Universität Basel
Medizinische Fakultät
Departement Public Health

La Source.
Institut et Haute
Ecole de la Santé

Scuola universitaria professionale
della Svizzera italiana
SUPSI

Sub-aim 1.1: Evidence on data quality in long-term care facilities, use of risk adjustment and scale-up strategies

NATIONAL IMPLEMENTATION PROGRAMME – STRENGTHENING QUALITY OF CARE IN PARTNERSHIP WITH RESIDENTIAL LONG-TERM CARE FACILITIES FOR OLDER PEOPLE 2022-2026

NIP-Q-UPGRADE

Version 1.0 (2023.12.27)

Authors: Bastiaan Van Grootven, Aurora Monticelli, Magdalena Osińska, Jianan Huang, Megan Davies, Lisa Kästner, Nathalie I.H. Wellens, Laurie Corna, Franziska Zúñiga

Institute of Nursing Science (INS), Department of Public Health, University of Basel, Basel
La Source School of Nursing (La Source), University of Applied Sciences Western Switzerland, Lausanne
University of Applied Sciences and Arts of Southern Switzerland (SUPSI), Manno

National Implementation Programme – **Strenghtening quality of care in partnership with residential long term care facilities for older people 2022–2026** (NIP-Q-UPGRADE), commissioned by the Federal Quality Commission (FQC) to ARTISET with the industry association CURAVIVA and senesuisse – Laufende Programme und Projekte (admin.ch)

The NIP-Q-UPGRADE supports long-term care facilities in data-driven quality improvement based on the national quality indicators.

The National Programme is implemented using implementation science approaches. ARTISET/CURAVIVA and senesuisse have delegated the scientific management of the programme to their collaboration partner, the University of Basel, Institute for Nursing Science (INS). For its part, the INS works collaboratively with the Institut et Haute École La Source in Lausanne (La Source) and the Scuola universitaria professionale della Svizzera italiana (SUPSI) to implement the programme nationally and has delegated different sub-aims to the partner institutions. The research institutes' interpretation of the scientifically substantiated results, their conclusions and recommendations to the trustee and to the Federal Quality Commission EQC may differ from the trustee's point of view.

Suggested citation: Bastiaan Van Grootven, Aurora Monticelli, Magdalena Osińska, Jianan Huang, Megan Davies, Lisa Kästner, Nathalie I.H. Wellens, Laurie Corna, Franziska Zúñiga: Sub-aim 1.1: Evidence on data quality in long-term care facilities, use of risk adjustment and scale-up strategies. Mandate on behalf of the National Implementation Programme – Strengthening quality of care in partnership with residential long-term care facilities for older people 2022-2026 (NIP-Q-UPGRADE), Laufende Programme und Projekte (admin.ch). doi: 10.5281/zenodo.10115835.

Table of Contents

Tables

List of abbreviations

WP	Work Package
LTC	Long Term Care
LAMal	Swiss Federal Law on Compulsory Health Care
ERIC	Expert Recommendations for Implementing Change

Abstract

Project description: Sub-aim 1.1 summarised the evidence regarding determinants for and strategies to improve data quality in long-term care facilities, described how risk adjustment influences public reporting, and summarised the evidence regarding scaling-up strategies for evidence-based interventions.
Methodological approach: Four literature reviews were performed.
Core results: Key determinants for data quality were: the use of electronic health records (in comparison to paper-based records), perceptions and attitudes towards care and older persons, and perceptions towards the usefulness of resident documentation. Most studies used reminder strategies in the form of assessment protocols, and some coupled this with educational strategies to improve completeness of documentation. Three examples demonstrated that risk adjustment reduces the influences of case-mix differences between facilities. Implementation strategies supporting scale-up of complex interventions included developing collaborations with stakeholders (i.e., facility staff and other partners in the implementation process), as well as providing them with education, training and interactive assistance.

Summary

Mission: This report summarises the results from four literature reviews. The evidence-base identified in this sub-aim (WP 1.1) will support the development of a program to support data quality in LTC facilities, provides evidence for them regarding the importance of risk adjustment, and supports the development of an implementation and scale-up plan for the developed program (WP 1.7).

Background: The measurement of quality indicators in Swiss LTC facilities was introduced in 2019 through the Swiss Federal Law on Compulsory Health Care (LAMal) (i.e., article 59*a*). This was to promote transparency through public reporting, monitor quality of care and support long-term care facilities with quality improvement for their residents. Quality indicators are routinely assessed for every resident in Swiss LTC facilities, and data are received by the Federal Statistical Office and publicly reported by the Federal Office of Public Health. In order to develop solutions to support facilities with good data quality for the national quality indicators, insights from previous research complement the primary research conducted in the NIP-Q-UPGRADE programme.

We defined four aims: 1. To identify what factors (determinants) are associated with the data quality of quality indicators in the LTC facilities for older persons; 2. To identify interventions that are effective for improving data quality of quality indicators in the LTC facilities for older persons; 3. To investigate how risk adjustment influences the performance of LTC facilities on quality indicators; 4. To identify implementation strategies that support the regional/national scale-up of complex interventions in LTC facilities.[1]

Methods: Four literature reviews were performed. Search strategies included key databases (e.g. Pubmed, Embase), screening reference lists and prospective citations, and searching grey literature sources. Endnote was used to manage references and study selection followed standard processes. Data collection was supported by data abstraction manuals/guides. For the purpose of this report, a narrative summary was produced.

Results:

Review 1: Eleven studies were identified that reported determinants for data quality in long-term care. Nearly all evidence was derived from English speaking countries. The majority of evidence was related to the facilitating nature of electronic health records in comparison to paper-based documentation systems. This was related to the structured nature of the electronic health records (e.g., use of templates for registering information), its ease of use, and acted as a reminder for the completion of data (through pop-ups or decision support systems). Positive attitudes towards older persons, belief in the usefulness of quality indicators, and belief in the usefulness of the standardised documentation were identified as determinants that facilitate data quality.

Review 2: Eighteen studies that investigated interventions to improve data quality were identified across different countries. However, only two experimental studies were found in the literature. The majority of evidence was derived from quasi-experimental studies and quality improvement projects. On average, data quality was improved across a range of indicators. Most studies evaluated completeness of data registration for different clinical indicators (pressure ulcers, pain, dementia). On average, completeness of recorded items was improved in comparison to a control group. Most studies used reminder strategies in the form of assessment protocols, and some coupled this with educational strategies (meetings,

[1] The third review question according to the concept of WP1 addresses the question “Which communication channels, methods, data preparation tools support health institutions to use quality data for data-based quality development? What is the importance of risk adjustment for understanding the data?” The current question 3 addresses the second part. The rest of the review is integrated in sub-aim 1.6. A protocol has been prepared and is accessible on Zenodo (https://zenodo.org/records/10014476). The results will be submitted as planned by end of March 2024.

materials). A small number of studies observed that overall data quality was improved by the implementation of electronic health records. Accuracy of data registration was assessed in only two studies, while only one assessed reliability.
Review 3: Three case examples described the influence of risk adjustment and demonstrated that risk adjustment is useful in the context of public reporting. The three examples demonstrate that risk adjustment reduces the influence of case-mix differences between facilities. In particular, this benefits facilities with more 'complex' residents who, following risk adjustment, are less likely to be an outlier facility. The reverse was also demonstrated, that quality of care problems become more visible in facilities with 'less complex' residents using risk adjustment. There may be some concerns that risk adjustment may not always correct adequately, indicating the need to test risk adjustment in the local setting before implementing it.
Review 4: Sixteen studies that reported a scale-up or a large-scale implementation of a complex intervention in LTC settings and were successful in significantly improving their primary outcome were included. The studies were conducted in high-income countries, mostly in North America and western Europe and included 27- 404 LTC facilities. The majority of studies used several implementation strategies, most commonly developing collaborations with stakeholders (i.e., facility staff and other partners in the implementation process), as well as providing them with education, training and interactive assistance. Evaluative and iterative strategies, such as audit and feedback, readiness or needs assessment were also reported. Strategies at a system level (policy, funding), and consumer engagement strategies were reported less often.
Conclusions: Although the evidence is sparse, it appears that cognitive processes (attitude, beliefs, perceptions) by healthcare professionals and the design of electronic health records (e.g., reminder strategies to increase data completeness) are key areas that could be targeted to support data quality in residential LTC facilities. There is insufficient data to inform how to improve the accuracy and reliability of data for quality indicators in long-term care facilities. Furthermore, because of the diversity of interventions and combination of interventions found in the literature, it is not possible with the current evidence to predict how much improvement in data quality can be expected when implementing data quality improvement programmes. Evidence regarding risk adjustment demonstrate its importance for public reporting when comparing performance across facilities or when identifying poor performing facilities it the goal. Implementation of effective programmes should be supported by multiple implementation strategies targeting different levels and needs of the target group.

Recommendations:

1. We recommend that a theory-driven, context-related data quality improvement program should be developed.
   1.a The data improvement program should specifically design interventions to improve accuracy and reliability of data.
   1.b The data improvement program should seek to create definitions and instructions for data collection and registration to be integrated in the Swiss LTC system.
   1.c The data improvement program should also include strategies to include appropriate risk adjustment.
   1.d The data improvement program should use the strengths of the electronic health records to support good quality data.
2. We recommend that future evaluation studies measure the data accuracy and reliability.
3. We recommend that public reporting should be based on risk adjusted quality indicators. Before implementing risk adjustment, their appropriateness should be tested.
4.a. We recommend that future quality improvement and implementation programs use targeted implementation strategies, and that strategies at different levels (individual,

organization, system) and implementation phases (pre-implementation, implementation, sustainment) are considered.
4.b-g. Scale-up programs should consider the use of one or more of the following strategies, based on an implementation needs assessment: foster collaborations between stakeholders, recruit and train implementation facilitators, regular audit and feedback, integrating scale-up strategies in current LTC systems, and use consumer engagement strategies for dissemination.
4.h. Future studies should clearly indicate and describe their implementation strategies with regard to involved actors, actions, context, targets, time and rationale.

Report

Background and context

The measurement of quality indicators in Swiss long-term care (LTC) facilities was introduced in 2019 through the Swiss Federal Law on Compulsory Health Care (LAMal) (i.e., article 59*a*). This was to promote transparency through public reporting, monitor quality of care and support long-term care (LTC) facilities with quality improvement for their residents. Quality indicators are routinely assessed for every resident in Swiss LTC facilities, and data are received by the Federal Statistical Office and publicly reported by the Federal Office of Public Health.

Initial investigations on data quality of Swiss quality indicators in LTC indicate challenges with correctly calculating polypharmacy, (1) and more systematic problems with missing data, coding errors or coding inconsistencies in facility datasets generated through the different software systems that register quality indicator information. (2) Conversations with LTC facilities indicate the collection and registration of data for the national quality indicators in LTC facilities is challenging. In order to develop solutions to address these challenges and support facilities with effective methods to improve their data quality, insights from previous research will complement the research conducted in the NIP-Q-UPGRADE programme. This report therefore summarises the results from four literature reviews. The evidence-base identified in this sub-aim (WP 1.1) will contribute to the development of a program that supports LTC facilities with having good data quality, informs them about the importance of risk adjustment, and supports the development of an implementation and scale-up plan for the developed program (WP 1.7).

In the first literature review, determinants of data quality were investigated. These factors help us understand what influences data quality in LTC facilities. Identified determinants can be used to specify objectives for improvement and think about strategies to overcome or address these factors.

Second, interventions for improving data quality were investigated. Information on these interventions inform the development of potential solutions that could be used to support LTC facilities in the collection of high-quality data.

Third, risk adjustment for quality indicators was investigated. Public reporting of quality indicator entails a comparison or even ranking between facilities, either explicitly or implicitly. Observed differences in quality indicator ratings between facilities are not solely based on differences in quality of care. One of the underlying mechanisms is differences in resident profiles, i.e., case-mix differences between facilities. To get fairer QI ratings reflecting the real-life situation of the facilities and its variety in residents, risk adjustment will consider the differences in the facilities' case-mix. Examples of those differences are intensity of care needs, level of autonomy, or level of cognitive abilities. Understanding how risk adjustment influences public reporting is important for facilities when they use public information to evaluate or compare their quality of care.

Fourth, scale-up strategies for evidence-based interventions were investigated. A key aim of the NIP-Q-UPGRADE programme is to scale-up solutions that support good data quality and quality of healthcare services in Swiss LTC facilities. Understanding what strategies are effective for scale-up will inform the implementation plan developed in sub-aim WP 1.7.

We first present an overview of the aims, followed by a summary of the methods and results for each literature review. In the final part, an overall conclusion and recommendations are detailed.

Aims

We defined four aims, one corresponding to each of the literature reviews:
1. To identify what factors are associated with the data quality of quality indicators in LTC facilities for older persons.
2. To identify interventions that are effective for improving data quality of quality indicators in LTC facilities for older persons.
3. To investigate how risk adjustment influences the performance of LTC facilities on quality indicators.
4.To identify implementation strategies which support the regional/national scale-up of complex interventions in LTC facilities for older people.

Review 1: Determinants for data quality in long-term care homes

Aim

The aim of the study was to identify what factors are associated with the data quality of quality indicators in LTC facilities for older persons.

Methods

A scoping review was performed. The databases PubMed and Embase were searched from inception up to 3 January 2023. The search string contained Mesh terms and synonyms for the following key concepts 1) long-term care, 2) determinants, 3) data quality, 4) quality indicators. The search strings are reported in Appendix 1. Screening reference lists and prospective citations, and searching Google scholar, clinicaltrials.gov and the ICTRP Search Portal were used as secondary strategies. A two-step screening process was used, using Rayyan. (3) First, titles and abstracts were screened by one researcher to select potential studies for inclusion. Second, full text articles were read by two researchers to determine inclusion, based on consensus between the two researchers. Studies were included if they were performed in the LTC setting and measured or investigated determinants for data quality using an observational or qualitative research design.

Endnote was used to manage the references. Study data was collected by one researcher and verified by a second researcher. Data was collected in an Excel database based on a data abstraction manual. Qualitative study results were uploaded in MAXQDA. (4) We collected information related to the study identification, study characteristics, determinants, and outcomes of data quality. Outcomes of data quality were defined as overall quality of data, accuracy, reliability, timeliness, and completeness. (5)

The results were tabulated per outcome measure for data quality and the underlying determinants. Determinants that were investigated in qualitative studies were identified using a meta-synthesis process based on a thematic analysis. (6) The results for the quantitative and qualitative are described separately.

Results

A total of 3178 records were screened, 67 full text articles were evaluated for inclusion, and 11 studies were included. A total of six studies were conducted in the United States of America, (7-12), four in Australia, (13-16) and one in Israel. (17) Nine studies were multicentre studies. (7-12, 14-16) Five studies tested determinants using an observational study design, (10-12, 16, 17) and six studies investigated determinants using a qualitative research design. (7-9, 13-14)

Results from observational studies

A retrospective cohort study evaluated the difference in the completion of resident assessment forms on admission between paper-based and electronic patient records in nine LTC facilities. (16) Completeness and overall quality of documentation was better in electronic records in four out of six data indicators. Timeliness of documentation was better in paper-based patient records in one study.

A cross-sectional descriptive study investigated the perceived improvement in reporting of resident information due to the implementation of electronic medical records in 284 LTC facilities. (11) Facility directors and administrators reported ‘some’ to ‘moderate’ improvements in completeness and overall data quality associated with the use of electronic patient records.

A cross-sectional cohort study evaluated the accuracy of documentation by care staff in 178 LTC facilities in comparison to trained study nurses. (10) Results were stratified by level of hospice care (need for palliative care) at the facility level. Facility staff overestimated severe pain in facilities with low to high concentration of hospice care. For mild pain, there were no significant differences in accuracy of documentation. The results of this study indicate that the accuracy of documentation may depend on certain characteristics of the resident.

One cross-sectional cohort study investigated associations between characteristics of nurses working in one LTC facility and the completeness of documentation of pain assessment. (17) The strongest predictor of the completeness of pain documentation was knowledge about pain assessment, followed by having a positive attitude towards older persons and the perceived level of control over pain management of a resident. Age of the nurse, duration of nursing career, duration of working with older people, attitude towards pain assessment, and training had small but non-significant associations.

One cross-sectional study investigated the reliability of assessments on eight indicators in 206 LTC facilities. (12) The assessment of the facility nurses was compared against that of a trained research nurse. Facility characteristics explained between four to twenty percent of the variation, and the geographical location (State within the U.S.A) of the facility explained an additional thirteen to thirty-four percent of the variation. The authors hypothesized that this was mainly due to differences in policy and systematic differences in practices that fostered measurement errors. An example would be systematic differences in training programs between states resulting in systematic differences in measurement of quality indicators. Resident characteristics did not contribute significantly to the model.

Results from qualitative studies

Nine determinants were identified in six qualitative studies.

The extent to which the structure of the electronic patient/resident record facilities data collection was identified as a determinant of data quality in six themes. The structured nature of electronic records facilitates documentation without errors, in comparison to handwritten notes. (13) This was associated with ease of use of the electronic patient records, which facilitated overall documentation. (15) The use of structured documentation templates and notes was identified as a facilitator for more consistency, accuracy and quality of documentation, (8) and completion of documentation. (15) Another facilitator associated with the electronic records was the use of automated pop-ups where information had to be documented, which supported completeness of data. (15) Lastly, the structure of electronic health records facilitated more concise reporting and it was easier to make corrections of mistakes resulting in fewer errors. (15)

The remaining determinants were identified in single themes in single studies. Table 1 below presents the various determinants.

Conclusion

Only a relatively small number of studies were identified that reported determinants for data quality in LTC. Nearly all evidence was derived from English speaking countries. The majority of evidence was related to the facilitating nature of electronic health records in comparison to paper-based documentation systems. This was related to the structured nature of the electronic health records (e.g., use of templates for registering information), its ease of use, and acted as a reminder for the completion of data (through pop-ups or decision support systems). A second important determinant is perceptions and attitudes towards care, and

perceptions regarding the perceived usefulness of resident documentation. Positive attitudes towards older persons, belief in the usefulness of quality indicators, and belief in the usefulness of the documentation facilitated data quality. Although the evidence is sparse, it appears that cognitive processes (attitude, beliefs, perceptions) by healthcare professionals and the design of electronic health records are key areas that could be targeted to support data quality in residential LTC facilities.

Table 1: Determinants of data quality

Determinant	Explanation
Perceived usefulness of documentation	Perceived usefulness of documentation systems was identified as a facilitator for overall data quality. Nurses were more likely to document information if they believed that their colleagues could easily access and read the information.
Access to electronic health record	Access to electronic health records was identified a facilitator for timeliness. Timeliness of documentation was improved if nurses could access the records from multiple terminals; at the point of care.
Appropriateness of quality indicator	Perceptions regarding the appropriateness of quality indicators was identified as a barrier. Data collection of quality indicators was influenced by the perceptions of nurses in regards to the appropriateness of the indicator. Data on medical quality indicators were less likely to be collected by nursing teams if they don't consider medical indicators as their responsibility.
Knowledge (Clinical assessments)	Knowledge about the clinical assessments was identified as a determinant. It was indicated that nurses needed to have the knowledge on how to conduct the assessment.
Automated documentation (administrative information)	Automated documentation was identified as a facilitator. In this study, the automated documentation was administrative information (name and function in facility), which was perceived as helpful to ensure meeting regulatory standards. Auto-correction of spelling mistakes was a facilitator for non-native speakers.
Perceptions regarding data quality	Negative perceptions regarding data quality of data systems were identified as a barrier. Some electronic patient records can generate automatic data responses, e.g., through decision support systems. This can improve completeness of data. However, some facilities turned this off because they don't trust the accuracy of the data that was generated by these automated data systems.
Information and Technology support	Having access to sufficient Information and Technology support was identified as a facilitator. Facilities with better Information and Technology infrastructure developed their own user-defined software and improved the documentation and reporting based on their needs
Fear of litigation	Fear of litigation was identified as a barrier. A facility was hesitant to document certain information in fear of litigation. The documentation could be used against the facility in court.

Review 2: Measures for improving data quality in long-term care facilities

Aim

The aim of the study was to identify interventions that are effective for improving data quality of quality indicators in the LTC facilities for older persons.

Methods

A scoping review was performed. The databases PubMed and Embase were searched from inception up to 4 November 2022. The search string contained Mesh terms and synonyms for the following key concepts 1) long-term care, 2) interventions, 3) data quality, 4) quality indicators. The search strings are reported in Appendix 2. Screening reference lists and prospective citations, and searching Google scholar, clinicaltrials.gov and the ICTRP Search Portal were used as secondary strategies. A two-step screening process was used, using Rayyan. (3) First, titles and abstracts were screened by one researcher to select potential studies for inclusion. Second, full text articles were read by two researchers to determine inclusion, based on consensus between the two researchers. Studies were included if they were performed in the LTC setting, measured or investigated interventions that aimed to improve data quality using an experimental, quasi-experimental or quality improvement methodology.

Endnote was used to manage the references. Study data was collected by one researcher and verified by a second researcher. Data was collected in an Excel database based on a data abstraction manual. We collected information related to the study record, study characteristics, interventions, and outcomes of data quality. Outcomes of data quality were defined as overall quality of data, accuracy, reliability, timeliness, and completeness. (5)

The results were tabulated per outcome measure for data quality and organised by type of intervention and type of comparison. Effects were calculated per outcome measure, i.e., proportional difference for event data and mean difference for continuous data (if sufficient data was reported by the studies). Missing data was imputed where possible. If one study had multiple measurements per data quality outcome, data were aggregated to an average effect accounting for the correlation between the dependent outcome measures. Effects were expressed with 95% Confidence Intervals to determine statistical significance. The effects are reported for three comparisons: 1) Change in data quality from baseline to endpoint within intervention group, 2) difference in data quality between control group and intervention group on endpoint, 3) difference in change from baseline to endpoint between control group and intervention group.

Results

A total of 3111 records were screened, 162 full text articles were evaluated for inclusion, and 18 studies were included. (15, 18-34) A total of ten studies were conducted in North America, (18 19, 22-24, 26, 28, 29, 32, 33) four in Europe (United Kingdom, Norway and Sweden (2x)), (20, 21, 25, 34) and four in Australia. (15, 27, 30, 31) Fifteen studies were multicentre studies. (15, 18, 20-29, 32-34) Two studies had an experimental design, (28, 29) twelve studies had a quasi-experimental design, (18-22, 25-27, 31-34) and four studies had a non-experimental quality improvement design. (15, 23, 30, 32)

Fifteen studies measured the data quality outcome completeness. (18, 20-24, 26-34) Three studies measured the outcome overall data quality. (30, 31, 34) Two studies measured the

outcome accuracy. (19, 25) One study measured reliability. (31) Outcome measured were related to the clinical indicators of pain (n = 5), pressure ulcers (n = 2), symptoms and behavioural problems related to dementia (n = 2), falls (n = 2), care preferences (n = 1), urinary tract infections (n = 1), medication review (n = 1), and were related to overall care documentation (n = 4). In all the studies, the data source was the resident documentation, which was analysed by research teams for data quality.

Studies used the following types of interventions: sending reminders (n = 12), introducing health information systems (n = 5), organising educational meetings (n = 4), clinical incident reporting (n = 3), use of information and communication technology solutions (n = 2), distributing educational materials (n = 4), audit and feedback (n = 1), and monitoring the performance of the delivery of healthcare (n = 1). More information is presented in table 2.

Outcome: data completeness

Ten studies measured improvement in the completeness of registered individual resident data from baseline to the endpoint in the intervention group. A total of 53 outcome measures were observed, and completeness was improved with 37%, (95% CI, 13% to 61%) on average, across the different types of interventions. Interventions contributing to this effect were audit and feedback strategies, reminder strategies, educational meetings, educational materials, the implementation of health information systems, the implementation of critical incident reporting systems, the use of information and communication technology, and monitoring the performance of the facility.
Five studies compared the completeness of registered individual resident data between a control and intervention group on the endpoint. On average, completeness was 12.5% (95% CI, 3% to 22%) higher in the intervention group. Interventions contributing to this effect were audit and feedback strategies, reminder strategies, educational meetings, the implementation of health information systems, and the implementation of critical incident reporting systems.
Three studies compared the change improvement in the completeness of registered individual resident data between control group and intervention group from baseline to endpoint. Five outcome measures were observed, and the intervention group had on average 17% (95% CI, -5% to 40%) more improvement than the control group. Interventions contributing to this effect were audit and feedback strategies, reminder strategies, educational meetings, and educational materials.

Outcome: overall data quality

Three studies measured improvement of data quality from baseline to the endpoint in the intervention group. No specific definition was given for overall data quality. Three studies that measured the outcome using a continuous scale observed an improvement in overall data quality. One study measured a proportional increase in data quality and observed an improvement of 24% (95% CI, 9% to 40%). Compared to the control group, the quality was 22% (95% CI, 6% to 38%) higher in this intervention group. Interventions contributing to these effects were the implementation of electronic health records and an educational program.

Outcome: accuracy

One study measured improvement in accuracy from baseline to the endpoint in the intervention group by using a tool to support assessment of urinary tract infections. Accuracy is defined as the degree to which the recorded data are correctly reflecting the clinical situation, and was improved by 63%. One study compared four outcome measures between a control and intervention group and observed that the accuracy was on average 14% (95% CI, 0.1% to 28%) better in the intervention group, using a computerized decision support system for medication management.

Table 2: Overview of data improvement

Author	Date	Audit and Feedback	Reminder	Educational meetings	Educational materials	Health Information System	Clinical incident reporting	The use of information and communication technology	Monitoring the performance of the delivery of healthcare
Carpenter (18)	2022	Sending monthly feedback reports on completion of data		Educational webinars on documenting goals of care (frequency not reported)	Educational materials on documenting goals of care				
Cooper (19)	2017		Tool to support assessment of urinary tract infection						
Ellis-Smith (20)	2018		Tool to support assessment of dementia behaviour						
Fossum (21)	2013		Decision support system for pressure ulcer assessment	Educational meetings on pressure ulcer assessment and management (frequency not reported)					
Gallant (22)	2022		Protocol for pain assessment						
Hadjistavropoulos (23)	2016		Protocol for pain assessment						

Author	Date	Audit and Feedback	Reminder	Educational meetings	Educational materials	Health Information System	Clinical incident reporting	The use of information and communication technology	Monitoring the performance of the delivery of healthcare
Horn (24)	2010		Structured documentation tool with decision support system for pressure ulcer assessment						
Johansson-Pajala (25)	2018		Computerized decision support system for medication management						
Kaasalainen (26)	2012		Protocol for pain assessment						
Ranasinghe (27)	2013		Residents assessment tool for dementia behaviour	One educational meeting on assessment of dementia behaviour			Incident reporting and follow-up with action		
Wagner (28)	2005					Menu driven incident reporting system to guide falls assessment	Incident reporting of a fall		
Wagner (28)	2008					Menu driven incident reporting system to guide falls assessment	Incident reporting of a fall		
Zhang (15)	2012					Introduction of electronic health record			

Author	Date	Audit and Feedback	Reminder	Educational meetings	Educational materials	Health Information System	Clinical incident reporting	The use of information and communication technology	Monitoring the performance of the delivery of healthcare
Bail (30)	2022					Introduction of electronic health record			
Munyisia (31)	2011		Structured tools and reports (not specified)			Introduction of electronic health record			
Tran (32)	2022		App for structured assessment for pain		Access to continuing educational materials on web-portal, including educational videos, relevant literature, recommendations			App for structured assessment for pain	Quality indicator website
Zahid (33)	2020		Checklist for pain assessment		Educational resources (not specified)			App version for pain assessment checklist (reminder) and web-based training (educational materials)	
Ehrenberg (34)	1999			Educational program with seminars group discussions & case discussions					

Outcome reliability

The reliability of data was higher in one study that implemented an electronic health record but this was not statistically significant; the study had a small sample size (n = 47 observations).

Conclusion

While the review identified and included 18 studies across a range of countries, only two experimental studies were included. The majority of evidence was derived from quasi-experimental studies and quality improvement projects. On average, data quality was improved across a range of data indicators. Most studies evaluated completeness of data registration for various clinical indicators (pressure ulcers, pain, dementia). Completeness referred to the registration of individual resident data. On average, completeness was improved, also in comparison to a control group. Most studies used reminder strategies in the form or assessment protocols, and some coupled this with educational strategies (meetings, materials). A small number of studies observed that overall data quality improved through the implementation of electronic health records that included the indicator variables in routine recordings. Only two studies assessed accuracy and only one focussed on reliability. Overall, the results point towards a possibility to improve data quality. However, it should be noted that the baseline data quality was poor in multiple studies (data not presented) giving more opportunity for larger effect sizes. Observed effects may therefore be difficult to transfer to other contexts. Because of the diversity of interventions and combination of interventions it is not possible with the current evidence to predict how large improvements in data quality can be expected when implementing data quality improvement programs.

Review 3: Risk adjustment for quality indicators

Aim

The aim of this study was to investigate how risk adjustment influences the performance of LTC facilities on quality indicators.
Risk adjustment refers to a statistical technique which uses resident characteristics (e.g., prevalence of dementia in a facility) to adjust the rating of that facility on a certain quality indicator.

Methods

A scoping review was conducted following the PRISMA-ScR checklist. (35) The design of the scoping review has been based on methods developed by Arskey and O'Malley 2005. (36) This includes developing informed research questions, extracting selective and relevant data from documents and synthesising data in the final review using appropriate techniques. A narrative synthesis output has been selected as a means of explaining and presenting information.

Searches, comprising terms for 1) long-term care, 2) risk adjustment measures and 3) quality indicators were run using PubMed and Embase. The search string is included in Appendix 3. In addition, a grey literature search was undertaken using the Knowledge Exchange database via the Knowledge Exchange website, The British Library, Library Hub (JISC), BASE, Cochrane Reviews, Google, Google Scholar and country specific government websites.

Papers were included if: they were conducted in/focusing on the residential LTC setting; reported adjusted and unadjusted quality indicator data (either primary or secondary research with no limitation on design); or reported risk adjustment variables using a longitudinal cohort design. No time restrictions were applied. Language was restricted to studies published in English, German, French, Italian, Dutch, Spanish or Polish. Included papers were screened by one reviewer. Data was extracted and tabulated using Microsoft Excel.

Results

A total of 455 papers were screened by title and abstract, of which 43 were full text screened and 3 case examples on the influence of risk adjustment were selected for inclusion in the review. All studies were conducting in the United States and used a retrospective cohort design using data from the Resident Assessment Instrument - Minimum Data Set (RAI-MDS), a standardised assessment instrument specifically adapted to the US context.

Li et al (2010) found that there were considerable discrepancies in facility rankings when looking at one or two quality indicators; in this case urinary and bowel incontinence. (37) However, by risk adjusting for age, sex, cognitive skill impairment, delirium, ability to make oneself understood, behavioural symptoms and activities of daily living, predicted indicator values derived from the dataset were useful. The risk adjustment successfully explained variation between facilities, indicating that the influence of 'case-mix' differences between facilities was reduced. However, the study did observe that risk adjustment had less of an influence in the very best and the very worst facilities (top and lowest ranked facilities). In these cases, the influence of case-mix was still substantial. The study also observed that the effect of risk adjustment is stable in the long-term and can also support longitudinal comparisons within one facility. There were concerns about short-term variation in facilities where risk adjustment was less able to explain this variation. Overall, this study demonstrates that risk adjustment can control for case-mix differences between facilities. This means that it

enables more balanced comparisons across facilities. In certain situation risk adjustment does fail to correct adequately, for example with small sample sizes.

For the outcome indicator 'worsening behaviours' in people living with dementia, Nazir et al (2011) found that risk adjustment significantly influenced the quality indicator. (38) Risk adjustment using the Cognitive Performance Scale resulted in significant shifts in the ranking of LTC facilities. Before adjustment in this study, facilities without special care units, and where the majority of residents have cognitive impairment or are living with dementia were ranked the highest with respect to quality. However, after adjusting for CPS scores, the LTC facilities with special care units had a higher percentage of 'good quality' ranking. The findings of Nazir et al (2011) suggest that risk adjusted quality indicators provide a fairer comparison of facilities caring for people living with dementia. This confirms the finding of Li et al that risk adjustment reduced the influence of case-mix differences between facilities, suggesting a fairer comparison.

Arling et al (1997) investigated the ranking of LTC facilities. (39) A comparison was made using risk groups (high, average, low) based on case-mix of facilities using a combination of four risk adjustment variables (cognitive impairment, Alzheimer's disease, other dementia, and the presence of a psychotic condition). Facilities classified as high risk due to their case-mix had a substantial higher prevalence on the indicators in comparison to facilities who were classified as average or low-risk. Risk adjustment resulted in changes in the ranking of facilities. On average across the indicators, 42% of facilities who were ranked as outliers (top-lowest 10% in ranking) were so after risk adjustment; without adjustment, they would not have been an outlier. This example demonstrates that risk adjustment helps identify facilities with quality problems (worst 10% in ranking), who without risk adjustment would not have been outliers. This further demonstrates that care quality problems can also exist in facilities with a 'lower-risk case-mix'.

Conclusion

The three case examples of the impact of risk adjustment demonstrate that risk adjustment is useful, if not crucial, for public reporting, especially when showing benchmarks and rankings. The three examples demonstrate that risk adjustment reduces the influences of case-mix differences between facilities. In particular, risk adjustment better reflects the clinical reality in facilities with more 'complex' residents. Those facilities are less likely to be categorized as a low-end outlier facility after risk adjustment. The reverse was also demonstrated, that quality of care problems become more visible in facilities with 'less complex' residents after applying risk adjustment. There may be some concerns that risk adjustment may not always correct adequately, indicating the need to test risk adjustment in the local context and adapt if needed before implementation.

Review 4: Strategies supporting scale-up of complex interventions in residential long-term care facilities

Aim

The aim of this study was to identify implementation strategies that support the regional/national scale-up of complex interventions in LTC facilities for older people.
Note: this review does not focus specifically on data quality improvement.

Methods
A scoping review of literature was performed. Medline (PubMed), Embase (Elsevier) and CINAHL (EBSCO) were searched from inception up to 15 August 2023. A search strategy was developed by the research team and consulted with an information specialist. The search terms described 1) scale-up or a large-scale implementation 2) interventions and 3) the residential LTC setting. The search strings are detailed in Appendix 4.

Studies were included if they involved residential LTC facilities for older people, which we define as a setting where older adults reside and receive 24 h formal LTC services provided by paid care staff, and where there is an expectation of a long stay. (40) We considered any information on implementation strategies used in complex interventions, which were scaled-up to a larger geographical or administrative area, such as a city, province, state, region or country or were otherwise implemented on a large scale – in around 30 facilities or more. For defining complex interventions, we followed the Medical Research Council guidance, e.g., interventions that contain several interacting components or target different groups. (41) To select strategies that support the scale-up or a large-scale implementation we included studies which reported a statistically significant effect of the intervention on the primary outcome of interest. Any techniques or methods used to promote and support intervention implementation or scale-up were considered, even if they were not explicitly labelled as implementation or scale-up strategies, but could be recognized as such, based on the Expert Recommendations for Implementing Change (ERIC) definitions. (42)

The records were exported to the Endnote software, where duplicates were removed. A two-step study selection process was conducted by two researchers independently. First, titles and abstracts were screened to select potential studies for inclusion. Second, full text articles were screened to determine inclusion, based on consensus between the two researchers regarding the inclusion criteria. A third senior researcher was involved in case of disagreement.

Data was extracted and tabulated using Microsoft Excel. We used a self-designed standardised data extraction template, which included definitions of the data items. Data extraction was conducted by three reviewers from the research team. We extracted data pertaining to study identification, study characteristics, intervention, implementation strategies, outcome measures and results. In a final step, identified strategies were mapped to the nine ERIC taxonomy categories. (42)

Results

A total of 3141 records were screened, 47 full text articles were evaluated for inclusion, and 16 studies were included. A total of eight studies were conducted in the United States of America (43–50), two in the United Kingdom (51,52), and one in each of the following countries: Australia (53), Canada (54), France (55), Germany (56), the Netherlands (57) and Switzerland (58). Two studies used an experimental research design, five studies were quasi-

experimental and nine non-experimental. The sample size varied from 27 to 404 LTC facilities, seven studies included over a 100 facilitates. The interventions focused on supporting care quality improvement (47,55,57), reducing inappropriate use of antipsychotics (52,54,50), antibiotics (49) or promoting rational drug use (58), prevention, control and management of infections (43,46,48), implementing person-centred care practices (44,51), fall and fracture prevention (56), reducing hospital admissions and emergency department transfers (53) and management of distress behaviour in dementia (45)

The identified implementation strategies covered eight ERIC taxonomy categories: develop stakeholder interrelationships, train and educate stakeholders, provide interactive assistance, engage consumers, evaluative and iterative strategies, adapt and tailor to context, change infrastructure, and financial strategies. We did not find any strategies from the category about supporting clinicians. In most studies, implementation strategies were not explicitly labeled as such, and were included in the description of the intervention or program. The detail of reporting varied between studies. Some strategies were only briefly mentioned, which impeded their accurate recognition and categorization.

Develop stakeholder interrelationships

Strategies aiming at developing interrelationships were mentioned in all but two studies. Most often reported was designating champions, called also change agents, site-leads or local coordinators. (45,50–52,54,56,58) These individuals were leading or supporting delivery and dissemination of the intervention. Their role was also engaging, supporting and empowering other healthcare team members, for example providing trainings, involving physicians, coordinating information flow, and administrative support. Another form of developing interrelationships was organizing meetings to support collaboration between stakeholders, e.g., of facility teams and other providers involved in the intervention (e.g., hospital physicians), or of different facility teams to learn from each other by sharing successes and barriers in the implementation or between members of an interdisciplinary team within a facility to discuss the interventions. (45,46,48,53–55,58) Studies also report building leadership structures for the projects and using advisory boards to guide the implementation. One study reported recruiting senior leadership at the national, regional, and local levels. (43) In one study, lead organizations e.g., state-based and professional associations were identified and involved in the recruitment, implementation and dissemination process. (46) In other work, organizations' various boards (executive, supervisory, and the employees' and clients' advisory board) were engaged in co-designing action plans. (57) Three studies mentioned obtaining formal commitments from the facilities to participate in the study and implement the interventions. (47,56,57)

Train and educate stakeholders

All studies included mention some type of training, education, coaching, consultation or supervision being provided to the facility staff or persons responsible for implementing the interventions. Six studies mention using train-the-trainer strategies to train designated persons to train others. (46,50–54) The training of the trainers, champions, or change agents was provided over 1 to 10 days, often in form of a workshop, sometimes followed by coaching, supervision or a consultation period (providing interactive assistance). Both on-site and virtual delivery forms of staff training were reported, e.g., face-to-face workshops, in-service training, webinars or calls. A frequently used strategy involved developing and distributing educational materials. These included, for example, an intervention manual, implementation guide or checklist, video on the intervention, protocols, leaflets, pocket information, reminder cards and posters. One study reported conducting outreach visits to the participating facilities to introduce the project, provide information and meet with the staff. (51) In another study,

monthly webinars served for creating a learning collaborative to support sustainment of an intervention. (45)

Provide interactive assistance

Several studies report providing local or centralized technical assistance, consultation or facilitation. Consultation, mentoring or external facilitation were provided by an external research or expert nurse, or a national consultant. (45,47,50) The external expert met with the team in person or provided telephone support.

Engage consumers

Four studies described strategies aimed at engaging residents, families, or the public. Three of them mention providing information materials for residents and families, e.g., brochures in lay language. (48,49,56) Two studies mentioned using marketing strategies to spread the message, gain public recognition and media coverage. (43,56)

Evaluative and iterative strategies

Around half of the studies reported using at least one strategy out of the evaluative and iterative strategies. Two studies report assessing for readiness and identifying barriers and facilitators at the stage of facility recruitment. (45,54) The participating facilities or wards were selected based on the organizational capacity to implement the intervention. Two studies report choosing participating facilities by the level of need. (45,47) Several studies mention reviewing clinical or implementation data, (e.g., benchmark reports) to assess the needs or evaluate the implementation. One study reported developing a special website to facilitate data collection. (43) Some studies mentioned providing regular reports on the data to the facilities (audit and feedback) (47,49,55,56), or regularly examining outcome and implementation data at the level of project coordinators and leadership (45,46,58). Two studies mentioned conducting cyclical tests of change and revising intervention plans or materials based on feedback from the facilities. (45,48)

Adapt and tailor to context

A few studies reported efforts to integrate the intervention into a usual care process, tailoring or adapting interventions, implementation strategies or their modes of delivery to the local situation and needs (45,47,49,57).

Change infrastructure

Changing infrastructure can be a strategy on a system or organizational level. In a Swiss study reporting implementation of a new pharmaceutical service, the change was facilitated through a cantonal law modification. (58) In another study, clinical equipment was assembled and made accessible to the staff to improve compliance with the intended procedures. (43)

Financial strategies

Financial strategies were rarely reported. One study reported using financial rewards for implementing a set of practices within a pay-for-performance program. (44) In another study funded by a provincial government, the authors mention that funding to support staff training, implementation and data collection was provided to the facilities based on their size. (54)

Conclusion

A moderate number of studies was identified. The studies were conducted in high-income countries, mostly in North America and western Europe. The studies used various research designs and the implemented interventions focused most often on optimizing medication use, preventing infections and overall quality of care. The interventions were implemented in 27 to 404 facilities. Implementation strategies used in the included studies were mostly not explicitly labelled as such by the authors and often not sufficiently described. Most studies used several implementation strategies. The strategies concentrated mainly on developing interrelationships between stakeholders (i.e., facility staff and other partners in the implementation process), as well as providing them with education, training and interactive assistance. Specially designated and trained champions often played a key role in leading and supporting the implementation in the facilities. Evaluative and iterative strategies, such as audit and feedback, readiness or needs assessment were also reported. The identified implementation strategies targeted mostly organizations and individuals. Strategies at a system level (policy, funding), and consumer engagement strategies were reported less often.

Overall conclusion

Improving data quality is a complex intervention that depends on the design and structure of electronic health records, contextual elements that support good data practices, and intra personal factors. Current interventions have focused mainly on the structure of documentation (electronic health records) and reminder-based strategies to improve the completeness of reporting. Other aspects of data quality remain largely unstudied. There is no evidence-base that informs how to improve accuracy and reliability of data for quality indicators. Overall, a program theory is missing to inform the design of a data quality improvement program. Such a program is needed to support public reporting using valid data. Risk adjustment is crucial to allow for a fair comparison and ranking when regional or national indicator performance is publicly reported, especially when including benchmarks. Scale-up can be supported by multiple strategies. The main strategies of successful programs were setting up collaborations with stakeholders and implementation partners, organising training and distributing educational materials, the use of implementation facilitators/champions, and the use of audit/evaluation strategies (with feedback).

Recommendations

The following recommendations can be made:

Table 3: Recommendations

Recommendation	Rationale	Link with NIP-Q-UPGRADE
1. We recommend that a theory-driven, context-related data quality improvement program should be developed.	Current evidence does not inform the optimal design of a program. A program theory for improving data quality in Swiss LTC facilities needs to be developed as such information and evidence is absent.	Sub-aim 1.7 will develop a program theory for improving data quality and will further operationalise this program for implementation.
1.a The data improvement program should specifically design interventions to improve accuracy and reliability of data.	Current interventions only provide information for the data outcome completeness. There is currently no evidence-base for interventions to improve accuracy and reliability	
1.b The data improvement program should seek to create definitions and instructions for data collection and registration to be integrated in the Swiss LTC system.	Evidence on determinants points towards the influence of differences in regional policies and support structures (e.g. training programs on QIs) on data quality. Structural differences between regions had the largest influence on data quality.	Sub-aim 1.6 will contribute to uniform measurement definitions for the quality indicators. Sub-aim 1.7 will develop materials to support data collection and registration. This will support creating a common standard for all Swiss facilities.

Recommendation	Rationale	Link with NIP-Q-UPGRADE
1.c The data improvement program should also include strategies to include appropriate risk adjustment.	Evidence demonstrates that risk adjustment should be included when comparing and ranking LTC facilities. To allow for appropriate adjustment, the data quality of those variables should be excellent.	Sub-aim 1.7 will include risk adjustment variables in its design.
1.d. The data improvement program should use the strengths of the electronic health records to support good quality data.	The use of electronic health records is associated with better data quality.	Sub-aim 1.5 will discuss improvements in current data systems.
2. We recommend that future evaluation studies measure the data accuracy and reliability.	Current evidence is limited to the completeness of data. Evidence is very sparse for the data accuracy and reliability.	Sub-aim 1.9 will measure improvement in data quality, including reliability of data collection.
3. We recommend that public reporting should be based on risk adjusted quality indicators. Before implementing risk adjustment, their appropriateness should be tested.	Evidence demonstrates that comparisons without risk adjustment are not fair and can be misleading.	Not applicable. Risk adjustment is already included in the Swiss LTC system
4.a. We recommend that future quality improvement and implementation programs use targeted implementation strategies, and that strategies at different levels (individual, organization, system) and implementation phases (pre-implementation, implementation, sustainment) are considered.	Current evidence shows that successful large-scale implementation projects in residential LTC use several implementation strategies at different levels and implementation stages.	In sub-aims 1.7, 2.4 and 3.4 interventions and corresponding implementation strategies will be developed.

Recommendation	Rationale	Link with NIP-Q-UPGRADE
4.b. Future programs should foster interrelationships between stakeholders through facilitating regular structured communication between them regarding program implementation.	Successful scale-up or large-scale implementation projects in residential LTC used organizing meetings or conference calls to support collaboration between stakeholders.	The insights from the literature will guide the development of implementation strategies in the programme. The fostering of interrelationships is already integrated via working with different stakeholders and both with the advisory group and regional / national sounding boards.
4.c. Future quality improvement programs should identify, recruit and train individuals who will lead, coordinate and support the implementation in LTC facilities and act as a link to other implementation partners.	Successful scale-up or large-scale implementation projects in residential LTC often reported designating champions, change agents or site-leads.	This recommendation will be taken up in the development of the measures for scale-up in WP1 and WP2.
4.d. We recommend that regular reviews of national quality indicator data are used as an evaluative strategy and that implementation data is also collected for monitoring implementation of future quality improvement projects.	Several successful scale-up or large-scale implementation projects in residential LTC reported using clinical outcomes and implementation data to identify needs, monitor and evaluate interventions and implementation process.	See 4.c

Recommendation	Rationale	Link with NIP-Q-UPGRADE
4.e. We recommend using strategies that will allow graduate shifting of facilitating, coordinating and monitoring the implementation and scale-up effort from the research team to other implementation partners (institutionalization), e.g., through recruiting key organizational partners, building a multilevel leadership structure, designating champions, training future trainers, developing openly accessible training materials.	Current evidence indicates that education, training and providing interactive assistance is often needed in a large-scale implementation, which requires capacity building and ensuring sufficient resources.	See 4.c The Federal Commission of Quality already assigned the main responsibility for the NIP to ARTISET Branchenverband CURAVIVA and senesuisse. Therewith the implementation partners are already in the lead of the program and will see to the sustainability of the program.
4.f. We recommend that interventions and implementation strategies in the future quality improvement programs are tailored and adapted to local needs.	Promoting adaptability and tailoring to the local context and needs is in line with principles of implementation science and can influence acceptability of the developed measures.	See 4.c
4.g. We recommend that future quality improvement programs in residential LTC use consumer engagement strategies for dissemination.	Though not extensively reported in the reviewed evidence, consumer engagement strategies may contribute to adoption of the interventions.	See 4.c
4.h. Future studies should clearly indicate and describe their implementation strategies with regard to involved actors, actions, context, targets, time and rationale.	Insufficient reporting of implementation strategies in current research studies limits the usefulness of the available evidence.	Scientific publications of NIP-Q-UPGRADE will apply state-of-the-art reporting of implementation strategies.

References

1. Zúñiga, F., Osińska, M., & Meyer-Massetti, C. (2022). Bericht zur Umsetzung von Medikationsreviews in Pflegeheimen. Institut für Pflegewissenschaft, Universität Basel und Berner Institut für Hausarztmedizin, Universität Bern.
2. Blatter, C., & Zúñiga, F. (2020). Wissenschaftliche Begleitung bei der Plausibilisierungsphase der Daten für die Med QI Pflegeheime. Version 1.2. Pflegewissenschaft - Nursing Science, Universität Basel.
3. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan — a web and mobile app for systematic reviews. Systematic Reviews (2016) 5:210, DOI: 10.1186/s13643-016-0384-4.
4. VERBI Software. (2021). MAXQDA 2022 [computer software]. Berlin, Germany: VERBI Software. Available from maxqda.com.
5. Chen H, Yu P, Hailey D, Wang N. Methods for assessing the quality of data in public health information systems: a critical review. Stud Health Technol Inform. 2014;204:13-8.
6. Noyes J, Booth A, Cargo M, Flemming K, Harden A, Harris J, Garside R, Hannes K, Pantoja T, Thomas J. Chapter 21: Qualitative evidence. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.3 (updated February 2022). Cochrane, 2022. Available from www.training.cochrane.org/handbook.
7. Alexander GL, Wakefield DS. Information technology sophistication in nursing homes. J Am Med Dir Assoc. 2009;10(6):398-407.
8. Cherry BJ, Ford EW, Peterson LT. Experiences with electronic health records: early adopters in long-term care facilities. Health Care Manage Rev. 2011;36(3):265-74.
9. Konetzka RT, Davila H, Brauner DJ, Cursio JF, Sharma H, Werner RM, et al. The Quality Measures Domain in Nursing Home Compare: Is High Performance Meaningful or Misleading? Gerontologist. 2022;62(2):293-303.
10. Wu N, Miller SC, Lapane K, Roy J, Mor V. The quality of the quality indicator of pain derived from the minimum data set. Health Serv Res. 2005;40(4):1197-216.
11. Hamann DJ, Bezboruah KC. Outcomes of health information technology utilization in nursing homes: Do implementation processes matter? Health Informatics J. 2020;26(3):2249-64.
12. Wu N, Mor V, Roy J. Resident, nursing home, and state factors affecting the reliability of Minimum Data Set quality measures. Am J Med Qual. 2009;24(3):229-40.
13. Bail K, Gibson D, Hind A, Strickland K, Paterson C, Merrick E, et al. 'It enables the carers to see the person first': Qualitative evaluation of point-of-care digital management system in residential aged care. J Clin Nurs. 2023;32(1-2):174-90.
14. Chadwick LM, MacPhail A, Ibrahim JE, McAuliffe L, Koch S, Wells Y. Senior staff perspectives of a quality indicator program in public sector residential aged care services: a qualitative cross-sectional study in Victoria, Australia. Aust Health Rev. 2016;40(1):54-62.
15. Zhang Y, Yu P, Shen J. The benefits of introducing electronic health records in residential aged care facilities: a multiple case study. Int J Med Inform. 2012;81(10):690-704.
16. Wang N, Yu P, Hailey D. Description and comparison of documentation of nursing assessment between paper-based and electronic systems in Australian aged care homes. Int J Med Inform. 2013;82(9):789-97.
17. Ben Natan M, Ataneli M, Admenko A, Har Noy R. Nurse assessment of residents' pain in a long-term care facility. Int Nurs Rev. 2013;60(2):251-7.
18. Carpenter JG, Scott WJ, Kononowech J, Foglia MB, Haverhals LM, Hogikyan R, et al. Evaluating implementation strategies to support documentation of veterans' care preferences. Health Serv Res. 2022;57(4):734-43.
19. Cooper D, McFarland M, Petrilli F, Shells C. Reducing Inappropriate Antibiotics for Urinary Tract Infections in Long-Term Care: A Replication Study. J Nurs Care Qual. 2019;34(1):16-21.
20. Ellis-Smith C, Higginson IJ, Daveson BA, Henson LA, Evans CJ. How can a measure improve assessment and management of symptoms and concerns for people with dementia in care

homes? A mixed-methods feasibility and process evaluation of IPOS-Dem. PLoS One. 2018;13(7):e0200240.
21. Fossum M, Ehnfors M, Svensson E, Hansen LM, Ehrenberg A. Effects of a computerized decision support system on care planning for pressure ulcers and malnutrition in nursing homes: an intervention study. Int J Med Inform. 2013;82(10):911-21.
22. Gallant N, Hadjistavropoulos T, Winters EM, Feere EK, Wickson-Griffiths A. Development, evaluation, and implementation of an online pain assessment training program for staff in rural long-term care facilities: a case series approach. BMC Geriatr. 2022;22(1):336.
23. Hadjistavropoulos T, Williams J, Kaasalainen S, Hunter PV, Savoie ML, Wickson-Griffiths A. Increasing the Frequency and Timeliness of Pain Assessment and Management in Long-Term Care: Knowledge Transfer and Sustained Implementation. Pain Res Manag. 2016;2016:6493463.
24. Horn SD, Sharkey SS, Hudak S, Gassaway J, James R, Spector W. Pressure ulcer prevention in long-term-care facilities: a pilot study implementing standardized nurse aide documentation and feedback reports. Adv Skin Wound Care. 2010;23(3):120-31.
25. Johansson-Pajala RM, Martin L, Jorsäter Blomgren K. Registered nurses' use of computerised decision support in medication reviews. Int J Health Care Qual Assur. 2018;31(6):531-44.
26. Kaasalainen S, Brazil K, Akhtar-Danesh N, Coker E, Ploeg J, Donald F, et al. The evaluation of an interdisciplinary pain protocol in long term care. J Am Med Dir Assoc. 2012;13(7):664.e1-8.
27. Ranasinghe D, Bates L, Mynes P. Clinical risk assessment and management strategies for residents with severe dementia in a residential care setting: a best practice implementation project. JBI Evidence Synthesis. 2013;11(7):422-33.
28. Wagner LM, Capezuti E, Clark PC, Parmelee PA, Ouslander JG. Use of a falls incident reporting system to improve care process documentation in nursing homes. Qual Saf Health Care. 2008;17(2):104-8.
29. Wagner LM, Capezuti E, Taylor JA, Sattin RW, Ouslander JG. Impact of a falls menu-driven incident-reporting system on documentation and quality improvement in nursing homes. Gerontologist. 2005;45(6):835-42.
30. Bail K, Merrick E, Gibson D, Hind A, Strickland K, Redley B. A co-designed health information system implementation into residential aged care: A mixed-method evaluation. J Nurs Scholarsh. 2023;55(2):521-35.
31. Munyisia EN, Yu P, Hailey D. The changes in caregivers' perceptions about the quality of information and benefits of nursing documentation associated with the introduction of an electronic documentation system in a nursing home. Int J Med Inform. 2011;80(2):116-26.
32. Tran V, Winters E, Stroulia E, Hadjistavropoulos T. Implementation and evaluation of a pain assessment app and novel community platform for long-term care health professionals. Aging & Mental Health.1-10.
33. Zahid M, Gallant NL, Hadjistavropoulos T, Stroulia E. Behavioral Pain Assessment Implementation in Long-Term Care Using a Tablet App: Case Series and Quasi-Experimental Design. JMIR Mhealth Uhealth. 2020;8(4):e17108.
34. Ehrenberg A, Ehnfors M. Patient records in nursing homes. Effects of training on content and comprehensiveness. Scand J Caring Sci. 1999;13(2):72-82.
35. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018;169(7):467-73.
36. Westphaln KK, Regoeczi W, Masotya M, Vazquez-Westphaln B, Lounsbury K, McDavid L, et al. From Arksey and O'Malley and Beyond: Customizations to enhance a team-based, mixed approach to scoping review methodology. MethodsX. 2021;8:101375.
37. Li Y, Schnelle J, Spector WD, Glance LG, Mukamel DB. The "Nursing Home Compare" measure of urinary/fecal incontinence: cross-sectional variation, stability over time, and the impact of case mix. Health Serv Res. 2010;45(1):79-97.
38. Nazir A, Arling G, Perkins AJ, Boustani M. Monitoring quality of care for nursing home residents with behavioral and psychological symptoms related to dementia. J Am Med Dir Assoc. 2011;12(9):660-7.

39. Arling G, Karon SL, Sainfort F, Zimmerman DR, Ross R. Risk adjustment of nursing home quality indicators. Gerontologist. 1997;37(6):757-66.
40. Siegel EO, Backman A, Cai Y, Goodman C, Ocho ON, Wei S, et al. Understanding Contextual Differences in Residential LTC Provision for Cross-National Research: Identifying Internationally Relevant CDEs. Gerontol Geriatr Med. 2019;5:2333721419840591.
41. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: The new Medical Research Council guidance. International Journal of Nursing Studies. 2013 May 1;50(5):587–92.
42. Powell BJ, Waltz TJ, Chinman MJ, Damschroder LJ, Smith JL, Matthieu MM, et al. A refined compilation of implementation strategies: results from the Expert Recommendations for Implementing Change (ERIC) project. Implement Sci. 2015;10:21..
43. Clifton M, Kralovic S, Simbartl L, Hasselbeck R, Martin T, DeRoos KA, et al. National implementation of evidence-based bundles for prevention of device-associated infections in veterans health administration (VHA) facilities. AM J INFECT CONTROL. 2015;43(6):S59.
44. Cornelison LJ, Hermer L, Syme ML, Doll G. Initiating Aha moments when implementing person-centered care in nursing homes: a multi-arm, pre-post intervention. BMC GERIATR. 2019;19(1):115.
45. Curyto K, Wray LO, Sullivan JL, McConnell ES, Jedele JM, Minor L, et al. Implementation Lessons Learned: Distress Behaviors in Dementia Intervention in Veterans Health Administration. Gerontologist. 2023.
46. Mody L. Translational models of infection prevention and control: lessons from studying high risk aging populations. CURR OPIN INFECT DIS. 2018;31(4):359–67.
47. Rantz MJ, Zwygart-Stauffacher M, Hicks L, Mehr D, Flesner M, Petroski GF, et al. Randomized multilevel intervention to improve outcomes of residents in nursing homes in need of improvement. J Am Med Dir Assoc. 2012;13(1):60–8.
48. Salem-Schatz S, Griswold P, Kandel R, Benjamin-Bothwell S, DeMaria A, McElroy N, et al. A Statewide Program to Improve Management of Suspected Urinary Tract Infection in Long-Term Care. J AM GERIATR SOC. 2020;68(1):62–9.
49. Sloane PD, Zimmerman S, Ward K, Kistler CE, Paone D, Weber DJ, et al. A 2-Year Pragmatic Trial of Antibiotic Stewardship in 27 Community Nursing Homes. J AM GERIATR SOC. 2020;68(1):46–54.
50. Tjia J, Hunnicutt JN, Herndon L, Blanks CR, Lapane KL, Wehry S. Association of a Communication Training Program With Use of Antipsychotics in Nursing Homes. JAMA INTERN MED. 2017;177(6):846–53.
51. Ballard C, Corbett A, Orrell M, Williams G, Moniz-Cook E, Romeo R, et al. Impact of person-centred care training and person-centred activities on quality of life, agitation, and antipsychotic use in people with dementia living in nursing homes: A cluster-randomised controlled trial. PLOS MED. 2018 Feb;15(2):e1002500.
52. Brooker DJ, Latham I, Evans SC, Jacobson N, Perry W, Bray J, et al. FITS into practice: translating research into practice in reducing the use of anti-psychotic medication for people with dementia living in care homes. AGING MENT HEALTH. 2016;20(7):709–18.
53. Hullick CJ, Hall AE, Conway JF, Hewitt JM, Darcy LF, Barker RT, et al. Reducing Hospital Transfers from Aged Care Facilities: A Large-Scale Stepped Wedge Evaluation. J AM GERIATR SOC. 2021;69(1):201–9.
54. Cossette B, Bruneau MA, Morin M, Gilbert S, Boyer D, Donald TM, et al. Optimizing Practices, Use, Care, and Services–Antipsychotics (OPUS-AP) in Long-Term Care Centers in Quebec, Canada: A Successful Scale-Up. J AM MED DIR ASSOC. 2022;23(6):1084–9.
55. Rolland Y, Mathieu C, Piau C, Cayla F, Bouget C, Vellas B, et al. Improving the Quality of Care of Long-Stay Nursing Home Residents in France. J AM GERIATR SOC. 2016;64(1):193–9.
56. Becker C, Cameron ID, Klenk J, Lindemann U, Heinrich S, König HH, et al. Reduction of femoral fractures in long-term care facilities: the Bavarian fracture prevention study. PLoS One. 2011;6(8):e24311.

57. Vermunt P, Reijmer Y, van Biessum C, de Groot V, van den Berg B, Nies H. Improving the quality of care in nursing home organizations with urgent quality issues: design and effectiveness of a Dutch government-funded support programme. BMC HEALTH SERV RES. 2023;23(1):507.
58. Locca JF, Ruggli M, Buchmann M, Huguenin J, Bugnon O. Development of pharmaceutical care services in nursing homes: practice and research in a Swiss canton. Pharm World Sci. 2009;31(2):165–73.

Appendices

Appendix 1: search string review 1

Appendix 2: search string review 2

Appendix 3: search string review 3

Appendix 4: search string review 4

Appendix 1: search string review 1

PubMed	Embase
1. "nursing homes"[MeSH Terms]	1. 'nursing home'/exp
2. "nursing homes"[Title/Abstract]	2. 'home for the aged'/exp
3. "nursing home"[Title/Abstract]	3. 'care home'/exp
4. "homes for the aged"[MeSH Terms]	4. 'nursing homes':ab,ti
5. "homes for the aged"[Title/Abstract]	5. 'nursing home':ab,ti
6. "home for the aged"[Title/Abstract]	6. 'homes for the aged':ab,ti
7. "care homes"[Title/Abstract]	7. 'home for the aged':ab,ti
8. "care home"[Title/Abstract]	8. 'care homes':ab,ti
9. "long term care"[MeSH Terms]	9. 'care home':ab,ti
10. "long term care"[Title/Abstract]	10. 'residential care':ab,ti
11. "residential care"[Title/Abstract]	11. 'residential care'/exp
12. "residential aged care"[Title/Abstract]	12. 'residential aged care':ab,ti
13. "nursing facility"[Title/Abstract]	13. 'nursing facilities':ab,ti
14. "nursing facilities"[Title/Abstract]	14. 'nursing facility':ab,ti
15. "aged care facility"[Title/Abstract]	15. 'aged care facility':ab,ti
16. "aged care facilities"[Title/Abstract]	16. 'aged care facilities':ti,ab
17. "institutional elderly care"[Title/Abstract]	17. 'institutional elderly care':ab,ti
18. "residential facility"[Title/Abstract]	18. residential facility':ab,ti
19. "residential facilities"[Title/Abstract]	19. 'residential facilities':ab,ti
20. "factor*"[Title/Abstract]	20. 'factor*':ab,ti
21. "determinant*"[Title/Abstract]	21. 'determinant*':ab,ti
22. "barrier*"[Title/Abstract]	22. 'barrier*':ab,ti
23. "facilitator*"[Title/Abstract]	23. 'facilitator*':ab,ti
24. "hindering"[Title/Abstract]	24. 'hindering':ab,ti
25. "enhancing"[Title/Abstract]	25. 'enhancing':ab,ti
26. "improving"[Title/Abstract]	26. 'improving':ab,ti
27. "improvement*"[Title/Abstract]	27. 'improvement*':ab,ti
28. "promoting"[Title/Abstract]	28. 'promoting':ab,ti
29. "supporting"[Title/Abstract]	29. 'supporting':ab,ti
30. "context" [Title/Abstract]	30. 'context':ab,ti
31. "contextual"[Title/Abstract]	31. 'contextual':ab,ti
32. "precipitating" [Title/Abstract]	32. 'precipitating':ab,ti

33. “experience*”[Title/Abstract]	33. ‘experience*’:ab,ti
34. “influence”[Title/Abstract]	34. ‘influence’:ab,ti
35. “influencing”[Title/Abstract]	35. ‘influencing’:ab,ti
36. “associated”[Title/Abstract]	36. ‘associated’:ab,ti
37. “association*”[Title/Abstract]	37. ‘association*’:ab,ti
38. “correlation*”[Title/Abstract]	38. ‘correlation*’:ab,ti
39. “correlated”[Title/Abstract]	39. ‘correlated’:ab,ti
40. “covariate*”[Title/Abstract]	40. ‘covariate*’:ab,ti
41. “predictor*”[Title/Abstract]	41. ‘predictor*’:ab,ti
42. ("Data accuracy"[MeSH Terms]	42. 'data accuracy'/exp
43. "data accuracy"[Title/Abstract]	43. ‘data accuracy’:ab,ti
44. "data accuracies"[Title/Abstract]	44. ‘data accuracies’:ab,ti
45. "measurement error"[Title/Abstract]	45. ‘measurement error’:ab,ti
46. "observer variation"[MeSH Terms]	46. 'measurement error'/exp
47. "interobserver variation*"[Title/Abstract]	47. 'observer variation'/exp
48. "intraobserver variation*"[Title/Abstract]	48. ‘interobserver variation*’:ab,ti
49. "inter-observer variation*"[Title/Abstract]	49. ‘intraobserver variation*’:ab,ti
50. "intra-observer variation*"[Title/Abstract]	50. ‘inter-observer variation*’:ab,ti
51. "observer variation"[Title/Abstract]	51. ‘intra-observer variation*’:ab,ti
52. "interobserver variability" [Title/Abstract]	52. 'information processing'/exp
53. "intraobserver variability"[Title/Abstract]	53. 'observer variation':ab,ti
54. "inter-observer variability"[Title/Abstract]	54. ‘interobserver variability’:ab,ti
55. "intra-observer variability"[Title/Abstract]	55. ‘intraobserver variability’:ab,ti
56. "observer bias"[Title/Abstract]	56. ‘inter-observer variability’:ab,ti
57. "data quality"[Title/Abstract]	57. ‘intra-observer variability’:ab,ti
58. "data qualities"[Title/Abstract]	58. ‘observer bias’:ab,ti
59. "data collection"[MeSH Terms]	59. 'observer bias'/exp
60. "data collection"[Title/Abstract]	60. ‘data quality’:ab,ti
61. "data management"[MeSH Terms]	61. 'data quality'/exp
62. “data management”[Title/Abstract]	62. ‘data qualities’:ab,ti
63. “data administration”[Title/Abstract]	63. ‘data collection’:ab,ti
64. "reliability"[Title/Abstract]	64. ‘data management’:ab,ti
65. "kappa"[Title/Abstract]	65. ‘data administration’:ab,ti
66. "timeliness"[Title/Abstract]	66. ‘reliability’:ab,ti

67. "completeness"[Title/Abstract]	67. 'reliability'/exp
68. "missing data"[Title/Abstract]	68. ‘kappa’:ab,ti
69. "missingness"[Title/Abstract])	69. ‘timeliness’:ab,ti
70. "Quality Indicators, Health Care"[MeSH Terms]	70. 'timeliness (data)'/exp
71. "quality indicator*"[Title/Abstract]	71. ‘completeness’:ab,ti
72. "health quality"[Title/Abstract]	72. 'completeness'/exp
73. "care quality"[Title/Abstract]	73. ‘missing data’:ab,ti
74. "healthcare quality"[Title/Abstract]	74. 'missing data'/exp
75. "quality of healthcare"[Title/Abstract]	75. ‘missingness’:ab,ti
76. "quality of health care"[Title/Abstract]	76. 'health care quality'/exp
77. "indicator*"[Title/Abstract])	77. ‘quality indicator*’:ab,ti
78. 1 – 19, OR	78. 'quality indicators'/exp
79. 20 – 41, OR	79. ‘health quality’:ab,ti
80. 42 – 69, OR	80. ‘care quality’:ab,ti
81. 70 – 77, OR	81. ‘healthcare quality’:ab,ti
82. 78 – 81, AND	82. ‘quality of healthcare’:ab,ti
	83. ‘quality of health care’:ab,ti
	84. ‘indicator*’:ab,ti
	85. 1 – 19, OR
	86. 20 – 41, OR
	87. 42 – 75, OR
	88. 76 – 84, OR
	89. 85 – 88, AND

Appendix 2: search string review 2

PubMed	Embase
1. "nursing homes"[MeSH Terms]	1. 'nursing home'/exp
2. "nursing homes"[Title/Abstract]	2. 'home for the aged'/exp
3. "nursing home"[Title/Abstract]	3. 'care home'/exp
4. "homes for the aged"[MeSH Terms]	4. 'nursing homes':ab,ti
5. "homes for the aged"[Title/Abstract]	5. 'nursing home':ab,ti
6. "home for the aged"[Title/Abstract]	6. 'homes for the aged':ab,ti
7. "care homes"[Title/Abstract]	7. 'home for the aged':ab,ti
8. "care home"[Title/Abstract]	8. 'care homes':ab,ti
9. "long term care"[MeSH Terms]	9. 'care home':ab,ti
10. "long term care"[Title/Abstract]	10. 'residential care':ab,ti
11. "residential care"[Title/Abstract]	11. 'residential care'/exp
12. "residential aged care"[Title/Abstract]	12. 'residential aged care':ab,ti
13. "nursing facility"[Title/Abstract]	13. 'nursing facilities':ab,ti
14. "nursing facilities"[Title/Abstract]	14. 'nursing facility':ab,ti
15. "aged care facility"[Title/Abstract]	15. 'aged care facility':ab,ti
16. "aged care facilities"[Title/Abstract]	16. 'aged care facilities':ti,ab
17. "institutional elderly care"[Title/Abstract]	17. 'institutional elderly care':ab,ti
18. "residential facility"[Title/Abstract]	18. residential facility':ab,ti
19. "residential facilities"[Title/Abstract]	19. 'residential facilities':ab,ti
20. "Quality improvement"[MeSH Terms]	20. 'quality improvement study'/exp
21. "quality improvement*"[Title/Abstract]	21. 'clinical trial (topic)'/exp
22. "Experiment*"[Title/Abstract]	22. 'controlled clinical trial (topic)'/exp
23. "pdca"[Title/Abstract]	23. 'quality improvement*':ab,ti
24. "intervention*"[Title/Abstract]	24. 'experiment*':ab,ti
25. "measure*"[Title/Abstract]	25. 'experiment'/exp
26. "trial"[Title/Abstract]	26. 'pdca':ab,ti
27. "Clinical Trials as Topic"[MeSH Terms]	27. 'intervention*':ab,ti
28. "Non-Randomized Controlled Trials as Topic"[MeSH Terms]	28. 'intervention'/exp
29. "Randomized Controlled Trials as Topic"[MeSH Terms]	29. 'measure':ab,ti
30. "randomised"[Title/Abstract]	30. 'trial*':ab,ti

31. "randomized"[Title/Abstract]	31. 'trial'/exp
32. "quasi-experiment*"[Title/Abstract]	32. 'randomized controlled trial'/exp
33. "quasiexperiment*"[Title/Abstract]	33. ‘randomised’:ab,ti
34. "time series"[Title/Abstract]	34. ‘randomized’:ab,ti
35. "effect*"[Title/Abstract]	35. ‘quasi-experiment*’:ab,ti
36. "impact"[Title/Abstract])	36. ‘quasiexperiment*’:ab,ti
37. ("Data accuracy"[MeSH Terms]	37. ‘time series’:ab,ti
38. "data accuracy"[Title/Abstract]	38. ‘effect*’:ab,ti
39. "data accuracies"[Title/Abstract]	39. ‘impact’:ab,ti
40. "measurement error"[Title/Abstract]	40. 'data accuracy'/exp
41. "observer variation"[MeSH Terms]	41. ‘data accuracy’:ab,ti
42. "interobserver variation*"[Title/Abstract]	42. ‘data accuracies’:ab,ti
43. "intraobserver variation*"[Title/Abstract]	43. ‘measurement error’:ab,ti
44. "inter-observer variation*"[Title/Abstract]	44. 'measurement error'/exp
45. "intra-observer variation*"[Title/Abstract]	45. 'observer variation'/exp
46. "observer variation"[Title/Abstract]	46. ‘interobserver variation*’:ab,ti
47. "interobserver variability" [Title/Abstract]	47. ‘intraobserver variation*’:ab,ti
48. "intraobserver variability"[Title/Abstract]	48. ‘inter-observer variation*’:ab,ti
49. "inter-observer variability"[Title/Abstract]	49. ‘intra-observer variation*’:ab,ti
50. "intra-observer variability"[Title/Abstract]	50. 'information processing'/exp
51. "observer bias"[Title/Abstract]	51. 'observer variation':ab,ti
52. "data quality"[Title/Abstract]	52. ‘interobserver variability’:ab,ti
53. "data qualities"[Title/Abstract]	53. ‘intraobserver variability’:ab,ti
54. "data collection"[MeSH Terms]	54. ‘inter-observer variability’:ab,ti
55. "data collection"[Title/Abstract]	55. ‘intra-observer variability’:ab,ti
56. "data management"[MeSH Terms]	56. ‘observer bias’:ab,ti
57. “data management”[Title/Abstract]	57. 'observer bias'/exp
58. “data administration”[Title/Abstract]	58. ‘data quality’:ab,ti
59. "reliability"[Title/Abstract]	59. 'data quality'/exp
60. "kappa"[Title/Abstract]	60. ‘data qualities’:ab,ti
61. "timeliness"[Title/Abstract]	61. ‘data collection’:ab,ti
62. "completeness"[Title/Abstract]	62. ‘data management’:ab,ti
63. "missing data"[Title/Abstract]	63. ‘data administration’:ab,ti
64. "missingness"[Title/Abstract])	64. ‘reliability’:ab,ti

65. "Quality Indicators, Health Care"[MeSH Terms]	65. 'reliability'/exp
66. "quality indicator*"[Title/Abstract]	66. 'kappa':ab,ti
67. "health quality"[Title/Abstract]	67. 'timeliness':ab,ti
68. "care quality"[Title/Abstract]	68. 'timeliness (data)'/exp
69. "healthcare quality"[Title/Abstract]	69. 'completeness':ab,ti
70. "quality of healthcare"[Title/Abstract]	70. 'completeness'/exp
71. "quality of health care"[Title/Abstract]	71. 'missing data':ab,ti
72. "indicator*"[Title/Abstract])	72. 'missing data'/exp
73. 1 – 19, OR	73. 'missingness':ab,ti
74. 20 – 36, OR	74. 'health care quality'/exp
75. 37 – 64, OR	75. 'quality indicator*':ab,ti
76. 65 – 72, OR	76. 'quality indicators'/exp
77. 73 – 76, AND	77. 'health quality':ab,ti
	78. 'care quality':ab,ti
	79. 'healthcare quality':ab,ti
	80. 'quality of healthcare':ab,ti
	81. 'quality of health care':ab,ti
	82. 'indicator*':ab,ti
	83. 1 – 19, OR
	84. 20 – 39, OR
	85. 40 – 73, OR
	86. 74 – 82, OR
	87. 83 – 86, AND

Appendix 3: search string review 3

PubMed	Embase
1. "Nursing Homes"[Mesh]	1. "Nursing Homes"
2. "Residential Facilities"[Mesh:NoExp]	2. "Residential Facilities"
3. "Assisted Living Facilities"[Mesh]	3. "Assisted Living Facilities"
4. "Homes for the Aged"[Mesh]	4. "Homes for the Aged"
5. "Long-Term Care"[Mesh]	5. "Long-Term Care"
6. “Nursing Home*”[Title/Abstract]	6. "Nursing Home"
7. “Care Home*”[Title/Abstract]	7. "Care Home"
8. “Residential Care Facilit*”[Title/Abstract]	8. "care homes"
9. “Residential Facilit*”[Title/Abstract]	9. "Residential Care Facility"
10. “Long-term Residential Care”[Title/Abstract]	10. "residential care facilities"
11. “long term residential care”[Title/Abstract]	11. "Residential Facility"
12. “long-term care”[Title/Abstract]	12. "Residential Facilities"
13. “long term care”[Title/Abstract]	13. "Long-term Residential Care"
14. “home* for the aged”[Title/Abstract]	14. "long term residential care"
15. "Risk Adjustment/classification"[Mesh]	15. "long-term care"
16. "Risk Adjustment/standards"[Mesh]	16. "long term care"
17. "Risk Adjustment/statistics and numerical data"[Mesh]	17. "home for the aged"
18. “risk adjustment*”[Title/Abstract]	18. "homes for the aged"
19. “risk classification*”[Title/Abstract]	19 "Risk Adjustment"
20. “prognostic model”[Title/Abstract]	20. "risk classification"
21. “prediction model”[Title/Abstract]	21. "risk standards"
22. “nomogram”[Mesh]	22. "Risk Adjustments"
23. "Quality Indicators, Health Care"[MeSH Terms]	23. “statistics”
24. "quality indicator*"[Title/Abstract]	24. "numerical data"
25. "health quality"[Title/Abstract]	25. "prognostic model"
26. "care quality"[Title/Abstract]	26. "prediction model"
27. "healthcare quality"[Title/Abstract]	27. “nomogram”

28. "quality of healthcare"[Title/Abstract]	28. "Quality Indicators"
29. "quality of health care"[Title/Abstract]	29. "health quality"
30. "indicator*"[Title/Abstract]	30. "care quality"
31. 1 – 14, OR	31. "healthcare quality"
32. 15 – 22, OR	32. "quality of healthcare"
33. 23 – 30, OR	33. "quality of health care"
34. 31 – 33, AND	34. “indicator”
	35. “indicators”
	36. 1 – 18, OR
	37. 19 – 27, OR
	38. 28 – 35, OR
	39. 36 – 38, AND

Appendix 4: search string review 4

MEDLINE via Pubmed

(scale up[tiab] OR scaled up[tiab] OR scaling up[tiab] OR upscaling[tiab] OR up-scaling[tiab] OR scalability[tiab] OR scalable[tiab] OR roll out[tiab] OR rolled out[tiab] OR large-scale*[tiab] OR wide-scale*[tiab] OR city-wide[tiab] OR province-wide [tiab] OR state-wide[tiab] OR region-wide[tiab] OR nation-wide[tiab] OR country-wide[tiab] OR largescale*[tiab] OR widescale*[tiab] OR citywide[tiab] OR provincewide [tiab] OR statewide[tiab] OR regionwide[tiab] OR nationwide[tiab] OR countrywide[tiab])

AND

(Implementation science [MeSH] OR implementation*[tiab] OR intervention*[tiab] OR innovation*[tiab] OR technolog*[tiab] OR practice*[tiab] OR program*[tiab] OR initiative* [tiab] OR service*[tiab] OR strateg*[tiab] OR change[tiab])

AND

("nursing homes"[MeSH] OR "long term care"[MeSH] OR "homes for the aged"[MeSH] OR nursing home*[tiab] OR long-term care[tiab] OR home for the aged[tiab] OR homes for the aged[tiab] OR nursing facilit*[tiab] OR care home*[tiab] OR residential care[tiab] OR residential aged care[tiab] OR aged care facilit*[tiab])

CINAHL via Ebsco

((TI scale up OR AB scale up) OR (TI scaled up OR AB scaled up) OR (TI scaling up OR AB scaling up) OR (TI upscaling OR AB upscaling) OR (TI scalability OR AB scalability) OR (TI scalable OR AB scalable) OR (TI roll out OR AB roll out) OR (TI rolled out OR AB rolled out) OR (TI large-scale* OR AB large-scale*) OR (TI wide-scale* OR AB wide-scale*) OR (TI wide-scale* OR AB wide-scale*) OR (TI city-wide OR AB city-wide) OR (TI province-wide OR AB province-wide) OR (TI state-wide OR AB state-wide) OR (TI region-wide OR AB region-wide) OR (TI nation-wide OR AB nation-wide) OR (TI countrywide OR AB countrywide) OR (TI largescale* OR AB largescale*) OR (TI widescale* OR AB widescale*) OR (TI citywide OR AB citywide) OR (TI provincewide OR AB provincewide) OR (TI statewide OR AB statewide) OR (TI regionwide OR AB regionwide) OR (TI nationwide OR AB nationwide) OR (TI countrywide OR AB countrywide))

AND

((MH "Implementation Science") OR (TI implementation* OR AB implementation*) OR (TI intervention* OR AB intervention*) OR (TI innovation* OR AB innovation*) OR (TI technolog* OR AB technolog*) OR (TI practice* OR AB practice*) OR (TI program* OR AB program*) OR

(TI initiative* OR AB initiative*) OR (TI service* OR AB service*) OR (TI strateg* OR AB strateg*) OR (TI change OR AB change)))
AND
((MH "nursing homes+") OR (MH "Long Term Care") OR (MH "homes for the aged") OR (TI nursing home* OR AB nursing home*) OR (TI long term care OR AB long term care) OR (TI home for the aged OR AB home for the aged) OR (TI homes for the aged OR AB homes for the aged) OR (TI nursing facilit* OR AB nursing facilit*) OR (TI care home* OR AB care home*) OR (TI residential care OR AB residential care) OR (TI residential aged care OR AB residential aged care) OR (TI aged care facilit* OR AB aged care facilit*))

EMBASE via Elsevier

('scale up':ti,ab OR 'scaled up':ti,ab OR 'scaling up':ti,ab OR upscaling:ti,ab OR up-scaling:ti,ab OR scalability:ti,ab OR scalable:ti,ab OR 'roll out':ti,ab OR 'rolled out':ti,ab OR large-scale*:ti,ab OR wide-scale*:ti,ab OR city-wide:ti,ab OR province-wide:ti,ab OR state-wide:ti,ab OR region-wide:ti,ab OR nation-wide:ti,ab OR country-wide:ti,ab OR largescale*:ti,ab OR widescale*:ti,ab OR citywide:ti,ab OR provincewide:ti,ab OR statewide:ti,ab OR regionwide:ti,ab OR nationwide:ti,ab OR countrywide:ti,ab)
AND
('Implementation science'/exp OR implementation*:ti,ab OR intervention*:ti,ab OR innovation*:ti,ab OR technolog*:ti,ab OR practice*:ti,ab OR program*:ti,ab OR initiative*:ti,ab OR service*:ti,ab OR strateg*:ti,ab OR change:ti,ab)
AND
('nursing homes'/exp OR 'long term care'/de OR 'homes for the aged'/exp OR 'nursing home*':ti,ab OR 'long-term care':ti,ab OR 'home for the aged':ti,ab OR 'homes for the aged':ti,ab OR 'nursing facilit*':ti,ab OR 'care home*':ti,ab OR 'residential care':ti,ab OR 'residential aged care':ti,ab OR 'aged care facilit*':ti,ab)