table 2: QIR1–QIR21 and Supplementary Table 4: QID10–29).

Criterion 2: Relevance to Quality of Medical Care

Of the QIs that the panel considered to fall under the direct control of medical practitioners, there were 20 QIs that were rated on relevance below our predetermined consensus criteria and therefore discarded (Supplementary Table 4: QID10–29). A wide range of arguments were provided by panelists as to why a QI was considered (not) relevant. Ranging from ‘In my opinion, hardly happens anymore, so not really relevant in the Dutch setting’ (panelist X on Supplementary Table 4: QID29) to ‘Essence of the profession’ (panelist Y on Table 2: QIR3). For 21 QIs, the ratings showed consensus on relevance to score well on the proposed QI as a sign of good medical care (Table 2). These QIs were retained in the last round.

Final Ranking

Table 2 presents the final ranking of the 21 QIs based on each panelist's top 5 selections in the last round. The highest-rated QI was about documenting new medication prescriptions (Table 2: QIR1-If a nursing home resident is prescribed a drug, then the prescribed drug should have an indication or target symptom clearly stated in the medical record or order). Following this, there were 3 QIs related to ACP (Table 2: QIR2-If a nursing home resident has documented treatment preferences to withhold or withdraw life-sustaining treatment [eg, Do-Not-Resuscitate order, no tube feeding, no hospital transfer], then these treatment preferences should be followed or the record should document why the treatment preferences were not followed; IQ3-If a nursing home resident has a long stay [≥90 days], then within 6 weeks of admission, the patient's chart should document a discussion regarding preferences for life-sustaining treatments or a reason that discussion did not occur; QIR4-Percentage of clients on the unit for whom treatment preferences regarding the end of life have been recorded in the care file), and the fifth highest rated QI focused on documenting efforts to identify the potential cause of a (suspected) change in mental status/level of consciousness in nursing home residents (Table 2: QIR5-If a nursing home resident has suspected or definite diagnosis of delirium, acute confusional state, or reduced level of consciousness, then there should be a documented attempt to identify a potential etiology).

Post Hoc Analysis

Post hoc analysis comparing physicians with advanced practitioners showed that differences on the level of direct control (criterion 1) were limited to 9 QIs in which one of the subgroups did not reach consensus on a QI, whereas the other subgroup reached consensus to retain/discard (Supplementary Table 5). Two QIs were discarded by the complete panel's rating on relevance to quality of medical care (criterion 2), and at the subgroup level, the QIs would have been retained for selection in the final ranking round (Supplementary Table 6). Comparing the top 5 QIs in the final ranking across subgroups showed that almost the same QIs were present, but their order varied somewhat (Supplementary Table 7).

Discussion and Implications for Practice and Research

In this online Delphi study, an expert panel of medical practitioners in Dutch nursing homes evaluated 50 existing QIs and consensus was reached on 2 criteria for a total of 21 QIs. Evaluating the level of direct control and relevance to quality of medical care is an important step to identify actionable QIs that accurately reflect the quality of medical care and are fit to use for quality improvement by medical practitioners. QIs perceived by practitioners as beyond their control but relevant for medical care or under the responsibility of others are much less likely to contribute to practitioner's own learning and improvement.¹²

The 21 selected QIs cover various domains in nursing home care, with a high number of them being related to medication prescriptions and ACP. It is not surprising that QIs related to medication and ACP were rated highest. In essence, medical practitioners in nursing homes are considered responsible for all medications prescribed to their nursing home residents.³⁶⁻³⁹ Moreover, ACP is considered an important aspect of nursing home care, particularly by elderly care physicians.⁴⁰ These indicators can give practitioners insight into their own practice and allow them to compare themselves with others and might help reduce unnecessary practice variations.

Before these QIs can be implemented in practice, additional steps are required. For example, to reduce the registration burden, the focus is on operationalizing the 21 selected QIs so that they can be automatically reported from electronic health record data. The suggestions gathered in this study on rephrasing certain QIs already serve as valuable input. Other steps include assessing the measurement feasibility and psychometric properties. This will be particularly useful for related

QIs in the same domain (eg, ACP) to provide additional information on which one can be most useful for clinical practice.

Most of the selected QIs originate from the international practice-based provider quality measure set, which supports the transferability of these internationally developed QIs. Three of the selected QIs (Table 2: QIR7 on ACP, QIR12 on pain, QIR13 on coordination of care) have already demonstrated good measurement feasibility and face and construct validity during the aforementioned pilot test in North American nursing homes.⁸ Countries incorporate medical care differently in their nursing home models, yet they all are faced with a rising demand for nursing home care and limited availability of staff, funding, and resources.⁴¹ Further research on international QIs provide opportunities to compare the quality of medical care across countries and to learn from the observed differences.

The strength of this study is the large number of experts who participated. As with any Delphi study, the consensus results are dependent on the composition of the Delphi panel and another group of experts could generate different results.¹⁸ To gather as much input and support as possible, we included not only physicians, but also NPs and PAs as experts. It was important to consult them all, because these professionals work together to provide the best medical care to nursing home residents and therefore are the intended users of these QIs. Because 92% of our panel consisted of active nursing home medical practitioners, the results likely serve as a good reflection of the face validity of the QIs within the workplace. The post hoc analysis showed minimal differences in the ratings between physicians and advanced practitioners.

A limitation in this study is the number of QIs that the panel needed to rate. To minimize panelist burden, the steering committee discarded certain QIs they deemed as not specific enough for the Dutch medical nursing home care. One may be worried that the pre-filtering of QIs may lead to selection bias. To ensure we did not omit relevant QIs, panelists were asked in round 1 to report any QIs they felt were missing from the presented set. No explicit existing QI was mentioned. An interesting suggestion made by several panelists was to include patient-reported outcome/experience measures (ie, PROMs/PREMs). To our knowledge, there are currently no PROMs/PREMs available that specifically measure medical practitioners' quality of medical care in nursing homes and are used for quality improvement.^{42, 43} Further research should assess suitability of existing PROMs/PREMs that are already implemented in other health care settings as QIs for quality improvement.

Conclusions

A panel of medical practitioners has identified a set of 21 existing QIs that they agreed are both under their direct control and relevant to the quality of medical care in Dutch nursing homes. The panel ranked QIs related to medications and ACP the highest. Most of the selected QIs have been developed in previous international studies, supporting the relevance of these international QIs across countries. Further work on these 21 QIs will be necessary before medical practitioners in nursing homes can effectively use them as tools for quality improvement. Involving medical practitioners in this stage of development and knowing that these QIs are considered relevant and actionable by medical practitioners may contribute to the successful development and future implementation of the QIs in professional learning and quality improvement programs for medical practitioners in nursing homes.

Disclosures

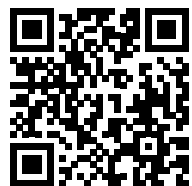
The authors declare no conflicts of interest.

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Supplementary Materials

Supplementary materials are available online at <https://doi.org/10.1016/j.jamda.2024.105089>



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Timely Documentation of CPR Codes and Medical Treatment Preferences in the EHRs of Nursing Homes

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Abstract

Context: Timely documentation of cardiopulmonary resuscitation (CPR) code and medical treatment preferences in electronic health records (EHR) is important for translating advance care planning conversations into actionable medical orders.

Objectives: To examine documentation rates of CPR code and medical treatment preferences within the recommended first six weeks of admission in Dutch nursing homes (NHs) from 2017 to 2022.

Methods: This retrospective cohort used EHR from 74 Dutch NHs. We assessed the prevalence of documented CPR codes and medical treatment preferences within six weeks of admission, and the median days until first documentation. To examine whether timely documentation odds improved annually, logit generalized estimating equation models -accounting for clustering of residents within NHs—were used, stratified by NH care type, and adjusted for resident factors.

Results: We included 163,180 residents. CPR code and medical treatment preferences was documented within 6 weeks of admission for 88% and 64% of the residents, respectively. The median time to first documentation were 0.5-2 days across care types. Overall, between 2017 and 2022, timely documentation of CPR code increased from 82% to 92% and for medical treatment preferences from 56% to 70%. Recent admission year was associated with higher odds of timely documentation for both type of orders in psychogeriatric and somatic care, and for CPR in rehabilitation care.

Conclusion: Most residents had documented CPR code and medical treatment preference within the recommended six weeks of admission, with rates improving from 2017 to 2022. The improvement coincided with a national quality indicator introduced in 2018 and the COVID-19 pandemic.

Introduction

One of the foundations of nursing home (NH) medicine is considered advance care planning (ACP),¹⁻³ which is a process for understanding residents' personal values, life goals, and preferences regarding future medical care through conversations with resident and their representative.⁴ ACP is a dynamic process, especially when the health of NH residents deteriorates, their preferences will likely change over time. ACP aims to ensure that people receive medical care consistent with their values, goals, and preferences even in situations when they become incapable of making care decisions.⁵ Therefore, it is important to document ACP conversations in the electronic health record (EHR) to enable healthcare providers to provide patient-centered medical care.⁶⁻⁸ Documenting specific physician treatment orders (PTOs) in the EHR is useful in translating the outcome of ACP conversations into actionable medical orders.

One of the most well-known PTOs is the cardiopulmonary resuscitation (CPR) code (eg, Attempt CPR or Do-Not-Attempt-Resuscitation). Another important PTO in NHs is about medical treatment preferences, which are classified into three categories: 1) Full treatment, which has the goal of curing or influencing disease in such a manner that a person will have a normal life expectancy; 2) Limited treatment, which focuses on the quality of life as the main outcome of medical care; and 3) Comfort measures only, which focuses on symptom management and explicitly foregoing life-prolonging medical interventions.^{9,10}

In the Netherlands, multidisciplinary guidelines and best practices are making ACP an increasingly standard care practice.¹¹⁻¹⁴ Qualitative studies conducted in Dutch nursing homes revealed that ACP was typically initiated by physicians shortly after admission.^{15,16} Although there were variations in approaches, it was standard practice to discuss medical treatment preferences and make decisions regarding CPR and hospitalization.¹⁵ Another study showed that between 2010 and 2013, 74% of newly admitted residents in Dutch NHs had at least one documented PTO within 6 weeks of admission.¹⁷ The lack of documented information can be problematic from a quality of care and patient safety perspective, particularly in medical emergencies when residents may be unable to express their preferences. It is unclear whether and how documentation rates after 2013 might have changed in Dutch nursing homes. Since 2018, as part of the set quality indicators (QIs) of the Dutch quality framework of NHs, required Dutch NHs to report annually to the National Health Care Institute the point-prevalence of residents with at least

one documented PTO per NH location.¹⁸ Other mandatory QIs covered topics on pressure ulcers, medication incident meetings, resident's medication reviews, involuntary care, the use of EHR, the annual quality report, and the NH's net promoter score. The quality framework and QIs are aimed to strengthen the learning capacity within the NH.¹⁹ The data and QI are not a goal in itself, but a means to support quality improvement. NHs are required to reflect on their learning and quality improvement processes in their annual quality report, which must be publicly accessible on the NH website. The annual quality report serves as input for the dialogue between NH organization and the regional care office, which is responsible for funding, contracts, and overseeing the availability and quality of NH care in the Netherlands. In addition, during the COVID-19 pandemic, there was an increased focus on ACP.²⁰ Additional guidelines for ACP conversations were developed and documentation practices changed.^{11, 16, 21} More recently, in 2023, a new national multidisciplinary ACP guideline in the Netherlands recommends initiating ACP within 24 hours after NH admission by assessing the existing wishes and agreements, and this process is continued within 6 weeks, ensuring that all involved parties have a clear understanding of the resident's wishes and goals,¹² a timeframe consistent with international ACP quality indicators.^{12, 22}

The aim of this paper is to examine documentation rates for CPR codes and medical treatment preferences within the recommended first six weeks of admission in Dutch NHs from 2017 to 2022.

Methods

Study Design and Setting

A retrospective cohort study was performed using pseudonymized routine EHR data from Gerimédica, an EHR vendor specialized in the Dutch long term care. Their EHR, Ysis, is one of the most widely used systems in Dutch NHs for documenting both inpatient and outpatient medical care.²³ This study was reviewed by the medical ethics committee of Amsterdam UMC and obtained a waiver of consent (no. 2016.516).

Study Sample

The study period was defined from January 2017 to July 2022, covering one year before the introduction of the national ACP quality indicator in 2018, and extending up to two years after the onset of the COVID-19 pandemic. To form our study

sample, Gerimédica extracted all active records during the study period to create the EHR database population (N = 348,341). We excluded individuals that were registered only on outpatient departments, a waiting list, or care units for people with intellectual disability (n = 84,592), residents with an admission date before January 1st, 2017 (n = 30,355), residents with admission date past July 1st, 2022 (n = 2071), and residents with an unknown type of inpatient NH care (n = 44,391). Also residents with unrealistic EHR dates (ie, admission date prior to birth date (n = 5), deceased date prior to admission date (n = 32), and year of birth <1910 (n = 29)) were excluded. Since the study focuses on older NH residents, residents with age at admission below 65 (n = 16,009) were excluded. One NH organization had approximately 900 annual admissions during the period 2017–2019 and doubled to approximately 1800–2000 annual admissions beginning in 2020. These numbers were considered unrealistic and assumed to reflect administrative (re-)enrollment of residents to the EHR. Therefore, this organization was excluded from the study sample (n = 7,675). Since missing data were minimal (gender n = 2), only complete cases were included. The final study sample consisted of 163,180 residents of 74 NH organizations.

For residents with multiple NH admissions, for instance, rehabilitation stays with discharge to home after different hospital admissions, the most recent NH admission was included as a new admission.

Documentation of PTOs

Primary outcomes were the rate of first documented CPR code and treatment preference within six weeks of admission. Data were derived from the PTO tab in the EHR containing structured fields with fixed-choice options for CPR code (attempt CPR / Do-Not-Attempt-Resuscitation), and medical treatment preferences (full treatment/limited treatment/comfort measures). Each structured field is accompanied with a manual date field and a free text field for additional comments. None of these fields in the PTO tab are mandatory. In this study, a PTO was defined as documented when at least one of the structured options was selected or free text field was filled.

Whenever the medical provider saved the PTO tab, the EHR automatically logged the calendar date (ie, time-stamp). The interval in days between admission and documentation of PTO were calculated by subtracting the date of the time-stamp from the admission date. This interval could be negative for cases with

readmissions in the same NH organization where the PTO of a previous stay was not actively overwritten at readmission. In case of a negative value, we assumed that the medical care provider at readmission continued the previously documented PTO without alterations to the PTO tab, so no system logging occurred. We transformed the negative value to 0 for analytical purposes. To differentiate these cases from instances where the medical provider actually altered the PTO fields upon admission we set for these latter instances the duration to 0.5 days.

Sociodemographic and Clinical Factors

NH Care Types:

We distinguished four types of inpatient NH care using multiple fields in the EHR: psychogeriatric care for residents with psychogeriatric conditions, somatic care for residents with physical impairments, hospice care for residents specifically admitted to end-of-life care, and rehabilitation care. There are two main sources for determining the NH care type in the EHR: one is a structured field in the resident's record, and the other is an unstructured field linked to the NH unit where the resident is registered. The structured field was often missing and may not be updated when residents transferred between units/care types. Therefore, the NH care type was primarily determined by the unit information provided in the unstructured free-text field. If the unit information was inconclusive (eg, 'inpatient care', 'first floor'), we then used the structured field to determine the NH care type. If unit information was inconclusive and this structured field was missing, we used proxy variables that were specific to psychogeriatric care (an active involuntary care module in the EHR or a registration in the EHR to receive compulsory medical care according to the Dutch Compulsory Mental Healthcare Act) or rehabilitation care (health insurance claim data specific to rehabilitation care). If these proxy variables were not available/applicable, then the NH care type was classified as 'unknown type of inpatient care'. The category includes residents under the care of the nursing home physician, although the specific type of nursing home care cannot be determined. It also includes residents from assisted living facilities affiliated with nursing home organizations. These residents receive medical care from a general practitioner, who is also responsible for documenting PTOs instead of the nursing home physician.

Residents in our study sample could have received different types of inpatient NH care consecutively during their most recent NH stay (e.g. transfer from the

rehabilitation unit to long-term somatic or psychogeriatric care unit). In situations that consecutive transfers were recorded, we analyzed the initial NH care type.

Admission Date:

Depending on which EHR field was used to determine NH care type, the date of admission was set by a computerized time stamp (EHR NH unit information or psychogeriatric proxy variables), a manually entered admission date (structured medical field of type of NH care), or the date belonging to insurance claim data (rehabilitation).

Other Variables:

Age (derived from birth month and birth year), gender, and previous admission to the same NH (ie, readmissions) were obtained from the EHR. Furthermore, the presence of various medical conditions was assessed, including chronic respiratory diseases, heart failure, other cardiovascular diseases without heart failure, stroke, diabetes, reduced kidney function, dementia, Parkinson, Korsakov, other chronic progressive neurological diseases, delirium, cancer or leukemia, hip fracture, indication palliative care or terminal/end-stage disease, and 'other conditions only'. The conditions were derived from the free text medical history field in the EHR, using a query with most common disease names and synonyms.²⁴ This query was informed by clinical practice insights from domain experts and relevant literature.²⁵⁻²⁸ Medical conditions without an onset date were assumed to be present at admission, while conditions dated later than the admission year were recoded as absent at admission. Residents whose medical history consisted completely of conditions that were not included in our comorbidity list were classified as having 'other conditions only'.

Analysis

To characterize the sample population, descriptive statistics were calculated overall and stratified by the type of NH care provided. The rate and types of documented PTOs within six weeks of admissions to NH were calculated overall and stratified by admission year and type of NH care. To provide insights into the time required for documentation, the percentage of residents with a documented PTO was plotted against days after admission by admission year. Additionally, the median and interquartile range of documentation time were plotted by type of NH care and admission year. To examine if PTO documentation within 6 weeks of

admission changed over the years, we studied the association between admission year (categorical variable; reference group is 2017) and timely documentation in a logit generalized estimating equation (GEE) model with exchangeable correlation structure to account for clustering of residents within NHs, and stratified by the type of NH care. Next to univariable analyses, multivariable analyses were conducted to adjust for age, gender, readmissions, and medical conditions. Results of regression models were expressed as odds ratios with 95% confidence intervals, and p-value <0.05 was considered statistically significant. Since missing data were minimal (gender n = 2), we did not impute missing variables. Analyses were conducted in R version 4.3.2.

Results

Study Sample Characteristics

In the period January 1, 2017, and June 30, 2022, in our study sample 163,180 residents were admitted to 74 NH organizations (Table 1). More than half of the residents received rehabilitation care (55%), followed by psychogeriatric care (24%), somatic care (17%), and hospice care (3%). At admission, the median age of residents was 83 years, and 62% was female. Overall, around 9% of residents deceased within 6 weeks of admission, however, for residents with hospice care this was 72%.

Documented PTOs Within Six Weeks of Admission

The percentage documented PTOs within six weeks of admission was 88% for CPR codes and 64% for medical treatment preferences between 2017 and 2022 (Table 2). Most residents with a timely documented PTO had both PTOs documented. The most common CPR code was Do-Not-Attempt-Resuscitation, and the most common medical treatment preference was full treatment. Stratified per type of NH care, the proportion of timely documented CPR codes ranged from 84% (hospice care) to 89% (rehabilitation care), while timely medical treatment preferences documentation ranged from 63% (somatic care) to 70% (hospice care). Fig. 1 shows the documented CPR codes and medical treatment preferences overall and stratified per type of NH care and admission year. Fig. 1 shows that the documentation rates increased over the study period for CPR from 82% to 92%, and for medical treatment preferences from 56% to 70%. An increase was seen for all NH care types, except for hospice care. The proportion of limited treatment

Table 1. Resident characteristics

	Overall	Per Nursing Home Care Type		
		Psychogeriatric	Somatic	Hospice
				Rehabilitation
N (% of Total)	163,180	39,478 (24)	28,550 (17)	4837 (3)
Age, median (IQR)	82.9 (76.6-88.1)	84.9 (79.7-89.3)	84.4 (77.8-89.7)	81.9 (75.0-87.6)
Female, n (% of N)	100,618 (62)	24,505 (62)	17,841 (62)	2515 (52)
Conditions in medical history, n (% of N)				
Chronic respiratory diseases	27,990 (17)	5616 (14)	5420 (19)	900 (19)
Heart failure	23,365 (14)	5402 (14)	5564 (19)	755 (16)
Other cardiovascular diseases without heart failure	90,097 (55)	22,779 (58)	15,220 (53)	2321 (48)
Stroke	44,154 (27)	10,338 (26)	8906 (31)	932 (19)
Diabetes	38,525 (24)	9426 (24)	7342 (26)	1019 (21)
Reduced kidney function	25,757 (16)	6920 (18)	5425 (19)	867 (18)
Dementia	47,559 (29)	32,114 (81)	5581 (20)	551 (11)
Parkinson	8126 (5)	2488 (6)	2167 (8)	100 (2)
Korsakov	666 (< 1)	399 (1)	86 (< 1)	18 (< 1)
Other chronic progressive neurological diseases	212 (< 1)	62 (< 1)	69 (< 1)	3 (< 1)
Delirium	14,906 (9)	5714 (14)	2767 (10)	325 (7)
Cancer or leukemia	45,662 (28)	10,207 (26)	8185 (29)	2960 (61)
Hip fracture	17,795 (11)	3856 (10)	2794 (10)	263 (5)
Indication Palliative care or Terminal/End-stage disease	2729 (2)	339 (< 1)	606 (2)	601 (12)
Other conditions only ^a	8569 (5)	468 (1)	1351 (5)	123 (3)
No medical history registered at admission	11,055 (7)	1340 (3)	1922 (7)	475 (10)

Table 1. Continued

	Overall	Per Nursing Home Care Type			
		Psychogeriatric	Somatic	Hospice	Rehabilitation
Year of admission, n (% of N)					
2017	24,759 (15)	7053 (18)	4287 (15)	755 (16)	12,664 (14)
2018	28,332 (17)	7831 (20)	4660 (16)	790 (16)	15,051 (17)
2019	29,443 (18)	6887 (17)	4579 (16)	856 (18)	17,121 (19)
2020	30,756 (19)	6977 (18)	5685 (20)	975 (20)	17,119 (19)
2021	34,405 (21)	7429 (19)	6424 (23)	970 (20)	19,582 (22)
2022 (first two quarters)	15,485 (9)	3301 (8)	2915 (10)	491 (10)	8778 (10)
% deceased within 6 weeks of admission	9	7	11	72	6
% readmission	17	14	18	14	19

^aEntire medical history does not include any of the aforementioned conditions

preferences (ie, Do-Not-Attempt-CPR, limited treatment, or comfort measures) was highest in psychogeriatric and hospice care, and lowest in those with rehabilitation and somatic care.

Table 2. Documented PTOs within six weeks of admission 2017-2022

	Overall	Per Nursing Home Care Type			
		Psychogeriatric	Somatic	Hospice	Rehabilitation
	n = 163,180	n = 39,478	n = 28,550	n = 4837	n = 90,315
Documented within 6 weeks	n (%)	n (%)	n (%)	n (%)	n (%)
Cardiopulmonary resuscitation (CPR) code	142,903 (88)	33,477 (85)	24,933 (87)	4068 (84)	80,425 (89)
Attempt CPR	37,518 (23)	3041 (8)	4844 (17)	107 (2)	29,526 (33)
Do-Not-Attempt-Resuscitation	103,010 (63)	29,544 (75)	19,619 (69)	3936 (81)	49,911 (55)
Only documentation in free text field ^a	2375 (1)	892 (2)	470 (2)	25 (1)	988 (1)
Medical treatment preferences	104,098 (64)	26,040 (66)	18,134 (64)	3398 (70)	56,526 (63)
Full treatment	71,996 (44)	11,604 (29)	11,546 (40)	199 (4)	48,647 (54)
Limited treatment	19,612 (12)	9041 (23)	3971 (14)	1546 (32)	5054 (6)
Comfort measures	7609 (5)	2791 (7)	1517 (5)	1596 (33)	1705 (2)
Only documentation in free text field ^a	4881 (3)	2604 (7)	1100 (4)	57 (1)	1120 (1)
Both types of PTO documented	103,943 (64)	25,969 (66)	18,092 (63)	3393 (70)	56,489 (63)
Only CPR code documented	38,960 (24)	7508 (19)	6841 (24)	675 (14)	23,936 (27)
Only Medical treatment preferences documented	155 (<1)	71 (<1)	42 (<1)	5 (<1)	37 (<1)

PTO=Physician treatment order.

^aDue to limitations, it was not possible to examine the content recorded in free text field.

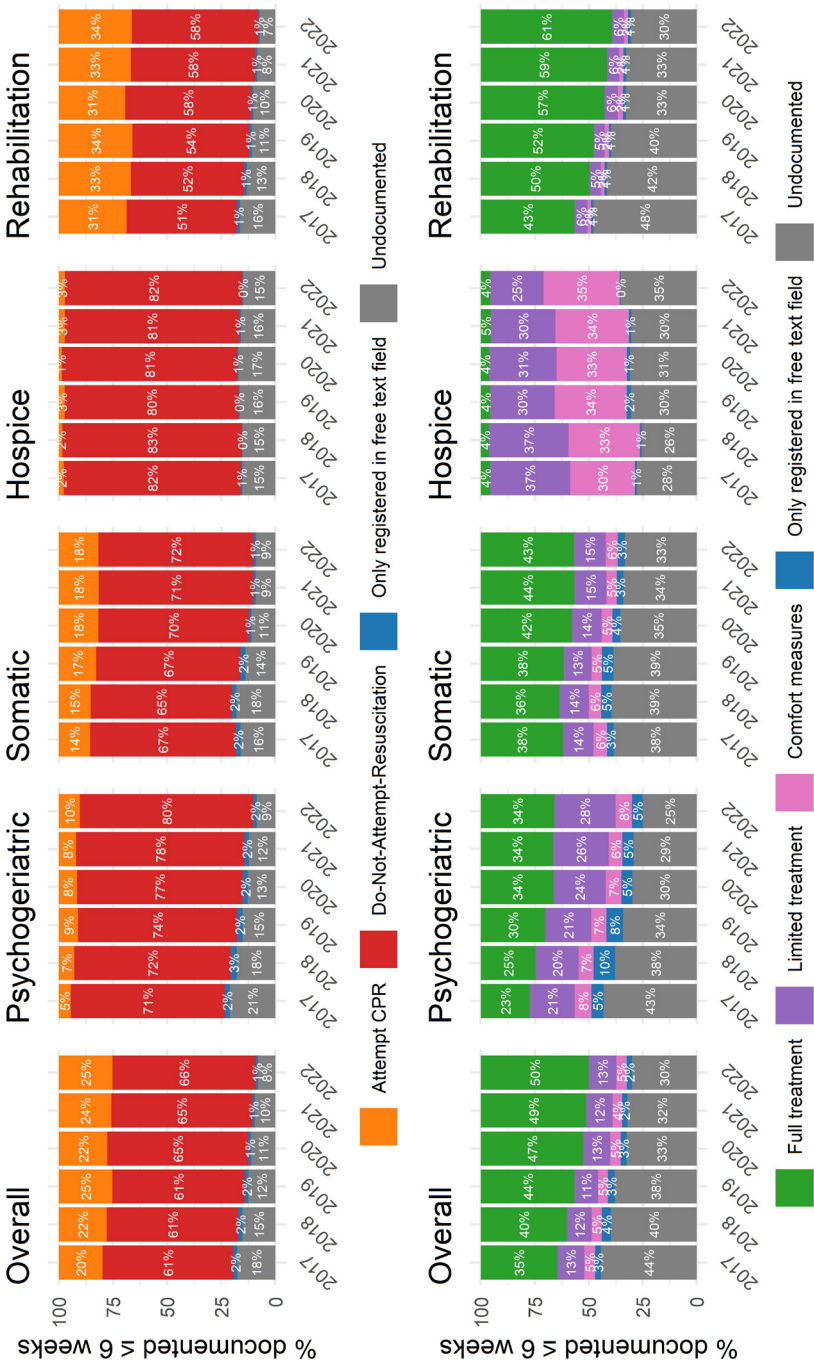


Figure 1. Percentage documented type of cardiopulmonary resuscitation (upper row) and medical treatment preferences (lower row) orders overall and per nursing home care type and admission year. Note that 2022 covers only first two quarters.

Days to First Documentation

As shown in Fig. 2, most of the PTOs were documented within the first day of admission or during the first week. Overall, both CPR codes and medical treatment preferences had a median documentation time of 1 day (IQR 0.5–3) (Fig. 3). When stratified by NH type and admission year, the median remained stable during 2017–2022 across all care types. Over the years, the interquartile range for CPR codes narrowed in both psychogeriatric and somatic care, as well as for medical treatment preferences in psychogeriatric care.

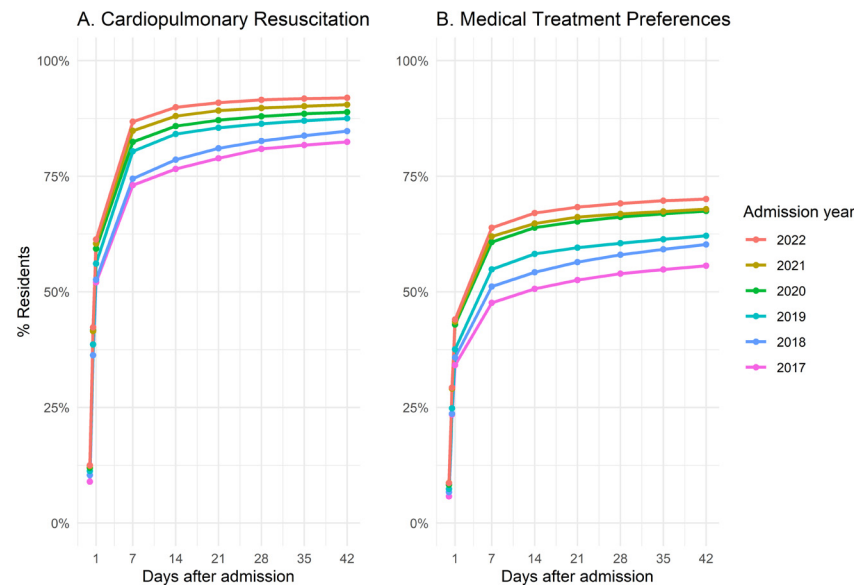


Figure 2. Cumulative percentage residents with documented cardiopulmonary resuscitation code and medical treatment preferences. Stratified by admission year. Note that 2022 covers only first two quarters.

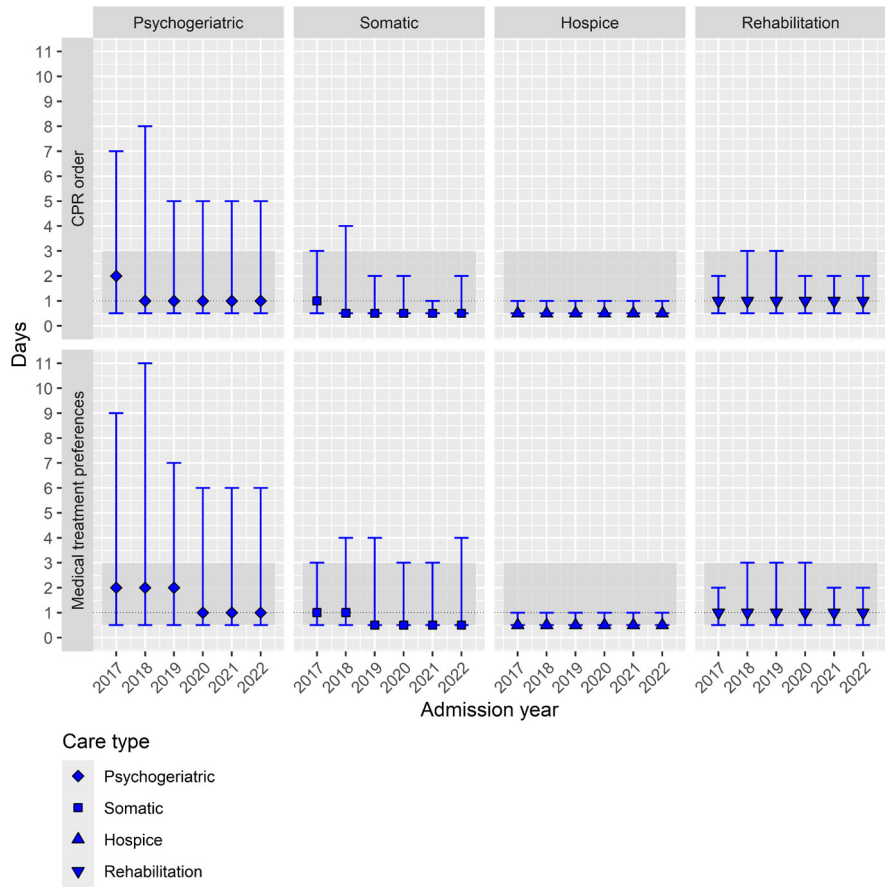


Figure 3. Median time and IQR to documentation physician treatment orders per nursing home care type and admission year.
For the unstratified whole sample, the median time is represented by the dotted line and the IQR is shaded in grey. Note: residents with a PTO continued from a previous stay were assigned a value of 0, while residents with a PTO documented on day of admission were assigned a value of 0.5. Year 2022 covers only first two quarters.

Association Between Timely Documentation and Admission Year per NH Care Type

The odds of documented CPR codes within six weeks of admission gradually increased with more recent admission years in psychogeriatric, somatic and rehabilitation care (Fig. 4). This increase was significant in psychogeriatric and somatic care for years 2019 to 2022 compared to 2017 and in rehabilitation care for the years 2018-2022 compared to 2017 (See Suppl Table S1 for the p-values). The odds of timely documented medical treatment preferences significantly increased with admission year in psychogeriatric care (2019 to 2022 compared to 2017) and somatic care (2022 compared to 2017). In rehabilitation care significant odds of timely documented medical treatment preferences was only seen in the unadjusted model (2018 to 2022 compared to 2017).

Discussion

This study examined the documentation rates for CPR codes and medical treatment preferences within six weeks of admission in Dutch NHs from 2017 to 2022. In the whole study sample, 88% of the residents had a documented CPR code within six weeks of admission and 64% had a documented medical treatment preference. While most residents (64%) had both PTOs documented within six weeks of admission, when only one PTO was documented, it was most often the CPR code. This pattern was consistent across all care types, suggesting that promptly documenting CPR code is more common than medical treatment preferences. In both psychogeriatric and somatic care, a more recent year of NH admission was associated for both PTOs with timely documentation. In rehabilitation care this association was only found for CPR code documentation.

The findings reveal improved CPR code documentation within six weeks of admission, increasing from 74% in the previous 2010-2013 study in Dutch NHs to 88% in our current study period.¹⁷ While the overall documentation rate of medical treatment preferences within six weeks of admission is comparable to the previous study, stratification by admission year and NH care type reveal improvements in the current study period from 2017 to 2022 across all care types, except in hospice care, which already reached a rate above the overall 64%. Compared to the previous study, which excluded hospice care, there have been improvements in the timely documentation of CPR codes across all care types, with increases ranging from 8 to 17 percentage points. Additionally, in rehabilitation care, the rate of

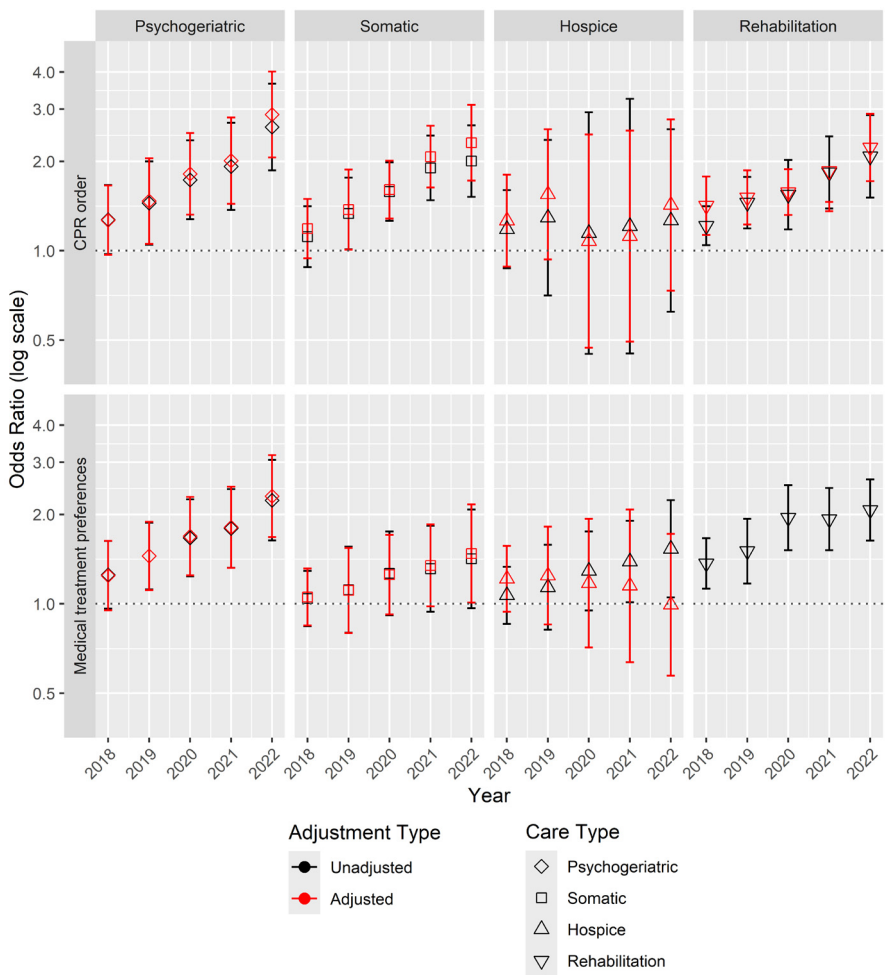


Figure 4. Odds ratios on timely documentation of cardiopulmonary resuscitation (CPR) code and medical treatment preferences and admission year (reference year = 2017) per nursing home care type.

Unadjusted (black) and adjusted odds ratio (red), adjusted for age at admission (included as a categorical variable split on quartiles, since univariable analysis showed no linear relationship between age and natural logarithm of the odds on both PTOs), gender, readmission, conditions in medical history (chronic respiratory diseases, heart failure, other cardiovascular diseases, stroke, diabetes, reduced kidney function, dementia, Parkinson, Korsakov, other chronic progressive neurological diseases, delirium, cancer or leukemia, hip fracture, indication for palliative care or terminal/end-stage diseases, other conditions only), or no medical history documented. In rehabilitation care the adjusted model for medical treatment preferences documentation did not converge. Note that 2022 covers only first two quarters.

timely documented medical treatment preference documentation rate improved from 57% to 63%. The observed decrease in undocumented medical treatment preferences coupled with an increase in ‘full treatment’ registrations over time may reflect either a shift in clinical practice or improved documentation practice, especially since in Dutch practice, undocumented PTOs can be interpreted as no treatment limitations (ie, full treatment). Moreover, ACP intervention studies that have shown that residents who participated in ACP conversations often prefer more limited treatment preferences.^{29, 30}

The median time from NH admission to documentation remained stable at around one day during our study period 2017–2022, with improved interquartile ranges for psychogeriatric and somatic care, especially compared to the previous study from 2010 to 2013. The time required for documenting PTOs appeared to improve between 2017 and 2022. Studies in the United States reported longer time to documentation (median times ranging from 1 to 48 days after admission).^{31–33} Variations in documentation rates are likely a result of varying policies and organizational practices in PTO documentation over time.^{34, 35} An international systematic review by Kang et al.³⁴ showed that the documentation rate in Finland doubled between 2004 and 2013, which may potentially be linked to Finish legislation.³⁶ In contrast, a Swedish study highlighted a more unregulated practice regarding documentation of advance care plans in EHRs and found a median time of eight months from NH admission to first documentation (range 0–120 months).³⁷ One possible explanation provided by the authors is that physicians may be waiting for residents to deteriorate before initiating the process, which reflects the challenge of determining the appropriate timing for initiating ACP.^{37, 38} Van Soest et al.¹⁵ also describes this more responsive strategy, alongside the proactive strategy that physicians adopt to address in advance more acute situations that have immediate impact on survival (eg, CPR and hospitalization). In the Netherlands, the developments of a national indicator on ACP documentation and multidisciplinary ACP guidelines during the COVID pandemic might explain why more recent years of admission for psychogeriatric, somatic, and rehabilitation care were gradually associated with higher odds of a documented PTO, although causal effects relationships cannot be confirmed with this study design. No such association was found for hospice care, likely due to the specialized goal of end-of-life care which aligns with comfort measures only.

Strengths and Limitations

The strength of this study is that it supports the findings of previous smaller studies,^{17, 39} highlighting that documentation of PTO is standard practice in Dutch NHs and can be documented at the time of admission. For this study routine healthcare data were derived from one of the largest EHR providers in Dutch NHs. By utilizing the direct source in which medical staff document PTOs, we were able to study a substantial sample of residents across a multitude of NHs over a long period. We were not hindered by inconsistencies when relying on quarterly assessment data and asynchronous Minimum Data Set assessments^{27, 40} or by selection bias likely to occur in experimental designs. Since results are based on data from one single EHR provider, any confounding due to for example EHR interface cannot be excluded. Research into EHR usage indicates that physician-related factors (eg, awareness of EHR functionality, user satisfaction) and organizational factors (eg, practice size, technical support) influence how physicians use the EHR,²⁵ and can form barriers and facilitators in documenting ACP conversations and PTOs.²⁶⁻³⁵

Routine healthcare data has the limitation of not being specifically collected for research purposes, which introduces a potential risk of misclassification, such as using the free text to derive medical history. The Dutch Minimal Dataset for Long-term Care, which is currently being developed, may provide future opportunities to minimize this bias.⁴¹ Another limitation of routine healthcare data is the factors that could be controlled for and introduce a potential source of unmeasured confounding. Other studies have suggested that resident factors, such as race, ethnicity, or religion, also impact ACP.^{17, 25, 31, 39, 40, 42, 43} These factors were not available as they are not routinely and not systematically recorded in the EHR. Another limitation of this routine healthcare data study is the absence of information regarding the ACP process that precedes the PTO documentation, such as conversations with residents and their representatives. Previous qualitative studies conducted in Dutch NHs have indicated that physicians often engage in conversations with (residents's representatives) prior to documenting PTOs.^{15, 16}

Other studies have validated a natural language processing (NLP) tool to analyze ACP documentation in free text.^{44, 45} We did not examine the content of the free text accompanying the PTOs, as this would require an extensive amount of time. Consequently, we cannot exclude the possibility that, for some residents physicians may have documented their medical treatment preferences in the free text field accompanying the CPR code.⁴⁶ This could have resulted in an underestimation

of our documentation rates for medical treatment preferences. However, documenting outside the designated EHR fields carries patient safety risks and is thus not desired.⁴⁷⁻⁴⁹

Another limitation is 9% of our sample had a shorter follow-up time for documentation because they died within the six week follow-up period. However, as the majority of documentation occurred during the first week of admission, we believe that the impact of this on the regression estimates is minimal.⁵⁰⁻⁵² A final limitation is that this study focused on prompt initial documentation of PTOs upon admission, further research should explore the differences between NH organizations and whether and when PTOs are updated during a NH stay, when for example changes in health of NH residents occur.^{27, 53} Furthermore, studies in the United States show that the delivery of end-of-life care was greatly in concordance with the PTOs,⁵⁴ especially in NHs.⁵⁵ It would be interesting to examine the extent to which documented PTOs are also acted upon in Dutch NHs.

Conclusions

Most residents had documented CPR code (88%) and medical treatment preference (64%) within six weeks of NH admission. The documentation rates improved in the period 2017 and 2022 for psychogeriatric, somatic and rehabilitation care. The increase coincided with the introduction of a national quality indicator for timely documented PTOs in NHs (in 2018) and the impact of the COVID pandemic (in 2020). The increases in timely documentation of CPR codes and medical treatment preferences are important to facilitate person-centered care that aligns with residents' values, goals, and preferences.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work author GY used Grammarly and ChatGPT in order to improve readability and language used in this manuscript. After using these tools, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

Disclosures and Acknowledgments

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Data Availability

Requests to access the data set should be directed to Karlijn Joling (k.joling@amsterdamumc.nl).

Supplementary Materials

Supplementary materials are available online at <https://doi.org/10.1016/j.jpainsymman.2025.07.022>



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Urinary Tract Infection Guideline Adherence in a Dutch Sentinel Nursing Home Surveillance Network

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Abstract

Objectives: To investigate guideline adherence 3 years after the introduction of a national guideline on urinary tract infections (UTIs) in frail older adults. Appropriate use of urine dipstick tests, treatment decisions, and antibiotic drug choices in residents with (suspected) UTIs without a catheter were examined.

Design: Observational prospective study.

Setting and Participants: Nineteen nursing homes participating in a Dutch Sentinel Nursing Home Surveillance Network.

Methods: As of September 2021, for a 3-month period, medical practitioners recorded additional clinical information in the electronic health record in case of a (suspected) UTI. Based on this information, adherence to guideline recommendations was assessed. Nonadherence was classified into 2 categories: (1) 'intentional nonadherence' as reported by practitioners and (2) 'nonadherence otherwise' applied to all other cases where the recorded information was discordant with the guideline recommendations.

Results: A total of 532 cases of (suspected) UTIs from 469 residents were analyzed. In 455 cases (86%), dipsticks were used. For the 231 cases where clinical signs and symptoms already indicated no UTI treatment according to the guideline, a dipstick was still inappropriately ordered in 196 cases (85%). The decision to prescribe or withhold antibiotics was in 69% of the cases adherent, in 6% intentionally nonadherent, and in 25% nonadherent otherwise. The type of prescribed antibiotic was adherent to the recommended antibiotics for cystitis in 88% and for UTIs with signs of tissue invasion in 48%. Overall, for 40% of suspected UTIs, adherence to all relevant recommendations could be established, and in 9% practitioners reported intentional nonadherence to the guideline.

Conclusions and Implications: There is considerable room for improvement in all clinical stages of managing a suspected UTI in Dutch nursing homes, particularly with regard to the importance of patient's clinical signs and symptoms for appropriate dipstick use and antibiotic UTI treatments.

Introduction

Urinary tract infections (UTIs) are one of the most common infections in nursing homes and are frequently managed with antibiotic treatment.¹⁻⁴ In nursing homes, multiple challenges exist in terms of diagnosing and treating UTIs for physicians, nurse practitioners, and physician assistants,^{1, 5-9} herein collectively referred to as medical practitioners. For instance, distinguishing between asymptomatic bacteriuria and UTI can be difficult, especially since prevalence of asymptomatic bacteriuria in nursing home residents is high.^{5, 6, 8, 10} Moreover, inappropriate antibiotic treatment can lead to incremental antibiotic resistance rates^{1, 11, 12} and increase risks on adverse events to residents,^{1, 10} such as gastrointestinal complaints (eg, diarrhea or even *Clostridium difficile* infection), allergic reactions, and other medication-related adverse effects.^{7, 13, 14} Therefore, it is important for medical practitioners to both manage suspected UTIs and prescribe antibiotics appropriately.

Several clinical algorithms are recommended by AMDA's Infection Advisory Committee to guide medical practitioners in identifying and managing (suspected) UTIs in nursing home residents, and to incorporate these algorithms also into antibiotic stewardship policy.¹⁵ One of the recommended algorithms is based on the international Delphi consensus criteria for suspected UTI in frail older adults.¹⁶ This algorithm shows overlap with the Agency for Healthcare Research and Quality (AHRQ) criteria and algorithms recommended in the United Kingdom and the United States.¹⁷⁻¹⁹ In the Netherlands, the international Delphi consensus criteria for suspected UTI in frail older adults were incorporated into a new national UTI guideline for frail older adults in 2018.²⁰ A key component of the guideline is that the UTI diagnosis and subsequent antibiotic treatment should be based on urinary tract-related signs and symptoms (Box 1). In addition, a urine dipstick test can only rule out a UTI and should not be used to confirm a UTI diagnosis. The guideline also includes recommendations on antibiotics that are appropriate for different types of UTI in the absence of local resistance data and/or prior patient urine culture results.

Adherence rates offer insights into the extent to which medical practitioners have adapted to practice recommendations, enabling quality assessment. Earlier reported rates of appropriate antibiotic prescribing for UTIs in nursing homes—before the new practice recommendations/guideline—ranged from 15% to 68%.^{21, 22} Direct comparison of these percentages is challenging, because of

Box 1. Dutch UTI Guideline Recommendations for Frail Older Adults Without Indwelling Catheters and Operationalized Adherence Criteria.

Diagnostics: Urine dipstick

Guideline Recommendation: Only use the urine dipstick to rule out a UTI.

A1) For cases meeting UTI treatment guideline criteria*

$$\text{Adherence} = \frac{\text{Cases with no dipstick performed} + \text{Cases with dipstick performed to rule out UTI in case of diagnostic uncertainty}}{\text{Cases meeting UTI treatment guideline criteria}}$$

A2) For cases meeting guideline criteria for no UTI treatment[†]

$$\text{Adherence} = \frac{\text{No Dipstick performed}}{\text{Cases meeting guideline criteria for no UTI treatment}}$$

Adherence only calculated for A2, not enough information available to calculate A1.

Management: UTI treatment decision

Guideline Recommendation: Be cautious about using antibiotics to treat UTIs in frail older adults unless (1) 2 or more urinary tract-related S&S [recent onset of dysuria, urgency, frequency, incontinence or (visible) urethral purulence] or at least 1 very bothersome urinary tract-related S&S; (2) at least 1 urinary tract-related S&S accompanied by flank pain and/or suprapubic pain; (3) systemic S&S (fever, rigors, delirium) accompanied by at least 1 urinary tract-related S&S or flank pain with no other focus of infection; (4) but do not give antibiotics if there is a negative dipstick result (negative nitrite test and negative leukocyte test).

A3) For cases meeting UTI treatment guideline criteria

$$\text{Adherence} = \frac{\text{AB initiated, unless negative dipstick result}}{\text{Cases meeting UTI treatment guideline criteria}}$$

A4) For cases meeting guideline criteria for no UTI treatment

$$\text{Adherence} = \frac{\text{No AB initiated}}{\text{Cases meeting guideline criteria for no UTI treatment}}$$

Adherence for total cases is the sum of the numerators of A3 and A4 divided by the sum of their denominators.

Management: Antibiotic choice[‡]

Guideline Recommendation: In case of cystitis, start with nitrofurantoin or, if contraindicated, fosfomycin, and in exceptional cases, can be treated with ciprofloxacin. If local resistance data and previous culture results are lacking, amoxicillin/clavulanic acid, cotrimoxazole, or ciprofloxacin can be started for urinary tract infections with signs of tissue invasion.

A5) For Women with cystitis[¶]

$$\text{Adherence} = \frac{\text{Women with cystitis and treated with nitrofurantoin, fosfomycin or ciprofloxacin}}{\text{Cases of antibiotics prescribed to women with cystitis}}$$

A6) For UTI with signs of tissue invasion

$$\text{Adherence} = \frac{\text{All cases treated with amoxicillin/clavulanic acid, ciprofloxacin or trimethoprim/sulfamethoxazole in women with no cystitis and men}}{\text{Cases of antibiotics prescribed to women with no cystitis or men}}$$

AB, antibiotic; S&S, signs & symptoms.

Nonadherence is complementary to adherence and split into intentional and otherwise.

* Cases with 2 or more urinary tract-related S&S (recent onset of dysuria, urgency, frequency, incontinence or (visible) urethral purulence) or at least 1 very bothersome urinary tract-related S&S, or with at least 1 urinary tract-related S&S accompanied by flank pain and/or suprapubic pain, or systemic S&S (fever, rigors, delirium) accompanied by at least 1 urinary tract-related S&S or flank pain with no other focus of infection.

[†] Cases with at most 1 not very bothersome urinary tract-related S&S with no systemic S&S, no flank pain, nor suprapubic pain or cases with flank pain with no urinary tract-related S&S and no systemic S&S.

[‡] Antibiotic choice adherence is assessed independently of the UTI treatment decision.

[§] Uncertainty in diagnosis despite S&S meeting UTI treatment guideline criteria.

[¶] Cases in the absence of any systemic S&S and flank pain.

variations in definitions of appropriate prescribing and approaches to calculate adherence rates.^{1, 21, 23, 24} Most studies have focused on the decision to initiate antibiotic treatment as representative of appropriate prescribing.^{1, 21, 24-27} Only a few studies also assessed whether the antibiotic drug choice was in accordance with guideline recommendations.^{13, 24, 28, 29} However, their data collection was limited by the number of UTIs that could be included,²⁸ or was partially collected before the evaluated guideline was published,²⁹ or used positive urinalysis as the inclusion criterion.¹³ Thereby introducing a form of selection effect. The majority of these studies were conducted before the introduction of the above-mentioned international consensus criteria for frail older adults. The adherence to these new practice recommendations has only been analyzed as secondary outcomes in intervention or diagnostic accuracy studies,^{26, 27, 29} possibly not reflecting the adherence rates in daily clinical practice.

Therefore, the aim of this study was to gain insight into guideline adherence in daily practice in nursing homes 3 years after the introduction of a national guideline on UTIs in frail older adults. Data collected through the electronic health record (EHR) by medical practitioners during their daily practice were used to assess adherence, focusing on the key components of the guideline, notably appropriate use of urine dipstick, the decision to initiate antibiotic treatment in residents with (suspected) UTIs, and the antibiotic drug prescribed for a UTI.

Methods

Setting

This study used data from a Dutch Sentinel Nursing Home Surveillance Network, which is an audit and feedback program for medical practitioners in nursing homes

where results on various topics are fed back annually during group feedback sessions to discuss their performances and possibilities for quality improvement.³⁰ Nursing homes participating in the sentinel network were recruited through the 6 academic networks of medicine for older people in the Netherlands^{31,32} and through the EHR vendor Gerimedica. Nursing homes were required to use Gerimedica's EHR Ysis, because the sentinel network's registration procedure is only integrated in this EHR. The EHR Ysis is used by approximately half of the nursing homes across the Netherlands.³³

The sentinel network program was reviewed by the privacy officer of Amsterdam UMC as a quality improvement program and therefore exempt from further institutional review. Residents were informed in accordance with the General Data Protection Regulation by their own nursing home organization about the pseudonymized data collection and could opt out at any moment during the study period.

Data Collection

The data collection period lasted from September 2021 to January 2022, where each participating nursing home collected data for 3 consecutive months. Prior to the data collection, medical practitioners received a 1-hour group instruction led by researchers of the network about the data collection procedure and included a short overview of the UTI guideline. Medical practitioners were instructed to complete a registration form in the EHR for each (suspected) UTI in the data collection period. Registration forms appeared in the EHR after accepting a pop-up alert when the medical practitioner saved progress notes containing key words such as 'UTI' or its synonyms. Practitioners could also complete forms at a later moment or decline if there was no suspicion of UTI, for instance, an evaluation note about a previous UTI. In addition, medical practitioners completed forms based on their own discretion, as no formal case definition for suspected UTI was provided. The registration form contained questions about the presence of urinary tract-related (eg, dysuria, frequency), systemic (eg, fever, delirium), and nonspecific signs and symptoms (eg, malaise, unexplained behavioral change) (see Supplementary Material). An answer category 'cannot assess/not assessed' was available for medical practitioners when signs and symptoms could not be evaluated or had not been evaluated. The form also held questions about the use of an indwelling urinary catheter in the last 7 days, dipstick testing, and choice of antibiotics. If

the medical practitioner intentionally deviated from the UTI guideline, the reason could be registered on the form. Resident characteristics such as gender and birth year were extracted automatically from the EHR.

Study Outcomes

Based on the reported signs and symptoms, adherence regarding the management of (suspected) UTI was assessed using the guideline recommendations as outlined earlier (see Box 1). Nonadherence was classified into 2 specific categories: (1) 'intentional guideline nonadherence' (ie, medical practitioner reported intentional deviation from the guideline); (2) 'guideline nonadherence otherwise' (ie, cases in which practitioners reported information that was discordant with the guideline without clarification on the form).

Data Analyses

Each episode of a (suspected) UTI is regarded as the unit of analysis ('case'). Cases in which patients had an indwelling catheter within the past 7 days and cases where medical practitioners reported relevant signs and symptoms for the assessment of UTI treatment indication as 'cannot assess/not assessed' were excluded. We investigated similarity in sociodemographic characteristics of the excluded and included residents (cases meeting criteria for UTI treatment criteria or no UTI treatment) by performing analysis of variance (continuous variables) and Fisher exact test (categorical variables) with Bonferroni adjustment for multiple testing ($P < .01$). Post hoc analyses were performed between the groups to confirm where differences occurred with Bonferroni adjustment for multiple testing ($P < .0167$). We calculated adherences by using frequency counts and percentages for the different guideline recommendations. We also used analysis of variance and Fisher exact test with Bonferroni adjustment for multiple testing ($P < .0167$) to test for differences in residents' age, gender, and type of care between adherent and nonadherent cases. For the intentional guideline nonadherent cases, the reasons for guideline deviation as reported by medical practitioners is reported. Open-text responses were if possible reclassified into existing answering options where possible, or clustered thematically by 2 research members with a medical nursing home background (G.Y. and I.G.). An overall adherence rate was calculated using an 'all-or-none measurement approach.'³⁴ In this approach, cases were seen as 'overall adherent' if care was provided in adherence with all eligible guideline recommendations. For example, cases without urinary tract-related signs and

symptoms nor flank pain were considered adherent if no dipstick was performed and no antibiotics were prescribed. To show practice variation across nursing homes, the median and interquartile ranges (IQRs) were reported. To demonstrate the influence of dipsticks on treatment decisions, the odds ratio (ORs) and 95% CIs were calculated using a 2 × 2 contingency table³⁵ for cases in which the guideline recommended no UTI treatment but still non-negative dipstick results were reported, compared with cases in which no dipstick was reported, while excluding cases with intentional nonadherence. The analyses were carried out using SPSS version 28.0 (IBM Corp) and the figures were built using Office 2016 (Microsoft Corp).

Results

Sample Characteristics

In 2021-2022, 19 of the 24 organizations in the sentinel network participated in the registration of (suspected) UTIs with their nursing homes (median 353 beds/organization; IQR 186–467 beds; range 30–1496 beds). The majority of nursing homes participated with all departments. Three nursing homes participated only with their geriatric rehabilitation department. A total of 675 cases of suspected UTIs without indwelling catheter were registered. The median number of total registered cases per nursing home was 30 (IQR 17.5–52.5; the median number of registered cases per 10 beds was 0.94; IQR 0.57–1.45). In total, 143 cases (21%; 143/675) were excluded because the relevant signs and symptoms were reported as ‘cannot assess/not assessed.’ The majority of excluded cases were managed with antibiotics (69%; 98/143). Excluded cases resided more often in the psychogeriatric wards (62%; 89/143) compared with the included cases (47%; 250/532) (Fisher exact test $P < .001$). No other statistically significant differences were found between the excluded and included cases. In total, 532 cases of suspected UTIs in 469 residents were included for further adherence analysis (Fig. 1). Of these cases, 301 presented with signs and symptoms that indicated antibiotic UTI treatment according to the guideline criteria and 231 cases presented with signs and symptoms not indicating UTI treatment; see Table 1 for more characteristics.

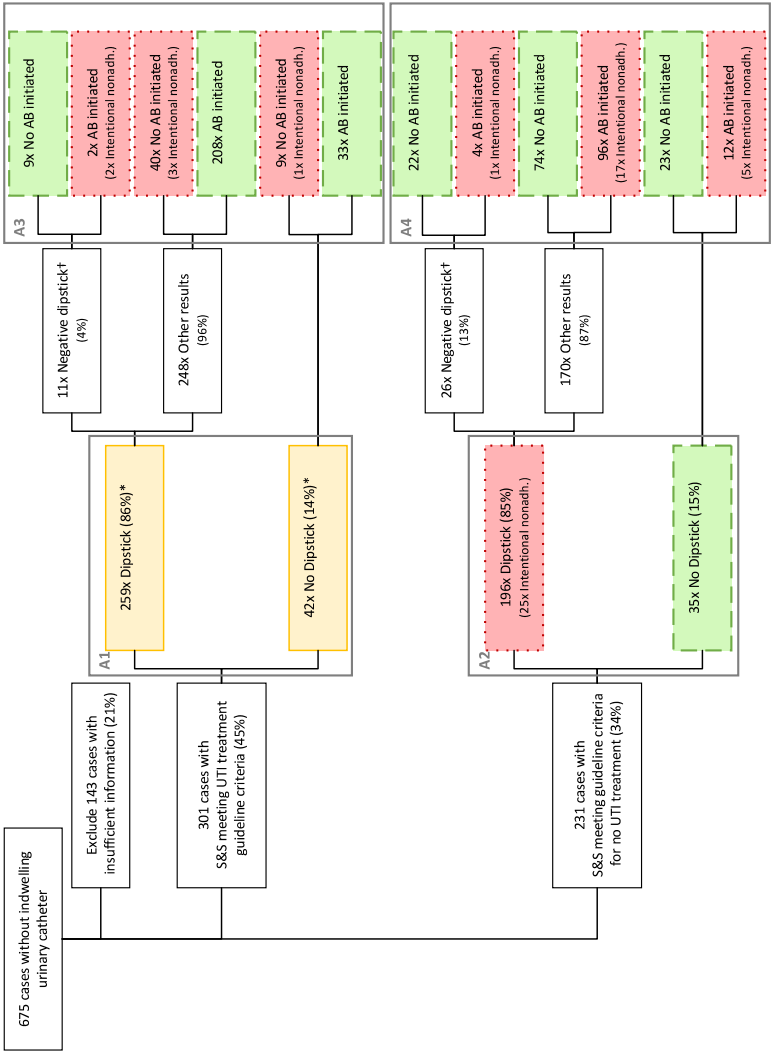


Figure 1. Flowchart of adherent (green boxes with striped border) and nonadherent (red boxes with dotted border) cases. For the nonadherent cases the number of intentional nonadherent cases are specified in parentheses with ‘intentional nonadh.’ The gray squares A1-A4 correspond to the cases used for the adherence calculations as formulated in Box 1. (S&S, signs & symptoms; AB, antibiotic.) *Not enough information available for these cases to assess adherence regarding indication for dipstick. †Negative for both leukocyte esterase and nitrite.

Table 1. Sample characteristics

	Total Cases for Analyses (n=532)		S&S Meeting Guideline Criteria for No UTI Treatment (n=231)		S&S Meeting Guideline Criteria for UTI Treatment (n=301)	
Sociodemographics						
Mean age, y (SD)	82.5 (11.1)		82.6 (11)		82.4 (11.2)	
Female, n (%)	405 (76.1)		155 (67.1)		250 (83.1)	
Type of nursing home ward, n (%)						
Psychogeriatric	250 (47)		113 (48.9)		137 (45.5)	
Somatic	189 (35.5)		64 (27.7)		125 (41.5)	
Rehabilitation and other (short term) wards	93 (17.5)		54 (23.4)		39 (13)	
Number of unique residents	478 (89.8)		224 (97)		273 (90.7)	
Number of residents ≥2 cases, n (%)	46 (8.6)		7 (3)		23 (7.6)	
Signs & symptoms of recent onset, n (%)	Present	Unknown	Present	Unknown	Present	Unknown
Urinary tract-related S&S, at least 1	346 (65)	0 (0)	51 (22)	0 (0)	295 (98)	0 (0)
Dysuria	159 (30)	-	18 (8)	-	141 (47)	-
Urgency	158 (30)	-	2 (1)	-	156 (52)	-
Frequency	78 (15)	-	14 (6)	-	185 (61)	-
Incontinence	24 (5)	-	13 (6)	-	65 (22)	-
Urethral purulence	90 (17)	-	4 (2)	-	20 (7)	-
Two or more of above urinary tract-related S&S present or at least 1 very bothersome	238 (45)	-	0 (0)	-	238 (79)	-
Flank pain	40 (8)	75 (14)	7 (3)	0 (0)	33 (11)	75 (25)
Suprapubic pain/tenderness	106 (20)	80 (15)	19 (8)	5 (2)	87 (29)	75 (25)
Systemic S&S	102 (19)	18 (3)	49 (21)	6 (3)	53 (18)	12 (4)
Non-specific S&S	283 (53)	21 (4)	139 (60)	2 (1)	144 (48)	19 (6)

S&S, signs and symptoms.

Diagnostics: Urine Dipsticks

Dipstick tests were performed in 86% of cases (455/532). Adherence was calculated for the total of 231 cases with signs and symptoms not indicating UTI. For 15% of the cases (35/231), no urine dipstick was performed in accordance with the guideline recommendations (median adherence rate nursing homes 12%; IQR: 6%–31%). In the majority of cases (196/231; nonadherence rate 85%), the dipstick was performed unnecessarily, because its test result would not change the indication for no UTI treatment according to the guideline. In 25 nonadherent cases (11% of total cases), practitioners stated they intentionally do not adhere to the guideline. Among cases with signs and symptoms not indicating UTI treatment, a nonnegative dipstick result showed a higher odds for antibiotic treatment compared with cases in which no dipstick was used (OR 3.51, 95% CI 1.42–8.66). There were no statistically significant differences in the sociodemographic characteristics between adherent and nonadherent cases (data not shown).

Management: UTI Treatment Decision

Of all cases, 69% (369/532) were managed in accordance with the guideline recommendations regarding initiating or withholding antibiotics for UTI (median rate nursing homes 74%; IQR: 60%–78%). The nonadherence rate was 31% of all cases (163/532). In 29 nonadherent cases (6% of all cases), practitioners mentioned they intentionally did not adhere to the guideline. The nonadherence otherwise group included 89 cases (17% of all cases) where antibiotics were initiated against guideline recommendations and 45 cases (8% of all cases) where antibiotics were not initiated despite guideline indications for UTI treatment. Most of the 89 cases in which antibiotics were initiated against guideline recommendations had no urinary tract-related signs and symptoms reported, nor flank pain, and no other focus of infection (64/89) or only 1 not very bothersome urinary tract-related sign and symptom with no other specific complaints that warranted antibiotic treatment (21/89). However, for the majority of the 45 cases in which the guideline would have recommended antibiotics, cases had at least 2 urinary tract-related signs and symptoms present (29/45). See Supplementary Table 1 for more information on the reported signs and symptoms in the nonadherence otherwise group. There were no statistically significant differences in the sociodemographic characteristics between adherent and nonadherent cases (data not shown).

Management: Antibiotic Choice

Table 2 shows an overview of all antibiotics prescribed for the different types of UTI and the adherence rates to guideline-recommended antibiotics. In 71% of the cases managed with antibiotics (253/355), the choice of antibiotics was adherent to the guideline recommendation (median rate nursing homes 72%; IQR 60%–86%). This high percentage is due to a large number of women with cystitis that were treated with antibiotics recommended in the guideline (88%; 184/210). The adherence rate decreased to 48% (69/145) for the antibiotics prescribed for UTIs with signs of tissue invasion (ie, fever, rigors, delirium, flank pain, and/or any UTI in men). The lowest percentage adherence (35%; 28/79) was found in women with UTIs with signs of tissue invasion. There was a statistically significant difference seen in gender between the adherent and nonadherent groups ($P < .001$). Around half of the cases presenting signs or symptoms of tissue invasion were prescribed fosfomycin, nitrofurantoin, or trimethoprim (50%; 72/145), none of which are recommended by the guideline for treatment of UTIs with signs of tissue invasion, since these antibiotics are considered not to reach adequate tissue levels outside the bladder.³⁶

Overall Adherence Rate

The overall adherence rate for the measures assessed together was 40% (median rate nursing homes 38%, IQR 28%–50%; Fig. 2), meaning that 40% of the cases received the guideline-recommended workup and management of a (suspected) UTI. Intentional nonadherence rate was 9% of all cases (48/532). Fifty-one percent of all cases were otherwise nonadherent to at least 1 recommendation (271/532): in detail, 1% was nonadherent to 1 of 3 eligible recommendations, 26% was nonadherent to 1 of 2 eligible recommendations, 11% was nonadherent to 2 of 3 eligible recommendations, and 13% was nonadherent to all eligible recommendations (for more detailed specification, see Supplementary Table 2).

On the registration form, the 4 most frequently reported reasons in the group from nonadherent cases in which the medical practitioner reported to have intentionally deviated from the guideline were as follows: too little/uncertain information obtained from/on the patient ($n = 10$), allergy/drug interaction ($n = 6$), prior urine culture results ($n = 5$), after consultation with the medical specialist in the hospital ($n = 4$) (see Supplementary Table 3 for more information).

Table 2. Frequencies and adherence rates of antibiotic choice

	Cystitis in Women (n=210)		UTI With Signs of Tissue Invasion in Women (n=79)		UTI With Signs of Tissue Invasion in Men (N=66)		Total Cases With Antibiotics (n=355)	
	n	%	n	%	n	%	n	%
Antibiotic prescriptions*								
Amoxicillin	1	< 1	1	1	2	3	4	1
Amoxicillin/clavulanic acid	14	7	12 [†]	15 [†]	20 [†]	30 [†]	46	13
Ciprofloxacin	12 [†]	6 [†]	16 [†]	20 [†]	17 [†]	26 [†]	45	13
Fosfomycin	54 [†]	26 [†]	14	18	0		68	19
Nitrofurantoin	122 [†]	58 [†]	33	42	21	32	176	50
Trimethoprim	7	3	3	4	1	2	11	3
Trimethoprim- sulfamethoxazole	2	1	1 [†]	1 [†]	5 [†]	8 [†]	8	2
No antibiotics (Fluconazol)	0		0		1	2	1	< 1
Guideline adherence								
Adherent	184	88	28	35	41	62	253	71
Non-adherent	26	12	51	65	25	38	102	29
Intentional non- adherence	11	5	8	10	5	8	24	7
Otherwise non- adherence	15	7	43	54	20	30	78	22

Antibiotic choice adherence is assessed independently of the UTI treatment decision.

*Number of antibiotic prescriptions (n) can be larger than the number of cases (n), because in some cases ($n = 3$) practitioners prescribed more than 1 drug.

†These are the recommended antibiotics in the national guideline for the specific type of UTI in the absence of local resistance data and/or prior patient urine culture results.

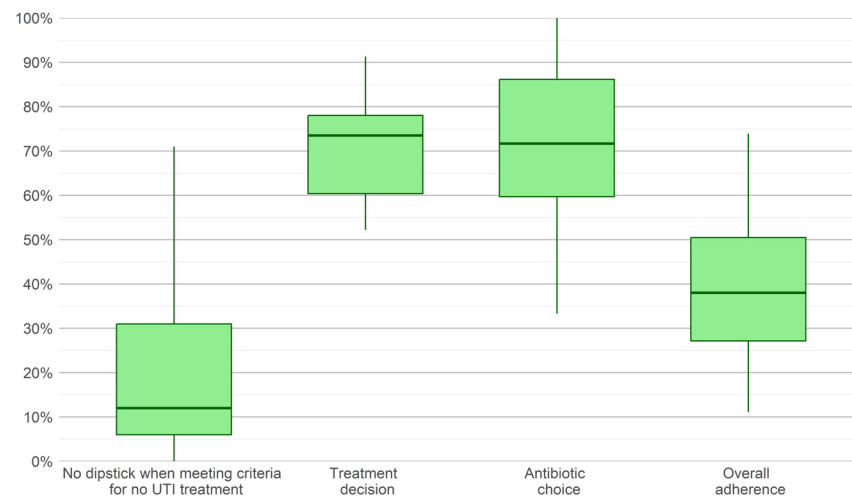


Figure 2. Frequency distribution of adherence rates by nursing homes.

Box plots represent median, 25th, and 75th percentiles, and lines for minimum and maximum adherence rates across nursing homes.

Discussion

Three years after the introduction of the national UTI guideline based on the international Delphi consensus criteria for suspected UTI in frail older adults,^{16, 20} we assessed guideline adherence in 19 nursing homes across the Netherlands to identify areas for improvement and further research in UTI management. Almost three-quarters of the reported treatment decisions made by medical practitioners regarding initiating or withholding antibiotics were in accordance with the guideline. According to the guideline, a watchful waiting approach without antibiotics would be considered more appropriate for at least a quarter of the cases that were managed with antibiotics. Dipsticks were often performed unnecessarily in patients with signs and symptoms that already indicated no need for antibiotic UTI treatment. Adherence to the recommended type of antibiotic drugs for women with cystitis was nearly 90%, whereas for women with UTIs with signs of tissue invasion, adherence was only a third. The study showed there is a considerable range in the rates of adherence to the different guideline recommendations. For around half of the suspected UTIs, the received care aligned with all eligible recommendations (ie, 'overall adherence') or the medical practitioner reported an intentional decision to deviate from the guideline (ie, 'intentional nonadherence') in their management of (suspected) UTIs.

As mentioned in the introduction, direct comparison of adherence rates to previous studies is challenging. Even when restricting our comparison to previous studies that used similar criteria, it remains complex. For example, to compare our current UTI treatment decision adherence rate with data from a diagnostic accuracy study and a cluster randomized controlled trial—both conducted around the time of guideline introduction—2 differences still need to be accounted for.^{26, 29} First, the cluster randomized controlled trial reported adherence rates exclusively for cases managed with antibiotics. This changes our 69% (369/532) adherence rate of all cases to 68% (241/355), by including in the denominator only the cases where the practitioner initiated antibiotic treatment and in the numerator only the cases where this decision to initiate was adherent (Fig. 1). Second, both studies did not exclude cases with unknown relevant signs or symptoms, but considered them as absent. As a result, the number of cases in which the practitioner initiated treatment against guideline recommendations (ie, 'nonadherent' cases) increases (in our study: $n = 98$), and consequently the adherence dropped to 53% (241/453). This rate is slightly higher than the 49% adherence rate observed in the usual care arm of the cluster randomized controlled trial and 50% in the diagnostic accuracy study,^{26, 29} suggesting a slight improvement over time. Repeated measurements within the sentinel network in the upcoming years could provide more insights into changes over time. The high adherence rate on prescribing recommended antibiotics in cystitis and the low rates in UTIs with signs of tissue invasion was also seen in the study based on the diagnostic accuracy data. Nitrofurantoin was also there frequently prescribed in UTIs with signs of tissue invasion. They hypothesize that this is partly because of the Dutch general practitioner's guideline published in 2020,³⁷ which recommends nitrofurantoin to certain male patients (although in our study the majority of women with signs of tissue invasion were also prescribed nitrofurantoin). In our group feedback sessions, the general practitioner's guideline was also mentioned as an argument to deviate from the UTI guideline for frail older adults. Some practitioners were even unaware that the antibiotic recommendation for men was different in the 2 guidelines. Another reflection shared by practitioners was that when deciding to prescribe antibiotics for UTIs with signs of tissue invasion, practitioners evaluated not only presence, but also severity of systemic signs and symptoms.

Although not the focus of this study, a strength of the network is the practitioners' reflections on reasons of guideline nonadherence that were shared

on the registration forms and during group feedback sessions. The reasons reported on the registration form most likely reflect situations where the guideline recommendations are too general to assist medical practitioners in specific cases, for example, the patient's medical history (eg, previous culture results or allergies), or because not all relevant information can be obtained from the patient, and consultation with specialists in hospitals is required for the most appropriate care. Some of the reflections have also been described in previous studies on inappropriate UTI management.^{5, 6, 9} The reflections not only demonstrate that practitioners encounter difficulties in translating guideline recommendations into clinical practice, but can also help practitioners to start the conversation in their teams on possibilities for a multifaceted improvement plan to reduce inappropriate antibiotics.^{27, 38}

Another strength of this study is the ability to electronically collect prospective data during daily practice to assess multiple components of guideline adherence on a large scale across different nursing homes using an EHR-integrated registration form. By using an EHR-integrated form, medical practitioners were automatically reminded of eligible cases through an alert. On request, around 80% of practitioners who registered cases perceived the alerts as adequate and were able to complete most of the registration forms directly after accepting the alert. Finally, by reporting separate percentages of intentional nonadherence, the study quantifies the number of cases where practitioners felt the necessity to deviate from the guideline to deliver appropriate care. Further research could explore the fitness of these deviations and whether, for example, medical practitioners' characteristics might be associated with nonadherence.

This study has several limitations, including the exclusion of registered cases because of insufficient information on relevant signs and symptoms to assess UTI treatment decision adherence rate. The residents of excluded cases resided more often in psychogeriatric wards compared to the included cases, which likely reflects the challenges practitioners face in retrieving information on residents with impaired awareness or ability to communicate signs and symptoms.^{5, 6, 9, 25, 39} Extreme scenario sensitivity analyses showed that the adherence percentages on treatment decision reported in this study could, for example, range from 55% (if all the cases with insufficient relevant information to the reported treatment decision were considered as nonadherent) to 76% (if the cases were considered adherent). Another potential bias is misreporting by medical practitioners. For example, not

reporting that another infection was the reason for initiating broad-spectrum antibiotics in cases where a suspected UTI had been ruled out. If not explicitly reported on the form, we assume that all reported antibiotics were initiated for UTI treatment. This assumption could mean that our reported adherence rate for treatment decision is at most 5% too low if all broad-spectrum antibiotics prescribed in cases that did not require UTI treatment were actually initiated for another unreported infection (see Supplementary Table 1). Furthermore, our study lacked sufficient information to fully evaluate if dipsticks were used only in situations of diagnostic uncertainty to rule out UTI. However, similar to other studies,^{25, 40, 41} we found a high usage of dipsticks in cases where the test result did not contribute to the treatment decision. The 3.5 times higher OR of antibiotic prescriptions for nonnegative dipstick results, compared with cases where no dipstick was used, supports the need for diagnostic stewardship to reduce inappropriate urine testing and consequently antibiotic prescriptions.^{6, 25, 40, 42} This study is also limited by the absent number of (suspected) UTIs that have not been registered by practitioners. One might be especially concerned that practitioners selectively do not report nonadherent cases ('cherry-picking'). This underreporting would result in an overestimation of the reported adherence rate, implying that there is even more room for improvement. Adherence rates found in this study might also not be generalizable to nursing homes outside the sentinel network for various reasons. Nursing homes participating in the network might have special interest in appropriate antibiotic prescribing, although we did observe variations in their level of engagement to the program. The questions on the registration forms or the guideline overview presented during the group instruction might have prompted medical practitioners to adhere more closely to the guideline.

Conclusion and Implications

This study showed that there is considerable room for improvement in all clinical stages of managing a suspected UTI in the nursing homes of a Dutch Sentinel Nursing Home Surveillance Network. Specifically, more focus is needed on the presence of specific urinary tract-related signs and symptoms in relation to the need for further diagnostic tests and antibiotic treatment of (suspected) UTI. Dipsticks should be used in situations of diagnostic uncertainty based on signs and symptoms to rule out the need for antibiotic treatment for UTIs. Attention is needed when prescribing antibiotics for UTIs with signs of tissue invasion, ensuring

the prescribed antibiotics can reach adequate tissue levels outside the bladder. The presented adherence rates in this study can be used to monitor the impact of quality improvement programs focused on diagnostic and antibiotic stewardship.

Disclosure

The authors declare no conflicts of interest.

Acknowledgments

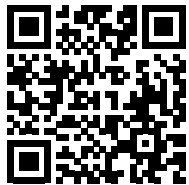
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Supplementary Materials

Supplementary materials are available online at <https://doi.org/10.1016/j.jamda.2024.105037>



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Audit and Group Feedback in Nursing Home Physician Groups: Lessons Learned from a Qualitative Study

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Abstract

Background: Audit and group feedback (A&F) is an instrument used to encourage healthcare professionals to improve the quality of care. Clinical practice was audited against a set of criteria and fed back to a group by a facilitator. The aim of this study was to gain a better understanding of how physician group feedback sessions in nursing homes were conducted and to what extent they resulted in action planning.

Methods: Fifteen group feedback sessions of the antibiotic A&F program within a nursing home network were audio-recorded, transcribed, and analyzed via the Framework Method for thematic analysis. The coding was performed using the existing Calgary A&F Framework and Cooke's conceptual model of physician behaviors, and open inductive codes were added.

Results: Elements of the conceptual model and the Calgary A&F Framework occurred within all group feedback sessions. The relationships within the group and with the facilitators were important elements when moving a group from interpreting the results to formulating action plans. Physician groups responded positively to the audit data, particularly if they were among the best performing. The data were met with doubt by physicians who did not recognize their own practice. When exploring potential reasons for lower guideline adherence, groups often considered data quality or external factors such as the choice of non-adherent treatment by locum staff. The degree of reflection on personal factors as explanations for low adherence and the extent to which groups identified learning and improvement opportunities varied: some groups were able to formulate action plans to address data problems and knowledge gaps, whereas others scheduled a follow-up meeting to develop action plans for treatment or prescribing practice changes.

Conclusions: The facilitator was crucial in supporting the group in interpreting the results, steering the conversation towards sharing change cues, and helping the physician group in developing action plans. The degree of reflection and action planning varied by group. By implementing the lessons learned from this study, group feedback sessions can be refined, supporting participants in action planning.

Introduction

Audit & feedback (A&F) is considered an instrument to improve quality in healthcare in which professional performance is systematically reviewed against a set of criteria and fed back to professionals in a structured manner.¹ Previous research has shown small to moderate improvements in desired practices, depending on the measures in the audit and the design of the feedback.² The improvements are stronger when baseline performance is low, when feedback is provided by a respected colleague, when it includes clear targets and an action plan for changing practices, and when it is provided regularly in both written reports and verbally.² However, the majority of studies have been conducted with primary care physicians in outpatient settings, whereas fewer studies have focused on nursing homes.^{2,3} The extent to which these recommendations apply specifically to the nursing home setting and the specific contextual factors (eg, nursing home vision, skill mix, and health care service integration) that can influence the impact of improvement interventions remain uncertain.⁴⁻⁷

A promising approach to A&F delivery involves a facilitator providing feedback to a group of recipients in a group feedback session.⁸ Research in the field of (medical) educational feedback indicates that recipients who actively engage with feedback through social interaction are better able to apply feedback to improve their own learning.⁸⁻¹² Along with other literature in implementation science and motivational and behavior change theories,^{8,10,13-18} these findings helped Cooke et al.^{19,20} to design and study their A&F projects with physician groups in Canadian hospitals. They developed the Calgary A&F Framework and a conceptual model of physician behaviors in group feedback sessions to better understand why some physician groups were more engaged than others.

The conceptual model of physician behaviors described the recurrent pattern of physician reactions and behaviors during group feedback sessions that was observed each time a finding (ie, data) was presented: after the initial reaction to the data, physicians tried to establish meaning and credibility to the data before reflections were shared on their own practice, experiences and views on evidence and clinical best practices.¹⁹ Essential in these group discussions were comments (ie, change cues), highlighting the importance of a performance gap revealed by the data. These change cues usually lead to a discussion on addressing the gap and planning for change (ie, change talk).

In the Calgary A&F Framework the different A&F design and implementation

elements are connected to the outcomes of physician group feedback.²⁰ Prerequisite activities such as the role and background of the group facilitator, the relationship and interaction between the facilitator and group, the feedback topic, and the visualization and actionability of the feedback were identified as mediating components for physician group feedback sessions. These prerequisite activities were used to better understand how some discussions progress towards action planning, whereas others stall. Cooke's et al.¹⁹ research showed that interactions between physician group members most often drove discussions to change cues and change talk.

In the Netherlands, approximately twenty nursing homes have been participating with their physician groups in group feedback sessions since 2021.²¹ The group feedback sessions are organized by our research team within the Dutch sentinel nursing home surveillance network, specifically for physician groups in nursing homes as part of an annual A&F program. During the audit period, physician group members record audit forms within their electronic health record on predefined topics, namely appropriate psychotropic prescriptions and appropriate antibiotic prescriptions for lower respiratory tract and urinary tract infections. The research team analyzed the data and a group feedback session was organized with each physician group to discuss their audit results to promote their professional learning and quality improvement activities.

The first cycle of group feedback sessions strongly varied across physician groups. Some sessions were highly interactive, with strong dynamics among participants as well as between facilitators and participants, resulting in concrete improvement plans. By contrast, other groups were more passive, perceiving the session as a presentation and focused on improving the audit rather than the clinical process. In the current study, by examining data from the second cycle, we aim to investigate the reasons for variations to improve the group feedback sessions. Since professional learning via group feedback sessions is relatively new in nursing homes, this study aims to gain a better understanding of how physician group feedback sessions in nursing homes are conducted and result in action planning. This study builds on research and theoretical models developed in other medical domains, notably the Calgary A&F Framework and Cooke's conceptual model of physician behaviors,^{19, 20} which are based on a similar setup of the A&F program and our experience with the first cycle. Based on the results of this qualitative empirical study, we formulate lessons learned to improve the group feedback sessions, professional learning and ultimately the quality of care in nursing homes.

Methods

Study Design

A qualitative approach was chosen to gain better insights into the experiences and behavior of physician groups that participated in the group feedback sessions. Due to the potential for the A&F design and implementation components to influence varying parts of the session in different ways, it was essential to maintain consistency in our analysis to enable a thorough and insightful comparison of the A&F design and implementation components. Consequently, our study focused on the lower respiratory tract infection (LRTI) part of each antibiotic group feedback session (See Supplementary Box 1, Additional File 1). The group feedback sessions were held between April and July 2023.

To guide the analysis, we followed the Framework Method, a form of thematic analysis that is particularly suited for identifying commonalities and differences within qualitative data.^{22, 23} It involves analyzing the relationships between the different parts of the data, thereby seeking to derive descriptive and/or explanatory conclusions clustered around themes, which can be derived inductively and deductively.

The consolidated criteria for reporting qualitative research (COREQ) were used as a reporting guideline (Supplementary file 2), and an audit trail was kept throughout the study to ensure transparency and rigor in the research process.

Context and Setting of the Audit and Group Feedback Sessions

Nursing homes in the Netherlands have a unique medical attending position known as the elderly care physician.²⁴ Elderly care physicians are medical specialists who provide 24/7 on-site medical care to nursing home residents. Depending on the size and medical staff model of the nursing home organization, they work together in physician groups that can also include nurse practitioners, physician assistants, medical residents in elderly care medicine or family medicine, and/or junior doctors. These professionals are all referred to as physicians unless otherwise specified.

In the A&F program, each physician group appoints a contact person who acts as the liaison between the physician group and our research team's coordinator. The coordinator encouraged physician groups in this cycle to participate in only one of the two A&F topics to enhance focus in the physician groups. Among the 24 physician groups in the nursing home network, nine chose the psychotropic topic, twelve chose the antibiotic topic, and three still chose both (S07, S12, S15).

Throughout the audit period, the coordinator maintained regular contact with the physician group's contact person and invited them to formulate learning objectives with their physician group and specific questions that they wanted the audit to answer. If necessary and feasible, the research team performed additional analyses, in addition to those already conducted for the group feedback session.

In the month before the audit, physicians were invited to attend instruction webinars on the audit procedure (± 30 min). A prerecorded version and written instructions were shared with the physician group's contact person.

Group Feedback Session

Group feedback sessions were planned preferably on-site in coordination with the physician group's contact person. Physicians obtained continuing medical education credits for their attendance. The group feedback sessions were scheduled to last 60 min, with an additional 30 min for physician groups that participated in both topics (Supplementary Box 1, Additional File 1). The session focused primarily on group discussion. To support this, the feedback information was provided in a PowerPoint presentation (Additional File 3), which was sent to the physician group prior to the group feedback session and used to facilitate the discussion during the group feedback session.

The presentation contained audit results aggregated at the physician group level for adherence to recommendations from the national elderly care physicians' guidelines.²⁵ For LRTI, adherence rates were calculated for three recommendations: A) appropriate treatment decisions regarding initiating or withholding antibiotics for LRTI; B) the appropriate use of C-reactive protein (CRP) tests in the diagnosis of LRTI, which was split into two rates, namely percentage of cases that were B1) appropriately tested and B2) appropriately not tested; and C) prescriptions of recommended antibiotics.

The results were displayed in bar charts and compared with the network's average, the top 10% performing nursing homes within the network (ie, achievable benchmark²⁶) and – when available – the physician group's previous results. The charts displayed the adherence rate for a specific guideline recommendation alongside the 'non-adherence' rate and the 'unable to assess' rate. A proportion of the non-adherence was classified as 'intentionally non-adherent' if the physician had recorded this in the corresponding field on the audit form. In addition to the charts, the presentation also contained slides with introductory statements to

introduce the different audit results and slides with general questions for reflection/discussion (eg, 'What do you notice?', 'Is this what you expected?').

Group Feedback Session Facilitators

The sessions were led by a faculty facilitator, together with a researcher as a research facilitator. The faculty facilitator was an elderly care physician with a background as a teacher at our department's residency program in elderly care medicine. The faculty facilitator's tasks in the group feedback session were to lead group discussions, support the group in exploring opportunities, barriers, and enablers to improve their practice, and help to formulate potential (learning) objectives and action plans. Before the start of the group sessions, the faculty facilitators had a two-hour introductory meeting with the research team on the A&F program, the audit measures, and the structure of the group session. In this introductory meeting, some attention was given to didactic skills, and there was some alignment between the facilitators to try to adopt the same approach in every group feedback session. The research facilitator's main role was to present the slides to the physician group and explain the charts, the data sources, and the data limitations behind the charts.

Three faculty facilitators and four researchers facilitated the group feedback sessions. They were paired based on their availability to participate in the scheduled sessions. Prior to the sessions, the facilitators held pre-meetings to discuss the specific physician group results. A description of all facilitators and research team members and their backgrounds is included in Supplementary Table 1, Additional File 1.

Ethics and Data Collection

This study was reviewed by the Medical Ethics Review Committee of Amsterdam UMC, which confirmed that the Medical Research Involving Human Subjects Act (WMO) did not apply to this study (reference number 2023.0261). All group feedback sessions in which the antibiotic A&F topic findings were discussed were completely audio-recorded (n=15). Together with the invitation for the group feedback session, participants were informed about this study. They were provided with the option to object without reason to the audio recording in advance or at the start of the group feedback session. Prior to recording, consent was obtained from all group session participants.

After every group session, both facilitators completed a structured evaluation questionnaire (Supplementary file 4). This evaluation questionnaire was developed specifically for our study, based on a questionnaire used by general practitioners in an A&F program.²⁷ Informed consent for the online questionnaires was acquired digitally at the start of the questionnaire.

Data Analysis

Our study followed the seven stages of the Framework Method described by Gale et al.²². GY and CA conducted all stages of the research, in collaboration with other researchers. In the first stage, the audio recordings of the complete feedback sessions were transcribed verbatim by students and checked by a member of the research team by relistening to the complete audio recording. Relistening was also part of the second stage of becoming familiar with and immersed in the data as researchers. In the third stage, four transcripts were coded independently, and after each transcript discrepancies between codes were resolved through discussion to familiarize us with the codebook. The first codes and themes were based on the Calgary A&F Framework and Cooke's conceptual model of physician behavior and used as a starting point for our codebook to analyze the transcripts (deductive). New (sub-)codes and themes were added inductively to identify actions and recurring patterns that were not sufficiently captured by the deductive codes. After the first four transcripts, the research team was assured that the coding scheme and approach developed were sufficient to apply to the remaining transcripts (stage 4: Developing a working analytical framework). The remaining transcripts were fully coded by one team member, while the other team member checked the coded transcripts and discrepancies were discussed (stage 5: Applying the analytical framework). CA was the initial coder of all group feedback sessions in which GY took part as a research facilitator. In stage 6, the data from each transcript were summarized overall and for each main element of the framework (prerequisite activities, facilitator, physician behavior, and change cues/talk) (charting data into the framework matrix) (Table 2). In the final stage 7, the research team compared the summaries of the different elements of the framework and looked for similarities and differences in terms of how the different sessions progressed through the model. Furthermore, the summaries of all cases were compared to explore different factors of influence on action planning. To triangulate findings, qualitative data in the form of answers to open-ended questions of the evaluation

questionnaire filled out by both facilitators after each session were explored for findings that substantiated or deviated from our data.

All qualitative analyses were performed in MAXQDA 2022 (VERBI Software).

Results

Participants

Across the fifteen physician groups, 163 physicians participated in group feedback sessions (Table 1). The number of participants per session ranged from three to twenty, reflecting the size of the nursing home organization and physician group that participated. It was also influenced by other factors, such as who was invited from within or outside the physician group (eg, affiliated pharmacist/physician group, manager), the scheduling of the session, and absence due to medical emergencies.

Calgary A&F Framework and Conceptual Model of Physician Behaviors

The results are described following the main components of the adapted Calgary A&F Framework and Cooke's conceptual model of physician behaviors (see Fig. 1 and Table 2). We included organization as an extra component to the existing prerequisite activities, influencing the group feedback session.

Prerequisite Activities

Organization

Among the fifteen group feedback sessions, twelve were in-person, one was hybrid, and two were held online. In-person group feedback sessions seemed to lead to the best group dynamics. Although the numbers of hybrid and online sessions were limited, there was a difference in the interaction and engagement between the hybrid and online sessions and the in-person sessions. Digital support appeared to be an important factor in this process, which was also indicated as an area for improvement by facilitators on the evaluation questionnaire. When some participants were gathered together behind a single screen, it was difficult for the facilitator and other participants behind their single screen to hear and understand what was happening among these groups of participants.

The group size also seemed to play a role in interaction and engagement, for both online and on-site sessions. Compared with the online session with twenty participants (S02), the online session with three participants had better interaction

Table 1. Description of the participants and organization of group feedback sessions

Physician Group	Total Number Participants	Size of Nursing Home Organization*	Session Facilitators [‡]			Type of Session	Remarks on Participants
			Faculty Facilitator	Research Facilitator			
S01	20	Medium**	n/a	FR1	On-site	-Contact person of the group took on the role of faculty facilitator -5 ECPs, 2 APs, 5 medical residents, 8 other participants of affiliated physician group and affiliated pharmacists	
S02	20	Large	FF1	FR2	Online	-ECPs, medical residents and junior doctors, exact numbers are unspecified	
S03	11	Medium**	FF1	FR2	On-site	-7 ECPs, 1 medical resident, 3 junior doctors	
S04	8	Medium	FF1	FR2	On-site	-2 ECPs, 4 APs, 2 junior doctors	
S05	10	Large	FF2	FR2	Hybrid	-5 ECPs, 1 AP, 1 medical resident, 3 unspecified	
S06	4	Medium [†]	FF1	FR3	On-site	-1 ECP, 1 AP, 1 medical resident, 1 junior doctor	
S07	13	Large**	FF3	FR4	On-site	-6 ECPs, 3 APs, 2 medical resident, 1 junior doctor, 1 medical intern	
S08	15	Large	FF2	FR2	On-site	-13 ECPs, 2 medical residents, 1 policy advisor	
S09	19	Large	FF1	FR1	On-site	-Contact person of the group had the role of both faculty facilitator and research facilitator; FF1 and FR1 attended in a supportive role -11 ECPs, 7 APs, 1 medical resident	
S10	5	Medium [†]	FF3	FR4	On-site	-2 ECPs, 2 APs, 1 director of care	
S11	3	Medium [†]	FF1	FR3	Online	-2 junior doctors, 1 non-clinical manager of physician group -a medical emergency hindered the ECP and nurse practitioner of the location from attending	
S12	6	Medium	FF3	FR2	On-site	-4 ECPs, 1 AP, 1 medical resident	
S13	8	Medium	FF1	FR1	On-site	-7 ECPs, 1 medical assistant (to take minutes)	
S14	8	Medium	FF3	FR3	On-site	-3 ECPs, 3 APs, 1 junior doctor, 1 medical intern	
S15	13	Medium	FF2	FR3	On-site	-6 ECPs, 4 APs, 3 junior doctors	

*Size of nursing home organization: Small = < 150 beds; Medium = < 500 beds, Large = > 500 beds or >15 locations.

**Participated in the antibiotic topic with a selection of their locations. [†]Participated with only one location.

[‡] For background information on the session facilitators, see Supplementary table 1, Additional File 1.

ECP = elderly care physician, AP = advanced practitioner (nurse practitioners, physician assistants and/or those in training), medical resident in elderly care physician or general practice.

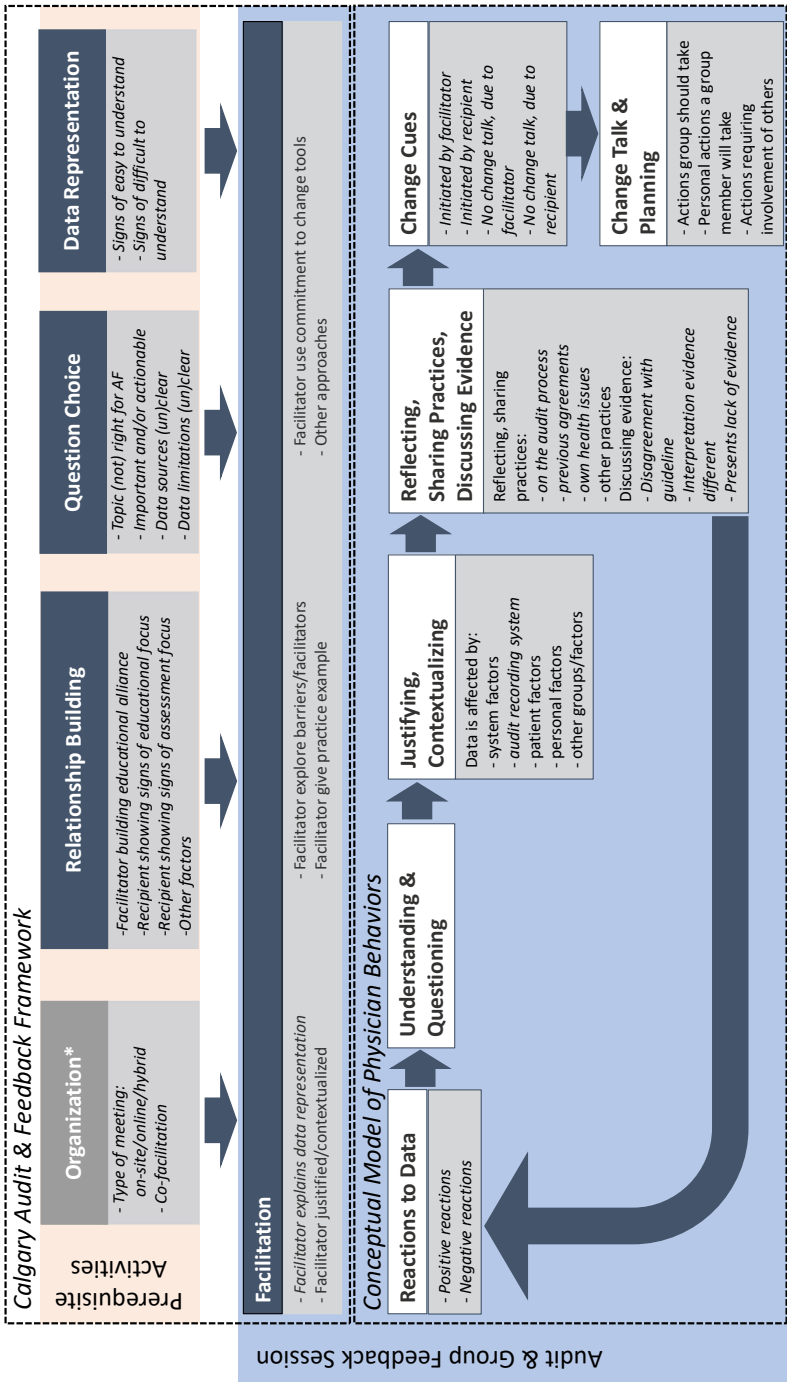


Figure 1. Adapted Calgary audit and feedback framework and conceptual model of physician behaviors
The codes used for data analysis in the current study are shown in light gray blocks, with specific codes inductively derived in this study in italic. *New factor included in this study

Table 2. Framework matrix

Group	Prerequisite Activities	Facilitator
S01	In-person GFS, in which the discussions were led by an ECP of the PG (co-F1), who was also the network's CP and part of the research team in the first cycle, having also led GFSs. Prior to the GFS, co-F1 had a meeting with FR1 about the results. The PG also invited the PG of another NH organization, with whom they carry out their pharmacotherapy discussion groups. The other PG had no experience with the audit procedure and not all wards of their own NH organization were included in the audit. co-F1 had also analyzed additional prescription data of both PGs, together with the NH's pharmacist. Several minutes after the session started, there was a power cut, meaning that the presentation could not be shown on the large screen. Rs had to follow the presentation on laptop screens. R remarked that stratifying results at the department level would be insightful to relate findings to more specific patient populations.	During the presentation, co-F1 also read aloud the official guideline recommendations to the group. co-F1 already contextualized the findings for the group and explicitly mentioned the learning points that she found in the data. co-F1 wanted to discuss action plans at the recap, after all of the LRTI data had been presented. co-F1 ensured that these actions were included in the minutes. For the AB, FR1 mentioned that they were doing well: FR1: (...) No, that's right, it's going really well. It's going better this year than last year. And what's more, that 5%... remains. co-F1: [Name of their organization] is orange. FR1: Yes, [Name of their organization] is indeed orange. And that one exception was someone who was sent to the hospital and, erm, eventually received Augmentin there as well. So.. 95, maybe even 100% are doing fine. (S1) However, there were only nineteen forms: FR1: This works, but it's about nineteen antibiotic prescriptions.. (S1) co-F1: Well, guys, what can be improved? .. CRP? co-F1: What should we write about that? co-F1: Should we do those more often? Or less often? Or...? (S1) When co-F1 asked what could be improved and an R mentioned the 'unable to assess' part, co-F1 said that they had already talked about this.
S02	Online GFS with a large PG of an NH with many locations. FF1 already knew some ECPs in the PG.	FF1 mentioned at the beginning that there is little time to discuss everything and repeated this during the session. Time pressure was mentioned as a reason to move on to the next section. The two Fs used different methods to increase the interactivity of the session, which included asking R to physically raise their hands to see if they agreed/ disagreed with the introductory statements, keeping long silences, or remarks at a meta-communication level.

Physician Behavior	Change Cues/Talk
Possible explanations were shared for non-adherence, especially regarding CRP testing. Some Rs disagreed with the guideline. Rs responded openly to critical questions asked by co-F1 about reasons for non-adherence. Regarding AB choice adherence, the PG had an 95% adherence rate with the remaining 5% being intentional non-adherence. R shared that the result was unexpected, 'because I see quite a lot of Amoxi passing during the on-call hours anyway' (S1). Rs thought that this might be due to upper respiratory tract infection, cases not captured during the audit, or occurring on wards that did not participate. When Rs heard the reason for intentional non-adherence (prescribed by hospital specialist), they believed that the result should have been 100% adherence. There was a brief discussion about the large proportion 'unable to assess' and audit forms not being properly filled out, although little action followed.	Many change cues/talks were not followed by actions, in most cases due to the co-F1 plan to formulate actions at the recap. Regarding the CRP testing, one suggestion was to acquire a second CRP POCT device. The R working on the PG's budget plan for next year indicated that he could add this to their budget plan. Other actions included adding a guideline-recommended AB to their local formulary that was missing and ensuring that everyone can use the CRP POCT device.
Minimal (plenary) interaction in the group, especially during the AB results. Most interaction was on the CRP testing. Rs who joined the online session collectively at a location seemed to interact with each other, although their input was not always heard by the rest. The conversation was also affected by Rs having problems in switching the mic on/off. R noted that adherence rates would look better if the category 'unable to assess' was omitted. R indicated as a reason that there is high staff turnover in the PG, including during the audit period, and as a new staff member had not received any instructions on the audit procedure.	Different issues were raised by Rs, including a lack of knowledge on the audit procedure for new and locum staff, a lack of qualified staff to perform CRP POCT, and the competence of (locum) staff (better-safe-than-sorry approach, or unaware of possibility of CRP POCT). R proposed solutions such as better instructing the new and locum staff.

Table 2. Continued

Group	Prerequisite Activities	Facilitator
S02 (cont.)		FR2: [...] we chose nitrofurantoin once. For, yes, a work diagnosis of lower respiratory tract infection, which is also interesting. I don't know if other people ... here ... see any other interesting things or [4-sec silence] recognize? [6-sec silence] For... is this how you expected it to be? [14-sec silence] FF1: I, I think so, listening to this... I'm not hearing any responses, so... Are you surprised by these numbers? (S2) FF1 not only summarized at the end of the LRTI part but also several times during the various discussions and also openly confirmed the accuracy of the summaries with the PG. In the recap, FF1 asked about areas for improvement but received few responses.
S03	In-person GFS. FF1 knew a couple of ECPs well in this group, as they were also involved as educators at the medical residency program. PG also participate in another national NH infection surveillance program. PG requested data to be split at the unit level, but according to the research team too few forms were registered to disclose these results safely. R asked for clarification on the top 10% benchmark.	FR2 not only explained the data but also tried to prompt PG for reactions based on earlier discussions in other GFS. FF1 complimented the group in the recap, noting that they had been doing very well: Furthermore, well, as we just discussed, overall it's going very well, you could say. Especially compared to last year, you've managed to adhere to the guidelines even better. (S3) FF1 explained here to the group that the recap would be short due to the limited time available.
S04	In-person GFS with a PG where, according to FF1, 'a nice distribution' of ECPs and nurse practitioners were present. During the introduction, one of the ECPs introduced herself as the medical manager of the PG.	Fs answered questions from the R about ambiguities regarding the recording and guideline. There was no summary at the end of the LRTI section. Fs referred to the minutes that a R had been taking and asked a general question if all learning objectives had been included. It is unclear how the R could have answered that question: FF1: No, I think, yes, we've now reflected enough on that and formulated learning objectives, haven't we? Those have also been noted. So, erm, are there any additional things you think you can take as learning objectives from this? Because then we'll close the topic of respiratory infections, okay?

Physician Behavior	Change Cues/Talk
Rs seem to experience different clinical problems depending on the location in which they practice. For example, regarding CRP POCT, some encountered the absence of qualified staff to perform the test when needed, while others doubted its usefulness for their specific patient population (post-operative rehabilitation patients).	
Very interactive session, with the CP initially being the first to respond. Rs did not expect so few recorded audit forms, which they found slightly disappointing. Rs believed that they had not recorded all cases. Discussions on different topics regularly ended with problems related to the audit procedure. The reactions to the data were predominantly positive. Although they scored 88% on the AB adherence rate, they were disappointed not to be in the top 10%. Rs found it interesting to see the reported reasons for intentional non-adherence and tried to contextualize/justify the non-adherent data. However, Rs suggested that most non-adherent cases had probably been 'forgotten' to be recorded as 'intentionally non-adherent'. The Rs shared difficulties that they encountered when ordering a CRP POCT.	During the discussion, the CP also prompted the group with questions (e.g., 'Why do we prescribe more?'), which resulted in Rs sharing personal reflections/opinions, although this did not necessarily lead to change cues/ talk. FF proposed in the recap that the PG can discuss the appropriate use of CRP in another meeting and due to time constraints continued to the UTI part.
The CP and medical manager were often first to speak and emphasized that participation in the A&F program should be seen as a quality improvement tool. R questioned what the results meant when a large portion was 'unable to assess.' Another R noted that if you leave out the cases due to lack of CRP POCT, the adherence rates were already near the Top 10%: R1: Well, if you take the CRP out of the equation, then we're already getting close to the top ten [laughs]. (S4)	The CP was in the process of implementing the new CRP POCT device and informed with the Fs if there was any support for that. Furthermore, the medical manager mentioned feeling responsible for the insufficient introduction of the new staff to the A&F program and committed to paying more attention to this. R thought that it would also be valuable to discuss patient cases/chart reviews with each other more often, including outside of the A&F program.

Table 2. Continued

Group	Prerequisite Activities	Facilitator
S04 (cont.)		FR2: Yes, I think so, given the time as well, otherwise it will come in due time, yes.
		FF1: Yes, no, I think, yes, no further additions. (S4)
S05	Hybrid GFS, which was initially unclear for the Fs, and it was only during the discussion about the first adherence rates that an on-site R remarked that they missed the presence of online R. An on-site cellphone was used to connect with the two online R, which made it difficult for the online R to participate. FF2 knew one ECP of the PG. CP of the group is a nurse practitioner who used to collaborate with an ECP, but the appointed ECP left without a replacement. This was brought up after a question from FF2 regarding whether there was a driving force in the group. An ECP-R responsible for medication safety proposed to also become involved as CP. The ECP CP who had left requested additional analysis of the data for the presentation (differences between psychogeriatric and non-psychogeriatric care). When the Fs raised this, the group found it interesting but were unaware of any specific reasons for these additional analyses. R asked for clarification on how cases would be classified as 'unable to assess.' R was unaware that the audit period had ended.	After FR2 presented the data, FF2 often responded first. FF2 contextualized the data for the group and explored reasons for non-adherence by making suggestions. PG ended up in a confusing discussion after FF2 asked if the local prescribing standard of LRTI had been reviewed against the regional resistance pattern. PG wondered if the pharmacist who they work with had assessed this and how reliable these assessments were. Many questions were raised about the added value for LRTI. FF2 concluded that the regional resistance pattern might be more appropriate for UTIs than LRTIs and moved on to the next section due to time constraints.
S06	In-person GFS in an NH where only the rehabilitation departments are participating. The group also sees opportunities to learn from the cases in the categories of 'intentionally non-adherent' or 'unable to assess.' CP would like further detailed information about the non-adherent audit forms so that	Fs emphasized the importance of learning. FF1 monitored this: when FR4 used words such as 'right' and 'wrong' FF1 reminded everyone that the goal is to learn and not to focus on whether something is right or wrong. Fs emphasized the low number of forms and the importance of effective recording during the audit period. Fs appeared to question whether these small numbers were realistic. FF1 used the benchmark results as input to reflect with the group.

Physician Behavior	Change Cues/Talk
Moderate interaction. R believed that non-adherent cases where AB were not initiated were 'intentionally non-adherent' due to factors such as treatment restrictions but had been forgotten to be registered. R indicated that a CRP is often not done because it is 'such a hassle' given that there is only one CRP POCT device at their main site. One R is involved in a new protocol to enable testing at each site. R3: Yes, previously we had no a CRP device at all, so that. (S5) R were not surprised about the high AB choice adherence rate, as similar results were also reported by their pharmacist. The PG mainly attributed this success to their local prescribing standard. A new occurrence this year was that 13% of the AB cases were prescribed ceftriaxone as adherent AB (n=2). R found this 'actually not much' and no further remarks followed.	During the first discussion on treatment initiation adherence rates, R raised a change cue on CRP testing, stating that she never performs a CRP test. FF2 responded by stating that the CRP results would follow in a moment, although other R were responding on the issue raised at that moment. This original change cue was not further explored later on. Discussion around CRP POCT prompted a R to speculate how CRP POCT sampling works and whether it is possible to practice that on each other.
The CP was often the first to respond and it seemed like the CP talked more than the other Rs, especially at the beginning. Rs found the low numbers of AB prescriptions realistic (n=2), as proof of already prescribing AB very selectively in their PG. Rs found the audit recording procedure not to be optimal, and shared the problems that they encountered. Fs responded to the recording problems by explaining how the system should be used to avoid those problems.	When talking about reasons for non-adherence, a R raised a change cue on the appropriate use of the CRP test. FR2 stated that this would be discussed later in the CRP section. However, the specific issue was not rediscussed. Another R tried to bring it up again after the AB section. In the subsequent discussion, a comparison was made with the urine stick, and Fs identified a transition to continue with the UTI part. FF1: Yes, fine. I think that's a nice transition,

Table 2. Continued

Group	Prerequisite Activities	Facilitator
S06 (cont.)	they can review the charts for additional learning points. Prior to the meeting, the CP requested a stratification of the data at the unit level of their rehabilitation department, although the number of recorded cases was insufficient.	No summary of the LRTI part was made.
S07	In-person GFS, where NH's rehabilitation departments participated in the AB topic and long-term care departments in the psychotropic topic to limit the registration burden. This selection was not clear to all Rs. At the LRTI recap, R wondered if they would be punished more. CP responded by stating that it is a waste of time and effort if forms are not filled out correctly and that it is therefore appropriate if it feels slightly like a punishment. R asked whether the results are based exclusively on registration forms or if other data sources were also used. They also questioned how one patient could have multiple recorded forms. Another R wondered about the duration of the audit period. An R found it 'a bit strange' to change practice or treatment based on audit results that do not incorporate patient outcomes. CP saw himself as the driving force when FF3 asked if the group had one.	There was a lot of discussion about the recording of the audit forms. FF3 tried to limit the recording discussion. FF3 pointed out that other participating NHs would have also encountered these recording problems and comparing the PG's own results to the average and top 10% benchmarks still looked less adherent. FF3 also explicitly stated that the discussion on the recording system had been covered now and should not be repeated again in the following parts. In the recap, FF3 started by asking: 'What are your conclusions and do you say, 'well we have to do something,' or, 'so be it?'" They then explored with the group ways to achieve the improvement goals that R shared. FF3 challenged Rs to make the goals SMART and reminded them that last year's goal was already to acquire a CRP POCT device.
S08	In-person GFS that had been included in the off-site day of the PG. Only ECPs and their medical residents were present, together with their policy advisor. FF2 knew some of the group due to his teaching activities. The reason for this PG's participation was to assess how they had improved over the past year. R asked clarification on the top 10% benchmark.	FF2 explored with the PG how to interpret the results and the possible causes for non-adherence. In the recap, FF2 concluded with a final remark that the PG is already addressing issues from multiple angles, whereby they should not tackle too much at once and rather focus on a few items, and see how the results are next year: FF2: Yes, that's a also a good one. Yes, you're already addressing many things from several angles. Yes. Yes, and you can't tackle too many things at once; at some point, you don't know, do you? Take on a few items and see what that does next year, I think that's important. (S8)

Physician Behavior	Change Cues/Talk
	right? For the urinary tract infection. So, well. Let's see what we have there, erm.. (S6) A change cue that was not addressed by Fs or Rs is the discrepancy between R mentioning that the local formulary follows the Verenso guideline but later on R mentioning that the Verenso guideline is possibly not very suitable for their rehabilitation department.
Moderate interaction. Rs believed that the number of recorded cases was low, feeling that they had not adequately recorded cases. Rs discussed the audit recording system extensively. During the CRP statement, R mentioned that insufficient testing is likely due to the absence of a CRP POCT device. The AB section began with R noting that they always adhered to the guidelines, but the locum staff, primarily trained in family medicine, did not follow the 'correct' guidelines. Upon reviewing the specific percentages of different AB, the group realized that their formulary was still not in accordance with the guideline. Some Rs believed that the formulary had been updated to align with the guidelines, while others thought that there were reasons for the discrepancy but could not recall them. CP concluded that they could 'defend' their non-adherence rates in AB choice given that their formulary is different.	For changes to the formulary, they plan to ask a peer PG member (who was not present) at their regular PG meeting this afternoon. PG must be more aware of the effect of the departments with a high medical staff turnover (e.g. temporary medical residents or junior doctors) on the audit procedure, the specific guideline to use and the local prescribing standard. Regarding CRP POCT, Rs still wanted to invest in this but found it challenging to make it a more SMART goal, then planned to discuss it further at the next PG meeting. FF3 probably noticed that the PG felt they had to defend themselves concerning his questions about why it had not been purchased in the past year, reminding them: FF3: Yes, this is not for me. It's for you all. (S7)
Interactive session. Rs concluded that they were scoring average and were quite satisfied with this result: R2: But overall, we score quite average compared to the rest of... to the other organizations. (S8) They noted an improvement compared to last year and believed that next year, with the CRP POCT device available at more locations, the results would further improve. R mentioned that participating in this program made them more aware of the guideline and its implementation:	When discussing the reasons why cases were 'unable to assess', R already brought forward that only one site has a CRP POCT device, which makes it challenging to adhere to the guideline. R are working to invest in more CRP POCT devices. FR2 intended to contribute to the discussion by presenting the CRP audit results, but overlooked that the slides comparing treatment initiation rates with last year were shown before the CRP results, and the conversation switched to the comparison with last year. During the CRP segment, the group discussion focused more on which situations are appropriate for testing.

Table 2. Continued

Group	Prerequisite Activities	Facilitator
S08 (cont.)		
S09	In-person GFS during an off-site day with the ECPs of the PG. An ECP of the PG who is also the network's CP presented the data and led the discussion (co-F2). co-F2 held a preparatory meeting with FF1 and FR4. co-F2 prepared printed versions of the guideline's flowchart for Rs to support the presentation and for Rs to use as a reminder at their desk. R saw the added value of the presented data, and for the CRP topic to measure again next year, for example. Rs wish to see the data in more detail, aggregated at the location level and office hours vs locum hours. co-F2 mentioned that these questions are valid and interesting but for now 'global feedback' was presented, and that they would definitely encounter other data limitations. R asked for clarification of the top 10% benchmark. They were happy to see that they were in the top 10% concerning the AB adherence rates and wished to also be in the top 10% for the other results.	co-F2 presented the data systematically and at the same time gave an interpretation/explanation. co-F2 also shared what he found complicated about the data or 'could not do anything with' due to the low numbers. Concerning the CRP data, co-F2 thought that it could not only be explained by the absence of a CRP POCT on locations, but the 'actual usage is still an issue.' FF1 and FR4 occasionally assisted co-F2 with more detailed information on the data analyses or addressed issues raised during other GFS.
S10	In-person GFS. PG was especially interested in the CRP results because they had acquired a CRP POCT device in the summer before the new audit period started. PG also set a goal for this topic. Some of the R reviewed the presentation that was sent in advance, while others did not have time for that.	Fs both emphasized the low number of recorded cases multiple times during the presentation. The issue raised around the presenting symptoms included in the guideline seemed to be approached by Fs with a focus on the audit recording system. FF3 also seemed focused on the question of whether Amoxicillin is in their emergency supply inventory, as well as the onboarding procedure of new medical staff.

Physician Behavior	Change Cues/Talk
R1: Yes, perhaps it's simply the fact that this is the first time we worked with the A&F program, which could explain it. So, the fact that it was discussed in an pharmacotherapy discussion group and received more attention, so, yes, maybe you're seeing that reflected here. (S8) R6CP: You can really see that learning from data, because these are data that we collected ourselves, are being discussed here. You already saw, in those two years we've been talking about it, that it led to better interventions, so it truly is a nice learning cycle, erm. (S08)	In the recap, FF2 raised the question to the group about addressing potential non-adherence related to medical residents. Several solutions were discussed, leading to a proposal by R to more clearly specify in the onboarding documents the guideline and drug formulary to which the PG adheres. It was suggested that these changes could be integrated with the current revision of their onboarding process for new physicians.
Interactive session in which Rs responded promptly to questions and other remarks. Rs appeared to follow/agree with the interpretation and explanation of the results presented by co-F2. Explanations for non-adherence were sought by R in the availability of CRP POCT (not available at every location), the locum services, and the audit recording system. After these issues had been addressed by the PG, R shared more individual actions: 'Here's hoping for the best, let's do an antibiotic course.' Rs believed their threshold to fill in a form was perhaps too low and all those forms that could not be assessed could have better been not recorded. Furthermore, audit recording problems such as completing audit forms and forgetting to record cases as 'intentionally non-adherent' were brought forward. In response to the introductory statement about the CRP POCT, R already reflected and provided different practice examples.	co-F2 announced during the introduction that he planned to review the findings more critically and in depth with a colleague to ensure a follow-up of today's session. The R within the PG responsible for the implementation of the CRP POCT devices planned an action to inquire within the organization on the progress. FR4 wondered how the PG will monitor progress on the CRP POCT. R responded that it would be addressed in their next PG meeting. R suggested that the AB selections in the formulary for LRTI should also be based on regional resistance patterns. The discussion that followed led to another R responsible for infection prevention within the PG explaining that this matter had already been addressed in a regional infection prevention meeting and that it is not meaningful for LRTI to do.
R recognized themselves in the presented data and did not seem bothered by the low number of cases. The first response by R as a reason for non-adherence was related to CRP testing, to which FF3 informed the group that those issues would be discussed later. The adherence rates on treatment initiation were slightly disappointing for the R: 'I am somewhat disappointed' (S10).	FF3 pointed out the number of Amoxicillin prescriptions in the data, and then asked about the emergency supply and suggested a potential improvement to remove Amoxicillin from the emergency inventory. An R initially responded they would look into this. Later, when FF3 reiterated this action, another R shared that Amoxicillin is not part of their emergency supply. The suggestion by FF3 to pay attention to their

Table 2. Continued

Group	Prerequisite Activities	Facilitator
S10 (cont.)	Rs became more aware of the possibility to check the ‘intentionally non-adherent’ box on the audit recording form. The first part about CRP testing was not audio recorded on tape.	
S11	Online GFS with an NH organization that participated in the A&F program with only one location. Only the medical team from that location took part. Two junior doctors and a non-medically trained manager from the PG were present, while the ECP and nurse practitioner were called away for an emergency situation. FF1 appeared to be very conscious of the fact that R were junior doctors, as she mentioned this several times. During the first introductory statement, an R’s camera remained off. However, it was switched on after FF1 remarked that it would be better if everyone could see each other. Following a remark by R about the delivery problems concerning Augmentin in their NH region, it became clear that R thought the audit period was still ongoing.	FR3 suggested at the start to move through the LRTI part quickly to allow more time for the UTI part, due to the low number of registered LRTI cases (n=8). During the CRP section, FF1 focused on the absence of a CRP POCT device in the NH. FF1 emphasized the importance of including in the minutes that having a CRP POCT device is essential for adhering to the guideline. AB adherence rate was 100% based on three forms. FF1 took a moment to explore the local formulary that they used, and Rs shared that the local formulary had been recently updated, but they were uncertain whether it had been done based on the Verenso guideline. In the recap of LRTI, FF1 summarized the findings and then asked Rs if anything was missing. FF1 was positive and encouraged R to continue in this manner. FF1 did not actively involve the manager in previous parts due to the manager’s non-medical background. FF1 explained this to her before inviting her to contribute to the summary if needed. FF1 proposed to Rs to report today’s findings/minutes at their next regular PG meeting.
S12	In-person GFS. One ECP-R knew FF3 because he did his medical residency training in an NH in which FF3 was the residency program director. PG participated in both AB and psychotropics topics.	When the Rs were discussing the audit recording system, Fs tried to redirect the discussion by asking, for example, which CRP adherence rate they would be satisfied with next year. However, R answered with doubts about whether the audit procedure can capture these improvements. Due to time constraints, Fs did not explore all issues raised by Rs.

Physician Behavior	Change Cues/Talk
They especially found the presenting symptoms on the flowchart difficult, as these did not always match with practice. This issue had already been brought up in the introductory statement discussion on the flowcharts and recurred in almost every discussion in the GFS. R also tried to understand why these cases were captured in the audit recording system. Fs took the time to explain this. CRP testing was not fully captured on the audio recording, but in the last part of the discussion Rs talked about CRP results and their clinical value. Interactive session. R thought that the low number of forms was due to the infrequent occurrence of LRTIs. R mentioned that they had sometimes cancelled an audit recording form because the suspicion was an upper respiratory tract infection. Based on the responses of Rs to the introductory statement about CRP, it appeared that they were unaware that the guideline recommendation for severely ill patients suspected of LRTI is to start antibiotics immediately rather than performing CRP testing. This possible knowledge gap was not explored.	onboarding procedure led to an idea from R to include more information on the guidelines that new medical staff should use. Furthermore, Rs saw possibilities to adapt the already planned clinical training to the results of this GFS, and decided to organize this training not only for the junior doctors but also for the supervising physicians. They also wanted to print the flowcharts as pocket-size cards as a reminder for them on the work floor. There are no change plans.
Rs were interested in the category of ‘intentionally non-adherent’ and ‘unable to assess’ to help them to better understand the data. From the data, R concluded that the low adherence can be explained by the lack of a CRP POCT device during the first part of the audit period. CRP POCT had only recently been introduced at their main site. When discussing the CRP adherence rates, Rs concluded it is clearly still an improvement goal. Rs also took	In the recap section, the group formulated the following action plans: -The R responsible for the medical GP residents will pay more attention during the onboarding to the difference between the GP and NH guidelines.

Table 2. Continued

Group	Prerequisite Activities	Facilitator
S12 (cont.)	R mentioned that by participating in this A&F program, they increased their awareness of adhering to the guideline.	The uncertainty in the group regarding the Amoxicillin prescription and their trust in the data prompted FR2 to check the data after the GFS. Upon confirming that the medical GP resident prescribed it, it made more sense to the group. FF3 asked Rs to summarize what is going well and what needs attention. FF3 explored with the group how they would approach the points that needed attention.
S13	In-person GFS. They specifically requested that their antibiotics data could be stratified between moderately and severely sick patients with LRTI to align with their regional formulary.	FR1 skipped the comparison slide showing last year's adherence rates, because only two cases were registered last year. FR1 also skipped the introductory statement on CRP usage as it had already been discussed in the previous introductory statement. In the questions and remarks placed by FF2, FF2 used examples mentioned in previous GFSs. In the recap, FF2 summarized the improvement points for the group, placing more attention on recording cases as 'intentionally non-adherent' and re-evaluating the decisions made regarding CRP testing in their practice.
S14	In-person GFS with a PG that participated for the first time. They saw this as a baseline measurement but were not exactly certain if all locations took part in the audit, especially the remote location that has no CRP POCT device. R asked for clarification on the top 10% benchmark.	Fs directed the group towards specific topics, and among other things the recording problems were discussed, but in other moments they let the group freely discuss. Fs asked the group what their take-home message is from the LRTI presentation.

Physician Behavior	Change Cues/Talk
the time to share their reflections on their experiences with the implementation process of CRP POCT and the improvements that they have already made. Rs also discussed issues that they encountered with the audit recording system. Fs addressed these issues in detail. R questioned whether the 6% difference in adherence rates shown in the comparison with last year was not just a coincidence. In the AB section, Rs expressed surprise that someone prescribed Amoxicillin. Rs could not believe who did this, and they were inclined to believe this was a recording error rather than reality, although R suggested that the medical GP resident was perhaps the prescriber.	-They will print out the guideline's flowcharts and hang them at their desk. -They will monitor the CRP testing for six months during out-of-office hours, and after the evaluation address any issues with the locum agency that cover their on-call shifts. -The Rs on the remote site will monitor the frequency of indications for CRP POCT for six months to see if a device is also needed at their site. Rs indicated that in the week following this GFS, the PG's quality visitation is scheduled by the professional association of ECP. Some of these plans can be incorporated into the upcoming year plan.
Interactive session. Rs were surprised that the 'intentionally non-adherent' rates were not higher. Given that the PG has a regional formulary/prescribing standard that differs from the guideline on CRP testing and recommended antibiotics, Rs repeatedly concluded during the presentation that they should remember to record their cases as 'intentionally non-adherent.' Several Rs also discussed in various ways whether a CRP POCT (device) would be useful in their practice. R found it difficult to decide this based on the presented data. Rs also mentioned the challenges of implementing CRP POCT across the numerous NH locations within the organization.	After the recap, Rs began to question the reasons for the regional differences from the guideline, and whether the decision for no CRP POCT should be re-evaluated. No R could share the exact reasons for the regional differences, but an R mentioned there is a regional meeting planned at the end of the year with the experts of the regional standard. This R, who is responsible for the meeting, asked everyone with questions to email them to her so she could collect them for the meeting. In the meantime, for the next audit round, PG decided that every recorded LRTI case should be recorded as 'intentionally non-adherent' given their deviating formulary/standard.
Interactive session, in which the CP had a lot of input. Rs shared audit recording problems when the results were shown on 'unable to assess.' R interpreted the 'intentionally non-adherent' cases as adherent, which brought their adherence rates closer to the top 10% benchmark. R also considered the possibility that some cases were simply forgotten to be recorded as 'intentionally non-adherent.' In the AB section, the PG discussed all of the prescribed drugs and reasons for starting non-recommended ABs. Critical remarks were made by R regarding the relatively high proportion of Ceftriaxion prescriptions, although this issue was not further explored.	During the LRTI recap, Rs expressed the desire to improve the audit recording process for intentional non-adherence, focusing particularly on reasons for initiating antibiotics.

Table 2. Continued

Group	Prerequisite Activities	Facilitator
S15	In-person GFS. FF2 knew a couple of ECP-R from back when they were still medical residents and FF2 was their teacher. Following the reactions and questions of R, it seemed that they (also) viewed participation as a form of assessment. R asked for clarification on the top 10% benchmark. R initially assumed that locations without a CRP POCT device would not be included in the CRP adherence rates.	FR3 likely felt time pressure as both AB and psychotropic topics were presented in the GFS. Especially early in the GFS, Fs answered many questions themselves. Later, Fs gave more room for the group to engage with each other. Topics postponed by Fs for later were not actively revisited by the Fs. There was no summary during the recap, but Fs mentioned additional actions that the PG could undertake to improve the audit recording.

A&F Audit & Feedback, CRP (POCT) C-reactive protein (point-of-care testing), ECP elderly care physician, GFS group feedback session, GP General practice, NH nursing home, PG physician group, GFS group feedback session, CP contact person of the physician group, AB antibiotics, LRTI lower respiratory tract infection, UTI urinary tract infection, co-F co-facilitator, FF faculty facilitator, FR research facilitator, Fs facilitators, R(s) recipient(s)

and engagement (S11). The on-site group feedback sessions with fewer than eight participants were the most interactive (S04, S06, S10-S14). Facilitators’ evaluation also revealed that in larger groups it was not possible to engage all participants in the group conversation (S01-S03, S07). Interactive group feedback sessions with more than eight participants were seen in physician groups where the facilitators were already acquainted with several participants (S03, S08, S09, S15) and/or the physician groups had a prominent contact person who actively participated during the group feedback session (S03, S04, S07, S09). The contact person of S03 prompted the group directly with several questions, which led other physician group members to share more reflections.

Relationship Building

The relationship between the facilitator and the physician group members played an important role in the dynamics of the group feedback sessions. The majority of the participants were not acquainted with the facilitators. At the start of the session, the facilitators held a plenary introductory round with all participants, except in the two sessions with larger groups, where the facilitators only introduced themselves to the participants (S01, S02).

The relationships among the participants and whether they felt they were in a safe environment seemed to influence the dynamics of the session. When the atmosphere seemed relaxed with participants making jokes, showing interest, and

Physician Behavior	Change Cues/Talk
Interactive session in which several clinical practice issues were addressed by the PG, but most discussions also included mistakes and problems related to the audit recording. Rs spoke openly to each other, as well as with room for humor, and reminded each other of previous agreements made within the group about the audit recording procedure and CRP testing.	During the discussion on reasons for non-adherence, the issue of CRP testing at their smaller locations was raised. Fs responded by stating that CRP would be addressed later on, but this specific issue was not readdressed. Rs perceived potential audit recording problems as explanations for non-adherence. Fs proposed solutions themselves to the problems raised and then moved on to the next section, possibly due to time constraints.

being willing to speak up, there tended to be more mutual interaction between the participants (S03, S14). According to the facilitators’ evaluation, S01 also had an ‘open’ discussion and in S06 the participants showed an ‘open’ attitude, strong enthusiasm, and a positive atmosphere. A facilitator commented that the interaction was difficult in the physician group S02’s feedback session, possibly due to the meeting being online and probably also given the apparent absence of a connection among the participants within the group.

To strengthen the educational focus of the physician groups, the A&F network coordinator encouraged groups to establish learning objectives and/or additional data analysis questions during the audit period, to which nine contact persons responded. Some of the groups requested analyses that were already part of the standard A&F: one group that participated for the first time requested a baseline measurement, whereas others requested a comparison of their adherence rates with those of the previous cycle or other participating groups. A specific learning objective was regarding LRTI diagnostics and specifically the effects of the CRP point-of-care testing (CRP POCT) device implementation in an organization (S10). Some of the additional data analyses could not be performed with the available audit data. For example, physician groups S03, S06, and S09 asked for adherence rates at a more detailed level than the whole physician group (eg, location level), although the number of registered cases was too small to share the results.

In two physician groups, the contact person was willing to facilitate their own

group feedback session. S01's contact person fulfilled the role of a faculty facilitator during the session, which was conducted together with a research facilitator. S01's contact person was an elderly care physician who led group feedback sessions in the first cycle as a research physician. S09's contact person was an elderly care physician who is the chairperson of the physician group. S09's contact person presented the data and led the discussion. The research and faculty facilitators were present in a supportive role in the group feedback session. Both co-facilitating physicians had a pre-meeting with the facilitators to discuss the audit results and the presentation and they made additional preparations for their own group feedback sessions. S01's co-facilitator conducted additional data analysis on their prescription data. S09's co-facilitator printed out the guideline flowchart and planned a follow-up meeting with a colleague in advance.

Question Choice

Question choice concerns whether the topic is right for A&F and important to participants, and whether the data sources and limitations are clear. The reactions across group feedback sessions revealed that physician groups recognized the added value of this A&F program and its topics (S08, S12).

R6CP: *You can really see that learning from data, because these are data that we collected ourselves, are being discussed here. You already saw, in those two years we've been talking about it, that it led to better interventions, so it truly is a nice learning cycle, erm. (S08)*

The usefulness of the feedback information concerning the use of the CRP POCT device was questioned most often. Some nursing home organizations had no CRP POCT devices, whereas others had locations with and without CRP POCT devices. This raised questions among participants about whether locations without CRP POCT devices should be excluded from the data (S01, S09, S15). Some participants questioned the data by commenting that the audit measures did not reveal whether non-adherent medical care affected patient outcomes, either generally or specifically in relation to CRP POCT (S07, S12, S13).

Based on the participants' questions and remarks, it became clear that the knowledge about the data sources used and the limitations of the audit results

varied within each physician group (S01, S02, S05-S07, S09, S13, S15). Although the contact person of the physician group had made a decision prior to the session concerning the antibiotic topic and the nursing home locations included in the audit, this was not always clear to the physician group (S01, S07, S14). This lack of clarity was partly due to some participants joining during the audit period or not being involved in the audit at all (S01, S02). Even among those involved in the audit process, there was a lack of understanding of how their audit recordings translated to the audit results (S01, S03, S04, S06, S07, S09, S13, S15).

Requests for additional in-depth analyses were also made during the group feedback sessions (S01, S06, S09), including requests to receive data at the patient level so that the group could review the records for further learning (S01, S06). One of the physician groups suggested planning chart review meetings outside of the A&F program (S04).

Data Representation

Based on the participants' reactions, the majority of the graphs – along with the research facilitator's explanation – were easy to understand. The top 10% benchmark was a difficult part of the graph for participants to understand and often needed additional explanation (S03, S08, S09, S14, S15).

Audit and Group Feedback Session Facilitation

Although sharing a common professional background (Supplementary Table 1, Additional File 1), each facilitator brought a unique perspective and individual expertise to the group feedback sessions. Comparing the group feedback sessions revealed both similarities and differences among the facilitators, as well as among sessions led by the same facilitators. All of the facilitators were aware that numerous topics had to be covered within a limited amount of time. Occasionally, the facilitator ended discussions and moved to the next part due to time constraints (S01-S05, S12). In other group feedback sessions, the facilitator informed participants from the start not all topics could be addressed in detail due to limited time (S02, S15).

Unexpected events such as a power cut (S01) or an on-site meeting turning hybrid after the start (S05) required facilitators to improvise and be flexible during the group feedback session. Furthermore, reactions of participants prompted the group session to topics that were scheduled for later in the session. Facilitators handled these situations differently: sometimes this was addressed directly (S03,

S04), while in other instances facilitators attempted to reserve the discussion for the intended part of the presentation (S05, S06, S10, S15). These unrecognized change cues were often not readdressed or appeared to be discussed less elaborately, especially in situations where the facilitator did not recognize these reactions as change cues (S06, S15).

All of the facilitators were able to lead the conversation in certain directions by – for example – highlighting certain results or asking questions to the group to move the discussion towards a change cue or help the physician group to develop action plans. In several group feedback sessions, the facilitator made the recording for the audit a subject of discussion (S01, S02, S14), even repeatedly in different parts of the session (S06, S10). In other group feedback sessions, the facilitators tried to steer the discussion away from the audit recording system (S07, S11).

FF3: *Yes yes, well. Erm, yes, I think we should move on, and this point [audit recording system] comes up in all three topics. We've kind of covered it now. So, we don't need to address it with the other two topics [urinary tract infections and psychotropic medications]... (S07)*

FF1: *Alright, but let's move on, because this is more about recording than about, erm, yes, content. (S11)*

A comparison of the co-facilitated sessions S01 and S09 with the other sessions revealed that the co-facilitators leveraged their experience in the physician group and the context/setting in which the group practiced. The co-facilitators were more direct in contextualizing the results by – for example – giving examples and dismissing irrelevant results or remarks from the participants. The 'regular' facilitators did not benefit from being part of the physician group, although they connected with the group by drawing on their own experiences or those shared by participants in previous sessions (S02-S05, S07-S10, S12, S13, S15).

Reactions to Data

Overall, groups reacted positively to the audit data, especially if they were among the best performing. Physician groups experienced achieving the top 10% as a 'pat on the back' (S09). Additionally, participants in several physician groups expressed an aspiration to be among the top 10% performing nursing homes (S03, S09, S10). When the data were not favorable, they were often met with doubt by participants

who did not recognize themselves in the data. Within groups with relatively low adherence rates, participants asked whether they 'would be punished more' (S07, S15) and felt that they needed to defend themselves (S07). Low numbers of registered cases were often met with disappointment. S06 saw these low numbers as confirmation of their selective antibiotic prescribing policy.

co-F2: *[...] Is the AB choice according to the guidelines? Erm, well, yes, you're among the top ten [percent].*

R8: *Yeah.*

R5: *Yay!*

R4: *There's a first time for everything. [laughter among the group]*

R6: *We've got that one to a tee! [laughter and talking over one another] (S09)*

Understanding and Questioning

The participants asked questions to better understand the data in relation to the audit procedure and questioned some of the non-adherence categories:

R2: *I have a question, if that's okay, erm, because I think it would look very different if you didn't include those 36 [items that were unable to assess] in the analysis. (S02)*

Questions about the audit procedure addressed issues such as the required level of suspicion on LRTI for inclusion in the audit, audit recording forms that were not immediately completed by the initiator, and the importance of recording cases on the form as being intentionally non-adherent to the guideline recommendations. (S01, S02, S04-S07, S09, S12-S15).

Justifying and Contextualizing

To justify or contextualize the data, physician groups mostly look at external reasons beyond their direct control as physicians. Examples of such external reasons are physicians in training and (external) locum physicians in the evening, night, and weekend shifts who are not always familiar with the nursing homes' guidelines (S01, S02, S07, S09, S12), changes in the physician group (S02), a specific patient population within the nursing home (S04, S12), or consultations with medical specialists who recommend different treatments (S01, S04).

Reflecting, Sharing Practices, and Discussing Evidence

The amount of reflections, sharing one’s own practice problems or discussing the evidence for best practices varied across the group feedback sessions. The reflections and challenges shared by participants regarding diagnostic uncertainty and the use of CRP testing were recognized by the other participants. The responses were mostly supportive of each other and occasionally critical (S06, S09, S10, S15). Notably, these critical remarks sometimes occurred the second time an issue was readdressed (S09, S10). In several instances, reflections and discussions on clinical topics in the group conversations circled back to problems related to the audit recording procedure or other external causes.

Change Cues, Change Talk, and Action Planning

Change cues and change talk occurred in physician groups most often about topics with low adherence rates (See Supplementary Fig. 1, Additional File 1). Therefore, given the relatively high adherence rate across the physician groups for antibiotic choice, fewer change cues and less change talk were observed on this topic. Change cues and change talk on the treatment initiation measure focused more on possible mistakes regarding the audit procedure than those in clinical practice. Change cues and change talk concerning CRP testing ranged from clinical indications and evidence around CRP testing to practical and logistical barriers. The introductory statements were sometimes sufficient reason for participants to start an in-depth discussion before the data was shown. Moreover, after the data had been shown on – for example – reasons for non-adherence, this already led participants to raise change cues on CRP testing (S01, S04-S06, S08, S09, S12, S14, S15).

Action plans formulated during group feedback sessions were often related to the audit recording procedure, knowledge deficits of (new/locum) staff, and the purchase of a new CRP POCT device (Table 3). In most groups, the feedback session alone did not provide sufficient time to develop action plans for changing treatment or prescribing practices. In these situations, groups ended up with an action to discuss their plans further in a subsequent meeting (S02, S07). Facilitators also parked change cues/talk with the suggestion to further explore them in another meeting (S03, S07-S09, S11, S13).

Action plans proposed by facilitators were rarely adopted immediately but could provide groups with new ideas for other actions or were rejected by the group following a short remark or extensive group discussion (S10). Facilitators especially

proposed action plans on how to handle audit recording problems, which were met with mixed feelings (S06, S07, S10, S13-S15). The participants felt that the facilitator’s suggestions were not always suitable for their group.

Table 3. Example of action plans

• Acquiring CRP POCT device (S01, S04, S09, S13) • Providing instructions to the physician group on how to use the CRP POCT device (S01, S02, S05) • Physicians on the remote site will monitor the frequency of indications for CRP POCT for six months to see if a device is also needed at their site. (S12) • Improving the onboarding procedure for new medical staff (S04, S07) • Instructing the GP in training and locum staff to use the appropriate guideline in nursing homes (S08, S12) • Discussing patient cases to improve quality of care (S04) • Improving knowledge about the audit procedure (S02, S05, S07, S09, S13-S15) • Revising the local formulary (S01, S07, S13)
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Comparison of All Physician Group Feedback Sessions

A comparison of the different action plans of the fifteen physician groups revealed that specific actions were formulated in physician groups S01, S04, S05, S07-S10, S12, and S13. These actions included acquiring a second CRP POCT device, updating the formulary, improving the knowledge of new physician group members, monitoring the implementation of a CRP POCT device, organizing training on how to use the CRP POCT device, and gathering additional information before changing clinical practice. Factors that appeared to contribute to these specific actions included the responsibility taken by a physician group member or their motivation to address a specific issue, which might have been influenced by the key role that the member held within the physician group (eg, responsible for antibiotic stewardship, the local formulary, or the implementation of CRP POCT devices), as well as the ability to integrate action plans with existing initiatives.

Physician groups S02, S03, S06, S11, S14, and S15 identified a range of possible causes of their current performance without reaching any action planning. Factors that appeared to contribute to this included physician groups’ adherence rate to the guidelines, the non-attendance of relevant physician group members, time pressure, a prominent facilitator, and strong focus on the audit procedure. In groups S03, S06, and S14, (parts of) the audit results might not have provided a direct reason for the physician group changing their clinical practice, as they perceived their results positively. Although the participants in these groups still shared practice dilemmas with each other, the conversation on these issues did

not evolve into change talk and action planning. Group S11 planned to readdress the audit results in their regular physician group meeting, since the session was only attended by the two junior doctors and their non-medical manager. In groups S02 and S15, time pressure experienced by the facilitator from the start might have been a reason why plans were not discussed in more detail. The faculty facilitator in both sessions was prominent in suggesting actions instead of letting the group formulate possible actions. Participants in both groups also had a strong focus on the audit procedure.

In some of the group feedback sessions – both with and without action planning during the session – another meeting was suggested by the facilitator or the group to discuss further action planning (S03, S07-S09).

The facilitators’ evaluation questionnaires indicated that formulating specific action plans was challenging in several group sessions (S01, S02, S05-S07, S09, S12, S14, S15). Facilitators had different approaches in all parts of the group feedback session. The facilitators also used various approaches in assisting groups to develop action plans, which were especially evident during the recap section. At times, facilitators used open questions to explore what changes were needed, followed by a coaching-oriented approach to guide the group on how to achieve their goals, offering suggestions and thinking along with them (S05, S08, S10, S14). In other sessions, the facilitators asked follow-up questions to make the action plans as specific as possible (S07, S11, S12). In some sessions, the facilitator summarized the main findings and proposed solutions to the group, which generally resulted in approving responses (S02-S04, S13, S15). The approach used appeared to be influenced by the group dynamics, the responsiveness of the group, and the extent to which physician group members took initiative in addressing an action.

Discussion

Principal Findings

The aim of this study was to gain a better understanding of how physician group feedback sessions in nursing homes were conducted and resulted in action planning, using the Calgary A&F Framework and Cooke’s conceptual model of physician behaviors.^{19, 20} Enhancing the group’s ability to explore opportunities for improvement can be achieved by focusing on building trust in the data and the mutual relationships among group members and facilitators. The pattern of reactions and behaviors when physician group members receive audit results

together with their peers is in line with Cooke’s conceptual model of physician group behavior.¹⁹ Whether or not a group moves to action planning depends on many factors of the various A&F designs and implementation components that also interact with each other. We have added ‘organization’ – such the type of meeting (online, hybrid or on-site) – as an important prerequisite component. The lessons learned to improve the group feedback sessions in our A&F program are summarized in Table 4, and the key lessons are discussed here.

Table 4. Lessons learned from physician group feedback sessions in nursing homes

- Train facilitators to engage participants and to effectively lead group discussions to action planning.
- Consider who among the physician group should participate in the group feedback session.
- Report audit results at both the physician group level and a more detailed level of feedback.
- Prefer in-person group feedback sessions. If physician groups plan an online/hybrid meeting, another setup is needed with adequate digital support.
- Focus on important areas with room for improvement and prioritize topics prior to the session, both in accordance with the physician group.
- Show the achievable benchmark in an absolute manner, such as the top three physician groups. This may be easier to understand than the top 10% physician groups.
- Encourage co-facilitation by a physician group member to lead the group discussion.
- Suggest specific actions to the physician group to formulate as an action plan to improve their practice.

Comparison With Prior Work

Our findings suggest that the combination of recording additional audit data, receiving the information in a presentation, and discussing it with peers makes physicians more aware of the guidelines and their implementation in practice. Among the various behavior change techniques, feedback on behavior, social comparison, and instruction on how to perform the desired behavior are among the most common,²⁸ whereas merely presenting an A&F report does not effectively reinforce behavior change.²⁹ Moreover, combining multiple behavior change techniques aligns with recommendations on delivering A&F to promote practice change.⁸

In addition to Cooke’s framework,²⁰ we identified another important component in group A&F sessions. Organization seems to play an important role in prerequisite activities, with the type of meeting (online, hybrid, or on-site) influencing the success of the group feedback session, for example. The use of in-person presentations without appropriate adaptations for online or hybrid settings could potentially contribute to reduced levels of interactivity and engagement. Online and hybrid physician group feedback sessions require a different setup than

in-person group feedback sessions. In online meetings, it takes longer to establish relationships, the social presence of participants is weaker, and interactivity is more difficult due to having fewer non-verbal cues and a dependence on audiovisual technology. It is therefore important to focus more on relationship building in online meetings. Blanchard and McBride³⁰ reported that a lack of social presence limits who is available for interaction. If everybody is behind their own screen with their camera on, everybody can be evenly seen, which increases social presence and therefore the chances of interaction. In-person meetings seem to be most effective to establish relationships and increase interactivity. According to Muller-Schoof et al.⁷ relationships that include a safe team climate and a good team spirit are important facilitators in learning in nursing homes. Future online and hybrid sessions require modifications and appropriate digital support.

Our findings confirm the importance of question choice in the effectiveness of A&F group feedback sessions. The importance and relevance of the audit measures are key variables that influence physicians' acceptance of the feedback and their intention to change their behavior.³¹ Given that physicians might feel a discordance between patient-centered ideals and quality improvement interventions,⁴ learning objectives should reflect the physician's priorities. Previous research has shown that group A&F might be more amenable by focusing on a single topic area, ideally identified by the group.^{20, 32, 33} Also, prioritizing themes within the group feedback session and focusing on certain action plans can contribute to quality improvement.³⁴

According to Crawshaw et al.²⁸ feedback that recommends specific (eg, if-then plans) rather than general actions is more likely to be effective. This is also in line with other research in which an action implementation toolbox with suggested actions and materials helps to translate intentions into action.³⁵ Furthermore, sharing examples of effective actions taken in response to A&F can inspire participants.³⁶ In our research, facilitators prompted the group with possible actions (more on audit procedures than LRTI topics), which led to groups either discussing them to adapt to their local circumstances or rejecting proposals. One common action proposed by physician groups was to schedule a follow-up meeting to discuss further action planning, especially when changes to clinical practice were involved. Similarly, multiple feedback sessions were often necessary in other A&F studies.^{32, 37, 38} A follow-up meeting could also be useful to evaluate the action plans carried out, discuss what successes have already been achieved and what follow-up steps are

needed.³⁴ To some extent, physician groups participating in consecutive years on the same topic have a follow-up meeting with the new A&F round.

Key Lessons Learned

Train Facilitators to Engage Participants and to Effectively Lead Group Discussions to Action Planning

Facilitators play a crucial role in supporting groups interpreting audit results, guide discussions toward sharing change cues, and explore potential actions. Similar to other studies on group feedback sessions, the (co-)facilitator's characteristics significantly impact data interpretation, group discussions, and action planning.^{20, 32, 39} Change cues are more likely to lead to change talk when the facilitator acknowledges and promotes dialogue around them. The Calgary A&F Framework recommends that having a physician group member as a co-facilitator enhances this process.²⁰ However, in our study, this dynamic was not evident in the co-facilitated sessions compared to those sessions led by our 'external' faculty facilitator. Nonetheless, since in some physician groups our faculty facilitators had prior relationships with some group members, they were not entirely unknown to each other. Desveaux et al.³² argued that group feedback sessions might be more effective when led by an external facilitator. Regardless of whether an external facilitator or co-facilitator is used, facilitators must have knowledge and understanding of the nursing home context, which all of our faculty facilitators and co-facilitators possessed. Additional training – as proposed by both Cooke et al.²⁰ and Desveaux et al.³² – could further enhance the effectiveness of group feedback facilitators. Facilitators' training often involved Cooke's findings²⁰ together with Sargeant's R2C2 model,¹⁰ which focuses on building relationships, exploring reactions and understanding, and engaging participants in change talk to develop achievable action plans. Facilitators' training might also benefit from incorporating motivational interviewing techniques, which helps to elicit change talk in ambivalent participants and support self-efficacy in action planning.⁴⁰⁻⁴² Such training can provide facilitators with the necessary skills to effectively lead group feedback sessions.

Consider Who Among the Physician Group Should Participate in the Group Feedback Session

Our results demonstrate – like in other research – that the effectiveness of action planning is influenced by the number and type of participants.^{43, 44} Smaller groups tend to foster more interaction, with members being more strongly influenced by

those with whom they engage.⁴³ In contrast, larger groups are often swayed by the most dominant speaker. However, this dynamic is not necessarily a drawback, especially as key physician group members can effectively leverage their social influence and possess the capabilities of an educator or change driver, thereby significantly facilitating change.^{29, 45} Following this, we found that in group feedback sessions where a key physician group member was absent, follow-up action was to reach out to this member. Given that group feedback sessions that included key members led to more concrete action planning, it might be useful to ensure that key physician group members attend the group feedback session. We also found that having a contact person or manager who is actively involved or present can positively affect interactions and action planning. Future research could explore this further.

Report Audit Results at Both the Physician Group Level and a More Detailed Level of Feedback

The participants in our study received feedback at the physician group level. However, several physician groups requested feedback on a more detailed level – at either the location, unit, physician, or patient level – prior to or during the group feedback sessions. Previous studies on group feedback sessions have provided individualized feedback reports.^{20, 32, 38} Desveaux et al.³² group feedback session was intended to focus on identifying organizational level actions that the team could take to improve the quality of care, while team members received individualized practice reports. They detected a tension between the perceived organizational focus of the group sessions and the individual-level nature of the data. Since aspects of team functioning are associated with improved patient outcomes, looking at both the individual and group level might be beneficial.⁴⁶ Other research suggests that individual – as opposed to team-wide – feedback, increases recipients' acceptance and intention to develop action plans.^{31, 47, 48} Physicians often struggle to understand how aggregate practice-level data reflect their individual work.⁴⁹ Moreover, earlier studies indicate that self-assessment among professionals – including physicians – is often unreliable, with the poorest performers being the least accurate in assessing their own performance, reflecting a phenomenon known as the Dunning–Kruger effect.⁵⁰⁻⁵⁴ In our study, the audit numbers per physician were currently too small to disclose individual results. However, depending on how care within a nursing home is organized, aggregating the data at a more detailed level might be both feasible and insightful.

Strengths, Limitations, and Future Research

To our knowledge, this is the first study to evaluate facilitated physician group feedback sessions in nursing homes. A specific strength of our A&F program is that physician groups can record intentional guideline non-adherence and the reason not to follow the guidelines. Another strength of the study is the data triangulation, using qualitative data from questionnaires filled in by both facilitators after each session. These data could be used to support our findings or detect deviant cases. A final strength is that rather than adopting a general framework or inductively developing a new one in our data analysis, we used a specific existing framework and model to evaluate the group feedback sessions. This approach strengthens our study by building on the Calgary A&F Framework and Cooke's model of physician behavior, both of which were especially developed for physician group feedback sessions.

One limitation of a deductive approach is the risk of not capturing new concepts. To mitigate this, we maintained an open focus during the analytic process, which led to a new theme within the framework and additional sub-codes in existing themes. Some of the sessions were coded individually by two researchers, while the rest of the transcripts were checked by a second researcher. Any discrepancies were discussed. Another limitation of the current study design is that we did not have independent in-depth observations of nonverbal interactions and group dynamics. The free-text responses collected on the evaluation questionnaire by facilitators leave the impression that nonverbal signals influenced group dynamics, group discussions, and, most likely, resulting action plans. Future studies would benefit from an observer present during the group feedback sessions.³⁴ Final limitation of this study is that we did not follow up with the action plans of the physician groups and rather evaluated the group feedback sessions based on their intentions for change. Nonetheless, studies suggest that the intention for change can predict actual subsequent practice change.⁵⁵⁻⁵⁷

Future research could explore how inter-facilitator differences in relation to context – such as group composition, size, and type of session (online, hybrid, on-site) – play a role in the effectiveness of an A&F session. Additionally, research could focus on the effects of audit and group feedback sessions on formulated action plans and their implementation, as well as whether this is more effective than other types of A&F. Finally, future research could focus on whether recommended action plans by – for example – the facilitator are more often implemented than

those developed by the physician group.

Conclusions

This study shows that across the group feedback sessions in our A&F program for physician groups in nursing homes, the same variety in the development of action plans was observed as in other audit and group feedback session studies in other settings. Group feedback sessions offer physician groups room for reflection on audit results. During the session, a focus should be placed on building trust in the data and investing in mutual relationships among physician group members, and among the facilitators and physician group members. Special attention to facilitator training, attendance by key group members, and the level of feedback can enhance a group's ability to discuss actions to improve the quality of care. The facilitator plays an important role in supporting the group in interpreting the results, steering the discussion toward sharing change cues, and helping the physician group in developing action plans. Since (routine care) data is becoming increasingly available, A&F is more appealing to improve quality of care, making it important to perform further research on how to effectively facilitate group feedback sessions. By implementing the lessons learned from this study, group feedback sessions can be refined, supporting participants in action planning.

Declarations

Ethics Approval and Consent to Participate

This study was reviewed by the Medical Ethics Review Committee of Amsterdam UMC, which confirmed that the Dutch National Medical Research Involving Human Subjects Act (WMO) did not apply to this study (reference number 2023.0261). All of the participants and facilitators in the study gave informed consent following the Medical Ethics Review Committee's policy regarding non-medical research involving human subjects (nWMO-study).

Consent for Publication

Not applicable.

Availability of Data and Materials

The data supporting the findings of this study are not openly available for reasons of confidentiality and are available from the corresponding author upon reasonable request.

Competing Interest

The authors declare that they have no competing interests.

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Authors' Contributions

All researchers were involved in writing the research proposal and KJ (PhD) and MS (MD PhD) acquired funding for the whole program. KJ, PJ and GY were involved in the organization of the group feedback sessions, and PJ and GY were part of some of the group feedback sessions as facilitators. CA and GY coded and analyzed all the group feedback sessions. The codebook and coding strategy was developed with all researchers. GY and CA wrote the initial draft of the manuscript. KJ supervised this process and contributed to the writing process. All authors reviewed and edited the manuscript and approved the final version of the manuscript for publication.

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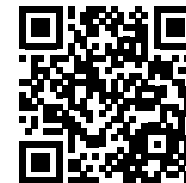
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List of Abbreviations

A&F: audit and feedback; LRTI: lower respiratory tract infection; CRP (POCT): C-reactive protein (point-of-care testing)

Supplementary Materials

Supplementary materials are available online at <https://doi.org/10.1186/s12913-025-12355-y>



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General Discussion

Within a learning health system, professionals seek to integrate a continuous learning cycle into clinical care processes (see Fig. 1).^{1, 2} In clinical care, professionals generate data with every patient encounter through, for example, routine documentation of clinical findings. These data can then be used to assess the quality of care (practice to data). These insights facilitate learning (data to knowledge) and are used to continuously improve the care delivered to patients (knowledge to practice). The overall aim of this thesis was to investigate how the quality of medical care in Dutch nursing homes can be assessed, evaluated, and improved by using electronic health record (EHR) data within the context of a learning health system.

In this chapter, I will summarize the main findings within the continuous learning cycle, followed by methodological considerations and future research directions, and conclude with implications and recommendations for practice and policy.



Figure 1 Learning community with its continuous learning cycle (Adapted from Foley and Vale,³ used under CC BY 4.0)

Practice to Data: Actionable Quality Indicators Suitable for Professional Learning and Continuous Improvement of Medical Care in Dutch Nursing Homes

To effectively convert data into knowledge and improve practice, it is necessary to identify key areas of clinical practice where data capture is most critical for medical practitioners in nursing homes. The Learning from Data Sentinel Nursing Home Surveillance Network (hereafter 'sentinel network') initially focused on topics

such as antibiotic prescribing for urinary and lower respiratory tract infections and psychotropic medication use.⁴ These topics were selected for their high prevalence and the importance of appropriate prescribing. For instance, inappropriate antibiotic use not only poses risks to individual nursing home residents but also contributes to public health risks, such as increased antibiotic resistance.⁵⁻⁷ These topics were initially piloted with physician groups.⁸

Another important source for identifying which data are relevant for practice comes from quality indicators, such as those proposed by the professional association of elderly care physicians and indicators developed by other national and international organizations.⁹⁻¹² In **Chapter 2**, a Delphi study with medical practitioners in Dutch nursing homes was conducted to compile a set of actionable quality indicators from existing sources. The compiled set of indicators was identified as being within their direct control and as relevant, important, and suitable for assessing the quality of medical care. Most of the quality indicators selected in **Chapter 2** originated from the international practice-based provider quality measure set.¹³ This set was designed to assess the quality of medical care in nursing homes across Canada, the United States, and Europe. The overlap highlights the transferability and international relevance of these indicators.

The highest-rated indicator in terms of importance was the documentation of indications for medication prescriptions, followed closely by indicators related to advance care planning (ACP). An international review of routinely used nursing home quality indicators across 13 countries found that most indicators emphasized safety and effectiveness of care, particularly those related to medication.¹⁴ However, the review identified only a limited number of indicators addressing residents' needs, values, and preferences, indicating that person-centered outcomes may be underrepresented. The ACP-related indicators selected in **Chapter 2** may facilitate monitoring and evaluation of person-centered approaches to medical care in nursing homes.

Operationalizing Data into Knowledge Using Electronic Health Record Data

Chapters 3 and 4 illustrated how EHR data can be converted into knowledge for clinical practice through quality indicators. The chapters showed how indicators identify gaps between guidelines and practice, as well as changes over time. Different data sources within the EHR can be used to generate knowledge from

data.

Timely documentation of physician treatment orders, such as cardiopulmonary resuscitation (CPR) codes and medical treatment preferences, is important for medical practitioners, as reflected by the ACP-related indicators identified in **Chapter 2**. Such documentation is essential for translating ACP conversations into actionable treatment orders, particularly in acute medical situations. Building on this, **Chapter 3** analyzed routine EHR data from daily clinical practice to assess documentation rates for these two physician treatment orders within six weeks of nursing home admission in the Netherlands. The documentation rate of new admissions within six weeks improved from 2017 to 2022. CPR code documentation increased from 82% to 92%, and medical treatment preferences documentation went from 56% to 70%. This improvement coincided with the introduction of a national quality indicator on physician treatment order documentation in 2018 and the onset of the COVID-19 pandemic in 2020. National policies and practices regarding the documentation of physician treatment orders appear to influence the variation in documentation rates observed across countries.¹⁵

Chapter 4 utilized EHR data from the sentinel network to assess the adherence to the Dutch guideline for urinary tract infections (UTIs) in frail older adults. Among 19 participating nursing homes, around half of suspected UTI cases without indwelling urinary catheters either fully adhered to all guideline recommendations or involved intentional nonadherence. Leaving the other half of cases with room for improvement in the diagnostic and/or therapeutic stages of managing suspected UTIs. Overall, 68% of antibiotic prescriptions for UTIs met guideline criteria for initiation. This adherence exceeds the 44% average reported in a large study of 110 nursing homes across eight other European countries, where adherence ranged from 36% to 61% across countries.¹⁶ Consistent with our findings that inappropriate use of urine dipstick testing was associated with nonadherent antibiotic initiation, the European study observed a trend whereby countries that used more urine dipsticks showed higher levels of potentially unnecessary antibiotic use.

The sentinel network data also allow for a more detailed analysis of antibiotics prescribed for different types of UTI. While antibiotic prescriptions for cystitis largely followed guideline recommendations (adherence rate 88%), adherence was lower for cases of UTI with signs of tissue invasion. In particular, among females, adherence was lower (35% for females vs. 62% for males). Nitrofurantoin was prescribed despite not being recommended in 42% of female cases of UTI with

signs of tissue invasion and 32% of male cases of UTI.

Chapter 4, demonstrates that EHR data collected within the sentinel network provide valuable knowledge for clinical practice, along with a study by Van der Griend et al.¹⁷ on guideline adherence in psychotropic medication prescribing.

Knowledge to Practice Through Group Feedback Sessions

Chapter 5 described how, within the sentinel network, knowledge is fed back to participating physician groups through group feedback sessions. Key factors shaping the translation of knowledge into practice included group dynamics and session facilitation. Facilitators were essential in guiding the group discussions, supporting the physician groups' transition from interpreting the data to developing action plans. These factors are consistent with the Calgary Audit and Feedback Framework and Cooke's model of physician behavior,^{18,19} both of which are specifically designed for physician group feedback sessions.

Our study adds a fourth prerequisite activity to the existing feedback framework: organization (see Fig. 1 in **Chapter 5**). While the prior framework emphasizes the importance of relationship building, question choice, and data representation, our findings show that organizational factors, such as session format (in-person, hybrid, or online), group size, and whether facilitation is external or by a physician group member, shape how group feedback sessions unfold. These factors influenced engagement and interactivity. Specifically, differences between in-person and online/hybrid sessions likely derive from the use of the same standardized outline and presentation template across all sessions within the sentinel network. The Calgary Audit and Feedback Framework has been adapted to improve online sessions in Canadian hospitals.²⁰ Compared with in-person sessions, their online sessions with up to 25 participants adopted a more structured agenda and incorporated polling. They also used breakout rooms of up to six participants, each led by a trained facilitator, thereby requiring more facilitators per session. This approach promoted online engagement and interaction and may offer a blueprint for the online feedback sessions in the sentinel network.

Lessons learned from **Chapter 5** were formulated to inform practical improvements for future group feedback sessions. Lessons included training facilitators to actively engage participants and guide discussions from data interpretation to action planning. Consistent with the organizational theme,

carefully consider who among the physician group should participate in the group feedback session. Additional lessons addressed the appropriate level of (dis)aggregation in audit results, focusing on important areas with potential for improvement, comparing results to achievable benchmarks, and proposing specific action plans to improve practice. These lessons align with the 2025 update of the Cochrane review on audit and feedback.²¹

Methodological Considerations and Future Research Directions

Operationalize and Validate Quality Indicators

The set of quality indicators compiled by medical practitioners in **Chapter 2** requires further operationalization to enable effective data extraction and to assess their measurement properties, such as validity and reliability. Dash et al.²² provide a detailed procedure for specifying quality indicators of the international practice-based provider quality measures, facilitating manual chart review. However, given the resource-intensive nature of manual chart extraction and the costs,²³ electronic computation of quality indicators using routinely collected health data is preferable. To make such electronic indicators feasible, adherence to the FAIR principles of data—findable, accessible, interoperable, and reusable—will be essential.²⁴ Adhering to these principles is necessary to enable the direct computation of quality indicators from EHR data.

Challenges in Using Electronic Health Record Data

Chapters 3 and 4 of this thesis highlighted several methodological challenges encountered when using routine EHR data to calculate indicators. Because EHR data were primarily collected for clinical rather than research purposes, additional assumptions were needed to ensure they were fit for purpose in addressing the research questions in **Chapters 3 and 4**. These assumptions concerned how information recorded in unstructured free-text fields could be used to determine the type of nursing home care and the medical history of residents. To operationalize this, algorithms were applied to structure and standardize primarily unstructured free-text fields before analysis. The introduction of a structured and standardized Minimum Data Set (MDS) within the Registry Learning from Data in Nursing Homes is expected to enhance data quality and completeness. International experience demonstrates that MDS systems can collect comprehensive, reliable, and valid

data on nursing home residents, supporting individual care planning, quality improvement, and research.^{25, 26} However, it should be noted that these MDS systems in North America are rather extensive and are mandated by regulators and/or linked to financial incentives for nursing home organizations,²⁷ whereas this is not the case for the MDS within the Registry Learning from Data in Nursing Homes.

Artificial Intelligence for Enhanced Data Reuse

Advances in artificial intelligence present promising opportunities to address several of the methodological challenges described above. Artificial intelligence has shown potential in supporting automated quality indicator measurement, particularly through natural language processing, which can analyze unstructured clinical text.^{28, 29} Nonetheless, structured and standardized data fields remain important for secondary data use. For example, relying solely on progress notes to identify signs and symptoms of UTIs may yield incomplete data. Clinicians typically document only information relevant to immediate clinical care.³⁰ For instance, if a resident presents with a single prominent UTI symptom, additional symptoms or contextual details may not be documented in the progress note. Consequently, secondary analyses based on progress notes cannot always distinguish between the actual absence of a symptom and the absence of documentation, which limits the interpretability and reuse of unstructured clinical data for secondary use. In the sentinel network, this ambiguity is addressed by utilizing structured registration forms. However, this approach requires medical practitioners to perform additional registration, explicitly indicating whether relevant signs and symptoms are present, absent, or of unknown status. The combination of unstructured and structured data has been proposed as a potential solution to enhance the reuse of unstructured data.³⁰

Advance Audit and Feedback Through the Sentinel Network

Chapter 5 distilled lessons for optimizing group feedback sessions within the sentinel network. These lessons were based on a qualitative analysis of feedback session transcripts and were compared with insights from the existing audit and feedback literature. However, it remains to be established whether the identified lessons will enhance participants' engagement, increase uptake of feedback, and improve action planning. The sentinel network, with its annual audit and feedback

cycle, provides a unique 'laboratory' for systematically testing and refining methods of delivering audit and feedback to medical practitioners in nursing homes over time. This aligns with recommendations from the Cochrane review calling for further advancement of audit and feedback research.^{21, 31} Future research could apply the lessons identified in **Chapter 5** as hypotheses to evaluate their impact on improving the quality of care in nursing homes. An upcoming study, funded by AMR Noord-Holland Flevoland and conducted by the Department of Medicine of Older Adults at Amsterdam UMC, is expected to provide further insights into the effects of participating in the sentinel network audit and feedback program on (inappropriate) antibiotic prescribing.³²

Implications and Recommendations for Practice and Policy

Integrate Quantitative and Qualitative Data

This thesis focused on how quantitative data could capture clinical practice and be reused to translate into actionable knowledge about the quality of medical care in nursing homes. However, there is growing evidence that narrative, unstructured data can also provide valuable insights into care processes and quality of care, thereby supporting continuous learning and quality improvement.^{33, 34} This was also observed in the physician group feedback sessions described in **Chapter 5**, where brief introductory statements (eg, 'we generally adhere to the guideline when performing the CRP test') were sometimes sufficient to prompt physicians to share personal experiences, tensions, and dilemmas related to guideline recommendations in everyday clinical practice. These physician 'stories' occasionally led to in-depth group discussions on ways to improve practice even before the quantitative data were presented.

The combination of quantitative and qualitative data is also seen in the annual quality reports published by nursing home organizations after the introduction of the Generic Compass.³⁵ In the Generic Compass, nursing home organizations have the freedom to collect the data (quantitative and qualitative) deemed necessary for continuous learning and quality improvement in their own local care context.³⁶ The indicators presented in **Chapter 2** may provide medical practitioners with guidance, similar to the former quality framework indicators, on which quantitative data could be relevant to collect/register.³⁷

Use Quality Indicators to Promote Standardized and Structured Documentation

There is a unique opportunity to integrate the quality indicators identified in **Chapter 2** with both the Registry Learning from Data in Nursing Homes and the sentinel network. The introduction of the new topic within the sentinel network on ACP, using routinely registered data, including structured and unstructured data, is a good example of enhancing the learning cycle.³⁸ Providing feedback on quality indicators derived from EHR data can motivate medical practitioners to document clinical information in a standardized and structured manner, as emphasized by Albers et al.³⁹ These successful feedback loops might also be observed in the sentinel network's audit and feedback program, where physician groups participate year after year to gain better insights into their own practice (data). A recent systematic review by Monticilli et al.⁴⁰ on resident documentation in long-term care supports this approach, highlighting that audit and feedback mechanisms can improve data quality by encouraging adherence to documentation protocols and identifying areas for improvement.

Clinical Relevance Influences the Utility of Structured EHR Fields

The analyses presented in **Chapters 3 and 4** revealed that the mere presence of structured and standardized fields in EHRs does not guarantee the availability of data suitable for secondary use. For example, while information such as CPR orders and nursing home care type can both be documented in structured fields, their completeness and reliability depend strongly on how these fields are used in routine care. CPR orders are generally recorded more consistently in the EHR, as demonstrated by the observed documentation rates exceeding 80% in our study sample, since they have immediate clinical relevance and implications for patient care. In contrast, the EHR field indicating nursing home care type was often left incomplete or outdated, limiting its usefulness for secondary data analysis, possibly because EHR users do not depend on this field in their day-to-day clinical work. This discrepancy illustrates that the clinical utility of an EHR data field influences its data quality, a finding observed in other studies as well.³⁹⁻⁴²

Merge Different Data Sources

The inconsistent quality of structured EHR data suggests that linking complementary databases could improve overall data utility. Integrating the Registry with additional sources can enhance data completeness while reducing the registration burden

for healthcare professionals. For instance, financial and administrative databases, used for billing or reimbursement, often contain information on the type of care provided. While this approach also introduces additional challenges related to data interoperability, privacy, and governance, it has been successfully applied in other Dutch health registries.^{43, 44}

A data source that has become available within the Learning from Data program but is not used in this thesis is the electronic prescription system Medimo. This system, widely adopted by nursing homes participating in the sentinel network, records all medication prescriptions for residents. Analyzing prescription data, such as antibiotic use, can provide detailed insights into adherence to guideline recommendations related to medication use, including duration, dosing, and adjustments for renal function or potential interactions. If these evaluations could be performed using Medimo data, they could derive more knowledge for practice without increasing the burden on medical practitioners by requiring additional registrations.

More Than Technical Aspects

While establishing the technical conditions necessary for capturing fit-for-purpose data is crucial, it is not enough to create an effective learning health system. This concept is evident in various learning health system frameworks.^{3, 45-48} For example, the comprehensive framework developed by Foley and Vale³ is arranged around four key questions, with only the final question addressing the technical aspects of capturing practice in data. The first three questions focus on the rationale for developing a learning health system, the complexity of the system in which it must operate, and the strategic approaches most appropriate for achieving change.

Time and Financial Resources

The Learning from Data program was established in 2020 and started in 2025 with the second five-year tranche.⁴⁹ Evidence from learning health systems in other healthcare settings shows that maturing and sustaining such systems requires considerable time and resources.⁵⁰⁻⁵³ For example, a primary care learning health system took nearly two decades to evolve from a research-driven initiative into a collaboratively owned partnership that integrates research and quality improvement to achieve more effective, efficient, and equitable care.⁵³ Similar challenges have been reported by long-term care providers within the Dutch national network Working Together Data-Driven in Care and Wellbeing (in Dutch:

‘Samen Datagedreven Werken in zorg en welzijn’).⁵⁴ They reported that, along with a fragmented IT infrastructure, a lack of financial resources and dedicated time hinders their ability to experiment, reflect, learn, and adjust care practices based on data. These findings underscore that both long-term financial stability and sufficient time are essential for developing a learning health system, ultimately enabling it to evolve into a self-sustaining system.

Leadership in a Learning Health System

Ensuring sufficient resources and funding alone, however, is not enough. Leadership is equally essential for fostering a culture of continuous learning and quality improvement.⁵⁵⁻⁵⁷ Leadership can promote reflection, innovation, and collaboration across the system.^{57,58} Moreover, leadership can enhance the integration of artificial intelligence into quality improvement by drawing on expertise in quality, safety, and implementation science.⁵⁹ By championing tools that strengthen data-driven improvement capabilities, leaders can help embed learning processes into everyday clinical practice. Evidence from U.S. nursing homes that implemented artificial intelligence-enhanced EHR dashboards demonstrates improved performance on Centers for Medicare and Medicaid Services quality measures compared with facilities lacking such systems.⁶⁰

Involve, Engage, and Collaborate with Stakeholders

Within the Learning from Data program, medical practitioners play a crucial role in advancing the quality of medical care in nursing homes. As demonstrated in **Chapters 2 and 5**, medical practitioners in Dutch nursing homes are receptive to exploring which data can meaningfully inform their practice and how resulting knowledge can change clinical practice. The findings highlight the active role that medical practitioners can play within the Generic Compass to promote continuous learning and development.

Strengthening collaboration among all stakeholders within the Learning from Data program is essential for realizing the full potential of a learning health system for medical care in nursing homes. A case study of an Australian primary care learning health system that also operated in collaboration with an academic institution demonstrated that such cross-institutional (academic) partnerships particularly contributed to a culture of learning among clinical staff.⁵¹ Notably, the involvement of nursing home residents has not yet been represented in the studies included in this thesis, identifying an important area for future development.

Final Conclusions

This thesis demonstrates that the quality of medical care in Dutch nursing homes can be assessed, evaluated, and improved through the use of electronic health record data within the context of a learning health system. Medical practitioners have identified actionable quality indicators relevant to daily medical care and within their direct responsibility. Analysis of routine healthcare data has shown improvements in documentation rates for CPR codes and medical treatment preferences over time. Additionally, data from the Sentinel Nursing Home Surveillance Network offered valuable insights into guideline adherence. Group feedback sessions with physician groups utilized this knowledge to develop action plans for clinical practice improvement. This knowledge served not only medical practitioners but also contributed to clinical practice and research in ways that routine healthcare data is currently unable to fulfil. Overall, this thesis illustrates the role of medical practitioners in an evolving learning health system for medical care in nursing homes. It highlights how professionals can be actively involved, engaged, and participate in the continuous learning cycle.

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Addendum

English Summary

Samenvatting

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Author Contributions

Portfolio

List of Publications

About the Author

Dankwoord

English Summary

Despite the large amount of information recorded in Dutch nursing homes, challenges remain in making this data available and in using it for research and to improve the quality of care. This thesis investigates how electronic health record (EHR) data can be used to assess, evaluate, and enhance medical care in Dutch nursing homes, within a learning health system. In a learning health system, a continuous learning cycle is integrated into daily practice so that the quality of care keeps improving over time. The thesis follows the learning cycle: capturing practice in data, translating data into knowledge, and applying knowledge back to practice.

Chapter 1: General Introduction

Medical care in Dutch nursing homes is provided by elderly care physicians, who are medical specialists trained to care for older adults living in the community and residents in nursing homes. In nursing homes, elderly care physicians often work in physician groups with other physicians, nurse practitioners, and physician assistants. Physician groups vary by nursing home size and medical staff model. In this thesis, all physician group members are referred to as medical practitioners.

Improving the quality of care in nursing homes through a learning health system is increasingly important. The Dutch National Quality Framework for Nursing Home Care and its successor, the Generic Compass, emphasize collective learning and continuous improvement. To support this effort for medical care in Dutch nursing homes, the 'Learning from Data' program started in 2020. It promotes the reuse of routine EHR data for quality improvement, research, and policy. The program also established a Sentinel Surveillance Network of Nursing Homes (in short: 'sentinel network'). In this sentinel network, physician groups record additional healthcare data on specific topics within the EHR (audit). Data on appropriate psychotropic prescriptions and appropriate antibiotic prescriptions for lower respiratory tract and urinary tract infections were among the first topics registered in the network. Researchers at the Department of Medicine for Older People at Amsterdam UMC analyze these data to provide feedback to the participating physician groups on adherence to national guideline recommendations. In addition, groups are benchmarked against one another within the network. For each participating group, the research team generates a performance report and organizes a physician group feedback session to discuss their performance and ways to improve their medical practice.

This thesis addresses three main questions:

- 1) Which quality indicators best capture medical practice in Dutch nursing homes?
- 2) In what ways can EHR data be used to assess and evaluate the quality of medical care in Dutch nursing homes?
- 3) How can physician group feedback sessions help translate knowledge into practice?

Chapter 2: Set of Actionable Quality Indicators

Most existing nursing home quality indicators reflect the practice of the entire multidisciplinary care team, instead of the practice of medical practitioners. An expert panel of 92 medical practitioners in the Netherlands participated in a Delphi study to identify indicators that capture their medical care practices in nursing homes. The expert panel included elderly care physicians, nurse practitioners, physician assistants, and trainees. Their goal was to select indicators that are under their direct control (ie, actionable for medical practitioners) and relevant to the quality of medical care in nursing homes.

The panel reviewed 50 national and international quality indicators and agreed on 21 actionable indicators. The highest-rated indicator in terms of importance was the documentation of reasons for medication prescriptions. Three indicators related to advance care planning (ACP)¹ were also ranked highly important. Most selected indicators came from an international set, demonstrating their transferability across countries.

Chapter 3: Timely Documentation of Physician Treatment Orders

This chapter examines how routine EHR data can be translated into knowledge by evaluating how timely cardiopulmonary resuscitation (CPR) codes and medical treatment preferences were documented for new nursing home admissions. CPR codes and medical treatment preferences are physician treatment orders that make ACP conversations actionable. EHR data from 163,180 residents admitted to 74 Dutch nursing homes from 2017 to 2022 were analyzed to examine trends in documentation rates within six weeks of admission. This six-week timeframe

¹ Advance care planning is the process for understanding someone's personal values, life goals, and preferences regarding future medical care. ACP aims to ensure that people receive medical care consistent with their values, goals, and preferences.

aligns with the recommended period for completing ACP after admission and with international ACP quality indicators.

Key findings included:

- CPR code documentation within 6 weeks of admission improved from 82% to 92%.
- Medical treatment preference documentation rates rose from 56% to 70%.
- Documentation was performed quickly: the median time from admission to the first documentation ranged from the same day to 2 days, depending on the type of care.

These improvements coincided with the introduction of a national quality indicator for treatment orders in 2018 and increased focus on ACP during the COVID-19 pandemic. The results suggest that medical practitioners in the Netherlands usually document initial treatment orders promptly after admission.

Chapter 4: Urinary Tract Infection Guideline Adherence

This chapter used sentinel network data to evaluate how well medical practitioners in 19 nursing home organizations followed urinary tract infection (UTI) guidelines for frail older adults, three years after their introduction. In late 2021, medical practitioners recorded 675 suspected UTI cases without an indwelling catheter, of which 532 contained sufficient information to be included in the analysis.

Findings revealed room for improvement:

- Diagnostic stewardship: Dipsticks were used in 86% of all suspected UTI cases. In cases where clinical signs and symptoms already indicated that UTI treatment was inappropriate, a dipstick was still ordered in 85% of cases, and non-negative dipstick results were associated with a 3.5-fold higher odds of antibiotic initiation.
- Treatment decisions: Decisions to start or withhold antibiotics were guideline-adherent in 69% of cases.
- Antibiotic recommendations for cystitis were followed in 88% of the cases, but only in 48% of UTI cases with tissue invasion (such as fever or rigors).

Overall, these findings highlight the need for better diagnostic practices and more symptom-based clinical decision-making to reduce inappropriate antibiotic prescriptions.

Chapter 5: Lessons from Audit and Group Feedback Sessions

This qualitative study analyzed 15 group feedback sessions in the sentinel network. The goal was to understand how physician groups turn audit data into action plans (or not). The analysis used established frameworks for audit and group feedback for physician groups.

Key insights included:

- In-person sessions led to better group dynamics and engagement than online or hybrid ones.
- Favorable results gave groups a ‘pat on the back,’ while lower adherence rates often prompted the mentioning of external factors, such as locum staff or data quality issues.
- Facilitators played a key role in moving the group from interpreting results to engaging in ‘change talk’ and creating concrete action plans.

Lessons learned include the need to train facilitators, ensure key staff members attend sessions, and present audit results at an appropriate level of detail to motivate physician groups to improve.

Chapter 6: General Discussion

The final chapter positions the findings within the learning cycle of the learning health system, reflected on methodological considerations, and provided recommendations for research, practice, and policy.

Core considerations and recommendations:

- The set of quality indicators chosen by medical practitioners requires further operationalization to enable electronic data extraction and to assess measurement properties, such as validity and reliability. At the same time, these indicators can guide medical practitioners in deciding which data to collect in order to support practice improvement.
- A key challenge in using current EHR data is the need to restructure and standardize data elements to make them suitable for reuse in research. The

structured Minimum Data Set in Dutch nursing home EHRs is expected to improve data quality. Applying the FAIR principles—Findable, Accessible, Interoperable, Reusable—can further enhance data completeness and reliability.

- Advanced technologies, such as artificial intelligence, can extract information from unstructured EHR free-text fields, potentially reduce the registration burden, and offer new ways of providing feedback to medical practitioners.
- A self-sustaining learning health system requires long-term financial support, dedicated staff time, and strong leadership to foster a culture of continuous learning and quality improvement.

This thesis illustrates the role of medical practitioners in an evolving learning health system for medical care in nursing homes. It shows how, together with medical practitioners, actionable quality indicators can be selected, how EHR data can be used to measure the quality of care, and how group feedback sessions can help translate insights into plans to improve medical care for nursing home residents. It demonstrates how professionals can be actively involved in the different phases of the continuous learning cycle, with the aim of delivering better and more appropriate care for nursing home residents.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

Draft versions of the summaries in this thesis were generated with the help of NotebookLM, and the author used Grammarly and ChatGPT to improve readability and language. All content was reviewed and edited by the author as needed, and the author takes full responsibility for the final content of this publication.

Samenvatting

Ondanks de grote hoeveelheid gegevens die in Nederlandse verpleeghuizen digitaal wordt vastgelegd, blijft het een uitdaging om deze data beschikbaar te maken en te hergebruiken in onderzoek en voor het verbeteren van de kwaliteit van zorg. Dit proefschrift onderzoekt hoe gegevens uit elektronische patiëntendossiers (EPD's) kunnen worden ingezet om de medische zorg in Nederlandse verpleeghuizen te beoordelen, te evalueren en te verbeteren, binnen een lerend zorgsysteem. In een lerend zorgsysteem wordt een continue leercyclus in de dagelijkse praktijk toegepast, zodat de kwaliteit van zorg in de loop van de tijd voortdurend verbetert. Dit proefschrift volgt deze leercyclus: het vastleggen van de praktijk in data, het vertalen van data naar kennis en het terugvertalen van kennis naar de praktijk.

Hoofdstuk 1: Algemene inleiding

De medische zorg in Nederlandse verpleeghuizen wordt geleverd door specialisten ouderengeneeskunde. Deze artsen zijn gespecialiseerd in de medische zorg aan ouderen thuis en aan bewoners in verpleeghuizen. In verpleeghuizen werken specialisten ouderengeneeskunde vaak in een vakgroep met andere artsen, verpleegkundig specialisten en physician assistants. In dit proefschrift worden alle leden van de vakgroep aangeduid als 'medisch behandelaren'.

Het verbeteren van de kwaliteit van zorg in verpleeghuizen via een lerend zorgsysteem wordt steeds belangrijker. Het Nederlandse Kwaliteitskader Verpleeghuiszorg en de opvolger daarvan, het Generiek Kompas, leggen veel nadruk op samen leren en continu verbeteren. Om de medische zorg in Nederlandse verpleeghuizen hierbij te ondersteunen, startte in 2020 het programma 'Leren van data'. Dit programma stimuleert het hergebruik van bestaande EPD-gegevens voor kwaliteitsverbetering, onderzoek en beleid. Binnen dit programma is ook een landelijk netwerk van medische vakgroepen in Nederlandse verpleeghuizen opgezet, de zogenaamde 'Peilstations'. Binnen de Peilstations registreren medische vakgroepen jaarlijks gedurende enkele maanden aanvullende gegevens in het EPD over bepaalde ziektebeelden, gebeurtenissen of verrichtingen (audit). Gegevens over passend voorschrijven van psychofarmaca en passend voorschrijven van antibiotica bij lage luchtweginfecties en urineweginfecties behoorden tot de eerste onderwerpen die in het netwerk werden geregistreerd. Onderzoekers van de afdeling Ouderengeneeskunde van Amsterdam UMC analyseren deze geregistreerde EPD-gegevens om vervolgens feedback te geven aan de

deelnemende vakgroepen over behandel- en voorschrijfgedrag, vergeleken met de aanbevelingen uit landelijke richtlijnen en met de andere deelnemende vakgroepen. Als onderdeel van de feedback maakt het onderzoeksteam een rapport met spiegelinformatie en organiseert het een spiegelgesprek voor de vakgroep (groepsfeedback) om te reflecteren op de uitkomsten en mogelijkheden om te leren en te verbeteren.

Dit proefschrift behandelt drie hoofdvragen:

- 1) Welke kwaliteitsindicatoren geven het beste de medische praktijk in Nederlandse verpleeghuizen weer?
- 2) Op welke manieren kunnen EPD gegevens worden gebruikt om de kwaliteit van medische zorg in Nederlandse verpleeghuizen te beoordelen en te evalueren?
- 3) Hoe kunnen groepsfeedbacksessies met medische vakgroepen helpen om kennis naar de praktijk te vertalen?

Hoofdstuk 2: Set van actiegerichte kwaliteitsindicatoren

Veel bestaande kwaliteitsindicatoren voor verpleeghuizen weerspiegelen de praktijk van het gehele multidisciplinaire zorgteam (dus artsen, verpleegkundigen, verzorgenden, therapeuten), in plaats van specifiek de praktijk van medisch behandelaren. Een expertpanel van 92 medisch behandelaren in Nederland nam deel aan een zogeheten Delphi-studie om indicatoren te identificeren die hun medische praktijk in verpleeghuizen weerspiegelen. Hun doel was om indicatoren te selecteren die onder hun directe invloed vallen (dus waar zij zelf iets aan kunnen veranderen, 'actiegericht') en relevant zijn voor de kwaliteit van medische zorg in verpleeghuizen.

Het expertpanel omvatte specialisten ouderengeneeskunde, verpleegkundig specialisten, physician assistants en collega's die in opleiding waren tot specialist ouderengeneeskunde, verpleegkundig specialist of physician assistant. Het panel beoordeelde 50 Nederlandse en internationale kwaliteitsindicatoren en bereikte overeenstemming over 21 actiegerichte indicatoren. De documentatie van de reden (indicatie) voor medicatievoorschriften werd als belangrijkste kwaliteitsindicator gerangschikt. Daarnaast werden drie indicatoren met betrekking tot proactieve

zorgplanning¹ als belangrijk beoordeeld en hoog gerangschikt. De meeste geselecteerde indicatoren waren afkomstig uit een internationale set, wat hun overdraagbaarheid tussen landen onderstreept.

Hoofdstuk 3: Tijdige vastlegging van medische behandelafspraken

Dit hoofdstuk onderzoekt hoe routinematige EPD-gegevens kunnen worden vertaald naar kennis door te evalueren hoe tijdig bij nieuwe verpleeghuisopnames het reanimatiebeleid en het medisch behandelbeleid² in het EPD werden gedocumenteerd. Dit zijn medische behandelafspraken die proactieve zorgplanning concreet maken. Daarbij is specifiek gekeken naar documentatie binnen 6 weken na opname, in lijn met aanbevelingen uit Nederlandse richtlijn en internationale ACP-kwaliteitsindicatoren. EPD gegevens van 163.180 bewoners die tussen 2017 en 2022 werden opgenomen in 74 Nederlandse verpleeghuizen zijn geanalyseerd om trends in de registratiepercentages te onderzoeken.

Belangrijkste bevindingen:

- De documentatie van reanimatiebeleid binnen 6 weken na opname verbeterde van 82% naar 92%.
- De documentatie van medisch behandelbeleid steeg van 56% naar 70%.
- De vastlegging vond snel plaats: de mediane tijd tussen opname en de eerste documentatie varieerde van dezelfde dag tot 2 dagen, afhankelijk van het type verpleeghuiszorg.

Deze verbeteringen vielen samen met de introductie van een landelijke kwaliteitsindicator voor behandelafspraken in 2018 en een toegenomen focus op proactieve zorgplanning tijdens de COVID 19 pandemie. De resultaten suggereren dat medisch behandelaren in de meeste gevallen snel na opname de belangrijkste behandelafspraken vastleggen.

¹ 'Proactieve zorgplanning is het proces van in gesprek gaan, vooruit denken, plannen en organiseren van gewenste passende zorg [...]. Met gezamenlijke besluitvorming als leidraad is proactieve zorgplanning een continu en dynamisch proces van gesprekken over huidige en toekomstige levensdoelen en keuzes en welke zorg daar nu en in de toekomst bij past.' (Uit Richtlijn Proactieve Zorgplanning, NHG, 2023)

² Bij reanimatiebeleid gaat het om documenteren wel of niet reanimeren, bij medisch behandelbeleid gaat het om een curatief/actief ziektebeleid, palliatief met als doel levensverlenging én symptoomverlichting of palliatief met als doel symptoomverlichting, waarbij levensverlenging niet gewenst is.

Hoofdstuk 4: Handelen bij urineweginfecties

Dit hoofdstuk maakt gebruik van gegevens uit het Peilstation netwerk om te kijken in hoeverre medisch behandelaren in 19 verpleeghuisorganisaties zich drie jaar na invoering van de richtlijn voor urineweginfecties bij kwetsbare ouderen aan deze richtlijn hielden. Eind 2021 registreerden medisch behandelaren binnen de peilstations gegevens over 675 verdenkingen van een urineweginfectie zonder verblijfskatheter. Van deze registraties bevatten er 532 voldoende informatie om in de analyses te worden meegenomen.

De bevindingen lieten ruimte voor verbetering zien:

- Urine werd in 86% van alle verdenkingen van een urineweginfectie getest met een urinestick.
- In situaties waarin klinische klachten en symptomen al duidelijk maakten dat behandeling van een urineweginfectie niet passend was, werd in 85% van de gevallen toch een urinestick gebruikt. Niet-negatieve uitslagen van de urinestick waren dan ook geassocieerd met een 3,5 keer hogere kans op het starten van antibiotica.
- Beslissingen om al dan niet antibiotica te starten waren in 69% van de gevallen in lijn met de richtlijn.
- De aanbevolen antibiotica voor een eenvoudige blaasontsteking (cystitis) bij vrouwen werden in 88% van de gevallen voorgeschreven. Bij urineweginfecties met weefselinvasie (zoals koorts of koude rillingen) werd in slechts 48% van de gevallen het aanbevolen antibioticum voorgeschreven.

Dit hoofdstuk concludeert dat kritisch gebruik van urinesticks en meer nadruk op klachten en symptomen (symptoomgericht denken) waarschijnlijk kunnen helpen om volgens de richtlijn te werken en daarmee passender antibiotica voor te schrijven.

Hoofdstuk 5: Lessen uit spiegelgesprekken

In dit hoofdstuk worden in een kwalitatieve studie 15 spiegelgesprekken binnen het Peilstation netwerk geanalyseerd. Het doel was te begrijpen hoe vakgroepen spiegelinformatie al dan niet omzetten in actieplannen om te leren en te verbeteren. Voor de analyse is gebruikgemaakt van bestaande raamwerken voor audit en groepsfeedback voor medische vakgroepen.

Belangrijkste inzichten:

- Fysieke bijeenkomsten leidden tot een betere groepsdynamiek en meer betrokkenheid dan online of hybride sessies.
- Als de resultaten goed waren, zorgde dat voor een soort ‘schouderklopje’ voor de groep. Bij minder goede resultaten werden daarentegen vaak externe oorzaken genoemd, zoals tijdelijk invallende artsen of problemen met datakwaliteit.
- Gespreksleiders speelden een belangrijke rol bij het bewegen van de groep van ‘uitleggen wat er staat’ naar ‘praten over veranderingen’ (change talk) tot het formuleren van concrete verbeteracties.

Geleerde lessen zijn onder andere de noodzaak om gespreksleiders te trainen, ervoor te zorgen dat belangrijke vakgroepleden bij de sessies aanwezig zijn, en spiegelinformatie op een passend detailniveau te presenteren zodat vakgroepen worden gemotiveerd tot verbetering.

Hoofdstuk 6: Algemene beschouwing

Het laatste hoofdstuk plaatst de bevindingen binnen de leercyclus van het lerend zorgsysteem, reflecteert op methodologische overwegingen en doet aanbevelingen voor onderzoek, praktijk en beleid.

Belangrijke overwegingen en aanbevelingen:

- De set kwaliteitsindicatoren die door medisch behandelaren is gekozen, vraagt om verdere operationalisering om elektronische data-extractie mogelijk te maken en om meeteigenschappen, zoals validiteit en betrouwbaarheid, te beoordelen. Tegelijkertijd kunnen deze indicatoren medisch behandelaren helpen bij het bepalen welke gegevens zij kunnen verzamelen ter ondersteuning van leren en verbeteren.
- Een belangrijke uitdaging bij het gebruik van huidige EPD-gegevens is de noodzaak om gegevenselementen te herstructureren en te standaardiseren zodat ze geschikt zijn voor hergebruik in onderzoek. De gestructureerde Minimale Data Set in Nederlandse verpleeghuizen zal naar verwachting de datakwaliteit verbeteren. Toepassing van de FAIR-principes (Findable, Accessible, Interoperable, Reusable – vindbaar, toegankelijk, interoperabel en herbruikbaar) kan de volledigheid en betrouwbaarheid van data verder vergroten.

- Nieuwe, geavanceerde technologieën, zoals kunstmatige intelligentie, kunnen informatie uit ongestructureerde vrije-tekstvelden in het EPD halen, mogelijk de registratielast verminderen en nieuwe manieren bieden om feedback te geven aan medisch behandelaren.
- Een zichzelf in stand houdend lerend zorgsysteem vereist langdurige financiële ondersteuning, toegewijde tijd van medewerkers en sterk leiderschap om een cultuur van continu leren en kwaliteitsverbetering te bevorderen.

Dit proefschrift illustreert de rol van medisch behandelaren in een zich ontwikkelend lerend zorgsysteem voor medische zorg in verpleeghuizen. Het laat zien hoe samen met hen geschikte kwaliteitsindicatoren kunnen worden gekozen, hoe EPD-gegevens kunnen worden ingezet om de kwaliteit van zorg te meten en hoe terugkoppeling in spiegelgesprekken kan helpen om inzichten om te zetten in plannen om de medische zorg voor verpleeghuisbewoners te verbeteren. Het toont hoe behandelaren actief betrokken kunnen zijn bij de verschillende fasen van de continue leercyclus, met als doel betere en meer passende zorg voor verpleeghuisbewoners.

Verklaring over het gebruik van generatieve AI en AI-ondersteunde technologieën in het schrijffproces
 Conceptversies van de samenvattingen in dit proefschrift zijn opgesteld met behulp van NotebookLM. Daarnaast heeft de auteur Grammarly en ChatGPT gebruikt om de leesbaarheid en de taal te verbeteren. Alle inhoud is door de auteur beoordeeld en waar nodig aangepast. De auteur neemt de volledige verantwoordelijkheid voor de uiteindelijke inhoud van deze publicatie.

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Chapter 1

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Chapter 2

Compiling a Set of Actionable Quality Indicators for Medical Practitioners in Dutch Nursing Homes: A Delphi Study. <i>Journal of the American Medical Directors Association</i> , 25(8), 105089. doi.org/10.1016/j.jamda.2024.105089	
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Chapter 3

Timely Documentation of CPR Codes and Medical Treatment Preferences in the EHRs of Nursing Homes. <i>Journal of Pain and Symptom Management</i> , 70(5), 427–436.e1. doi.org/10.1016/j.jpainsymman.2025.07.022	
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Chapter 4

Urinary Tract Infection Guideline Adherence in a Dutch Sentinel Nursing Home Surveillance Network. *Journal of the American Medical Directors Association*, 25(7), 105037. doi.org/10.1016/j.jamda.2024.105037

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Chapter 5

Audit and Group Feedback in Nursing Home Physician Groups: Lessons Learned from a Qualitative Study. *BMC Health Services Research*, 25(1), 227. doi.org/10.1186/s12913-025-12355-y

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Chapter 6

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PhD Period	2022-2026
Supervisor	prof. dr. Martin Smalbrugge, prof. dr. Martine de Bruijne
Co-supervisor	dr. Karlijn Joling
Department	Department of Medicine for Older People

PhD Training

Courses		Year	ECTS
Data Analysis in R	VU Graduate Winter School	2022	3
Basic Principles of Epidemiological Research	EpidM	2022	4
Getting Published: Effectively Communicating Your Research Workshop	Nature Research Academies	2022	0.4
Principles of Epidemiological Data Analysis	EpidM	2022	4
Writing a Scientific Article	Taalcentrum VU	2022	3
Regression Techniques	EpidM	2022	4
Clinimetrics: Assessing Measurement Properties of Health Measurement Instruments	EpidM	2022	3
Research Integrity Course	VUmc Academie	2022	2
Missing Data: Consequences and Solutions	EpidM	2022	2
Multilevel Modelling and Longitudinal Data Analysis	EpidM	2022	4
Data Stewardship- DATAclinic	Elevate Health	2022	1.5
Causal Inference and Propensity Score Methods	EpidM	2023	2
Advanced Methods of Epidemiological Research	EpidM	2023	4
Designing a Process Evaluation	AmsCIS	2023	0.3
Computing in R	AmsterdamUMC Doctoral School	2023	0.4
Methodological Advice	EpidM	2023	3
Qualitative Research Methods	EpidM	2024	2
Grant Writing Course	Research Grant Support	2025	0.3

Poster Presentations		Year	ECTS
APH Annual Meeting: Antibiotic treatment of urinary tract infections in nursing homes: Adherence to national guideline for vulnerable elderly in the Dutch sentinel nursing home network	Amsterdam	2022	1



European Geriatric Medicine Society Congress: Prioritizing candidate quality indicators for medical practitioners in Dutch long-term care: An online Delphi study	Helsinki, Finland	2023	1
Post-Acute and Long-Term Care Annual Conference: Urinary Tract Infection Guideline Adherence in Dutch Nursing Home Network	San Antonio, USA	2024	1
European Geriatric Medicine Society Congress: Timely Documentation of Cardiopulmonary Resuscitation Order and Treatment Preferences in Dutch Nursing Homes: Observational Study with Electronic Health Record Data from 2017-2022	Reykjavik, Iceland	2025	1

Oral Presentations		Year	ECTS
Verenso Voorjaarscongres: Lerende van data: Kwaliteitsindicatoren voor medisch behandelaar in het verpleeghuis	Den Bosch	2023	1
Post-Acute and Long-Term Care Annual Conference: Unlocking the Power of Electronic Health Records for Research, Policy, and Quality (symposium)	San Antonio, USA	2024	2
International conference on evidence-based policy and long-term care: Progress and opportunities in evaluating quality of medical care in long-term care using quality indicators ongoing work across countries (symposium)	Bilbao, Spain	2024	2
Verenso Voorjaarscongres: Lerende van data tijdens een spiegelgesprek: Hoe werkt dat bij medische vakgroepen in de Peilstations?, Verenso Voorjaarscongres	Den Bosch	2024	1
Verenso Voorjaarscongres: Lerende van data voor beslissondersteuning bij LLWI-Voorlopige inzichten	Den Bosch	2025	1
SOON congres Ouderengeneeskunde: Tijdige documentatie van behandelgrenzen in Nederlandse verpleeghuizen: Observatieonderzoek met elektronische patiënten dossiers van 2017-2022	Ede	2025	1

Awards & Grants		Year
Travel grant Aging and Later Life	APH Research Institute	2024
Inspirational Quote Contest	APH Research Institute	2024
Grant: Wel of geen antibiotica starten bij verpleeghuisbewoners met verdenking op een lage luchtweginfectie: Lerende van data voor passende beslissondersteuning	Regionaal zorgnetwerk AMR Noord-Holland Flevoland	2025

Other Activities		Year	ECTS
Intervisie		2022-2024	0.5
Talma Congres: Zorg onder druk	Amsterdam	2022	0.3
SANO Wetenschapsdag	Amsterdam	2023	0.3
CaRe days	Eindhoven	2024	0.6
Research meetings (various)		2022-2026	2
Thesis supervision of BSc student (3x) and MSc students (2x)		2024-2025	5
Peer review of scientific articles (BMC Health Services Research, Aging and Health Research, Journal of the American Medical Directors Association (2x))		2024-2025	1
Totaal Number of ECTS			64.6

List of Publications

This thesis

1. **Yeung GYC**, Smalbrugge M, de Bruijne MC, et al. Timely Documentation of CPR Codes and Medical Treatment Preferences in the EHRs of Nursing Homes. *J Pain Symptom Manage*. 2025;70(5):427-436.e1. doi:10.1016/j.jpainsymman.2025.07.022
2. **Yeung GYC**, Albers CAW, Smalbrugge M, et al. Audit and group feedback in nursing home physician groups: lessons learned from a qualitative study. *BMC Health Serv Res*. 2025;25(1):227. doi:10.1186/s12913-025-12355-y
3. **Yeung GYC**, Joling KJ, Dash D, et al. Compiling a Set of Actionable Quality Indicators for Medical Practitioners in Dutch Nursing Homes: A Delphi Study. *J Am Med Dir Assoc*. 2024;25(8):105089. doi:10.1016/j.jamda.2024.105089
4. **Yeung GYC**, Smalbrugge M, van Buul LW, et al. Urinary Tract Infection Guideline Adherence in a Dutch Sentinel Nursing Home Surveillance Network. *J Am Med Dir Assoc*. 2024;25(7):105037. doi:10.1016/j.jamda.2024.105037

Other

1. Dash D, Potter M, ...**Yeung GYC**..., et al. A Framework for Expectations of Physician Commitment in Long-Term Care Homes: A Consensus Statement. *J Am Med Dir Assoc*. 2026;27(1):106001. doi:10.1016/j.jamda.2025.106001
2. van der Griend J, Wouters F, **Yeung GYC**, et al. Adherence to Guideline Recommendations on Psychotropic Drug Use for Challenging Behavior in Dementia. *J Am Med Dir Assoc*. 2025;26(4):105474. doi:10.1016/j.jamda.2024.105474
3. Jepma P, Wouters F, **Yeung GYC**, et al. Leren in het verpleeghuis met spiegelinformatie: Resultaten uit de peilstations Leren van data. *Tijdschr voor Ouderengeneeskunde*. 2023;5.
4. **Yeung GYC**, van den Berg GJ, Lindeboom M, et al. The impact of early-life economic conditions on cause-specific mortality during adulthood. *J Popul Econ*. 27, 895–919 (2014). <https://doi.org/10.1007/s00148-013-0497-1>

About the Author

Gary Yeung (born 1987) graduated from Hermann Wesselink College in Amstelveen in 2005 and that same year started studying econometrics and operational research at Vrije Universiteit Amsterdam. In 2006, he also started medical training, thereby combining both disciplines. He obtained his bachelor's degree in econometrics in 2009 and completed the honors program in medicine at the Department of Health Economics and Health Technology Assessment.

In 2013, Gary began his clinical career as a junior doctor in internal medicine at Rijnland Ziekenhuis. He then worked in occupational medicine at the former Amsterdam Medical Center, where he gained valuable insights into the importance of workforce health and safety in providing high-quality care. Next, under the supervision of Caro Brumsen, he completed the hospital medicine residency program at Haaglanden Medisch Centrum. There, he was trained to integrate continuous quality improvement into clinical practice. After working as a hospitalist, he transitioned to long-term care at Saffier, a nursing home organization in The Hague.

In 2021, Gary combined his clinical work with his interest in data analysis and quality improvement by joining the 'Leren van data' (Learning from Data) program at the Department of Medicine for Older People at Amsterdam UMC. He started his PhD in 2022, during which he also completed a postgraduate master's in epidemiology (cum laude) at Vrije Universiteit Amsterdam. In the final stage of his PhD, he enrolled in the medical residency program for elderly care physicians to specialize in the medical care of older adults living in the community and nursing home residents. He completed his first residency year at Saffier in The Hague under the guidance of Charlotte Griffioen and is currently in his second year, while continuing his research in the Learning from Data program. Gary is dedicated to supporting healthcare professionals in using clinical data in practical and accessible ways to improve the quality of care.

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Cees, hoewel onze samenwerking kort was, was deze waardevol. Vooral bij de opstart en mijn eerste artikel over urineweginfecties heb ik veel aan jouw betrokkenheid gehad. De opgedane kennis over UWI's komt nog dagelijks van pas binnen het verpleeghuis.

De **leden van de leescommissie** wil ik bedanken voor hun tijd en aandacht om mijn proefschrift te beoordelen. Ik kijk uit naar een interessante en leuke discussie tijdens de verdediging.

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