

Review article

Using health information technology in residential aged care homes: An integrative review to identify service and quality outcomes

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ABSTRACT

Objective: To identify outcomes of using health information technologies to support direct resident care in residential aged care homes, for residents, staff and services.

Methods: In May 2022, a systematic search used CINAHL, Cochrane CRCT, MEDLINE, Proquest, PsychINFO and Scopus databases to locate papers published after 1990. Thematic analysis was used to synthesise extracted data. Results are reported using the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) statement.

Results: Of 3721 references imported for screening, 1017 duplicates were removed and 2609 excluded, leaving 95 papers for data extraction. The included articles were conducted in diverse residential care homes, and involved over 12,000 nurse, care assistant or resident participants. Thematic analysis identified a range of health information technologies were used for direct care in residential care settings, and outcomes focussed on acceptability, efficiency and success of implementation. Less frequent were outcomes focussed on residents and families, and the safety and quality-of-care delivery.

Discussion: Staff outcomes, focussed on the satisfaction of staff and usability of the system, dominate in research examining health information technology used for direct care in residential aged care homes. Outcomes examining the use of health information technology in delivering improvements in resident health, well-being, quality and safety was limited. There is a need to increase using quality and safety of resident care as outcome measures.

1. Introduction

Globally the combination of population growth and population ageing has led to increased demand for long term care, whether that be at home or in a residential aged care setting. Across OECD countries there were 46 residential aged beds per 1000 people aged 65 and over in 2019 [1]. More older people with more complex conditions and higher needs for expert health care places more demands on systems that are already under strain to provide safe and high-quality care [2]. In Australia the situation is no different, and although rates (per population) of utilization for residential aged care homes have declined, the numbers of residents and their complexity of conditions and care needs

have continued to rise [3,4]. As the demand for care grows over coming decades, so too will the demand for a productive and skilled workforce and technologies to support them with care delivery. In this context, health information technologies have the potential to improve quality, safety and efficiency of resident care and enhance nurse productivity.

The need for health information technologies that enhance the quality and safety of resident care by supporting caregiver effectiveness, efficiency and productivity is widely recognised. The use of health information technologies to support direct care, such as electronic care records is progressively increasing across the healthcare sector, addressing many of the short-comings of paper-based documentation and information sharing systems. Electronic documentation is expected

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to improve direct care delivery by enhancing access and accuracy of care records, capturing relevant steps in the care process, and supporting decision making about care delivery. In turn, leading to reduced adverse events, flawed documentation and improved communication for continuity of care [5]. Innovation in health information technologies that release nurses and care staff time from administrative work for direct-care, is also seen as a key solution for future sustainability of the aged care system [4,6].

Yet improvements in health information technology to support direct care delivery by nurses and other direct care workers have been relatively slow to develop in the residential aged care setting [7,8]. While many aged care homes use electronic documentation or care records to some degree, the level of person-centeredness, and nurse and carer usability in the context of their workflows vary enormously [9]. Few health information technologies have been evaluated for how effective, satisfactory or efficient they are in achieving desired health and lifestyle outcomes for residents, as well as satisfying staff with workflows [10]. Health information technologies offer an opportunity to contemporaneously capture care delivery, streamline documentation, and support point-of-care evidence-informed decision-making to optimise holistic person-centred care [11]. However, the implementation of such systems into existing health organisations such as residential aged care is challenging due to cultural, care processes and governance structures, and compounded by limited input from aged care recipients, care assistants, front-line nurses and members of the multidisciplinary team [12].

The literature review conducted by Ko, Wagner and Spetz [13] identified significant weaknesses relating to technology support and staff training in processes of implementation; mixed evidence relating to staff productivity; and no evidence relating to quality of care or resident health outcomes. Shiells, Holmerova, Steffl and Stepankova [14] focused their integrative review on the extent to which electronic care records were facilitating or hindering care provision. They concluded that while there was potential for these systems to assist staff in providing care, the nature of the device, the software applications, functionality, content and structure were all important for successful implementation. This review also highlighted the need for more research relating to the end-user experience of electronic records. Meissner and Schnepf [15], in their systematic review of available qualitative evidence, also drew attention to the lack of understanding of the way in which staff experience the technology implementation process. They concluded that the benefits (or perceived lack of benefits) of an electronic system were tied to the amount of time taken to complete the documentation process, which in turn related to ease of use and the individual's technical ability, equipment availability and functionality and individual staff attitudes. These reviews highlight a gap in understanding about the outcomes of health information technologies used for care delivery in residential aged care homes.

This integrative review was focused on studies implementing or evaluating health information technologies (i.e. computer-based information systems) used by nurses and personal carers, as well as other health care professionals, to provide direct care for residents. These kinds of systems provide information that record and communicate what care is needed, when it is needed, how it should be delivered to that particular person, if and when it was done and what the outcome was—this information is at the heart of 'person-centred care'. Health information systems relevant to or underpinning direct care in the residential aged care sector may serve a variety of functions, in addition to resident care. Debates concerning the enhancement these systems would benefit from a typology that clearly sets out that diversity of functions, taking account of what is the source of the data, the purpose for which the data is collected, who will be using it, at what level and when. [16]@@author-year} propose a preliminary purpose-based typology encompassing (a) direct care management (daily resident focus); (b) Indirect care management (resident history, key contacts); (c) Resource management (environmental or organisational focus including beds, staffing, support staff); (d) Regulation (quality oversight); (e) Financial

claiming and management system and (f) Statistical reporting (program management and research). This review is focussed on the first two components of this typology relating to implementation or evaluation of health information technologies used by nurses and/or assistants in nursing to provide direct care to residents. The technology may include interaction/documentation with other kinds of health professionals, may include medication only electronic systems, care documentation systems, or other aspects of care delivery, but the focus of the technology is on supporting direct care workers with delivery of daily resident care.

Given the key role for health information technologies in aged care in coming years, there is a clear need for a systematic understanding of what benefits and disadvantages these developments may bring for individual staff, for organisations and for residents in terms of both safety and quality of care, and quality of life. The systematic reviews described above have particularly, although not exclusively, focused on the staff experiences of implementation. In this review we set out to systematically explore the evidence base concerning technology systems that promote sustainable, safe and quality health care in aged care homes. There is a need for more emphasis on innovation in collecting and accessing data on the person (resident), at the point of care, to examine benefit for the person, and benefit for the staff. We need improvements that focus on facilitating direct-care staff to manage complex decisions and deliver holistic person-centred care. It was with this vision of a future of high-quality aged care in mind that we set out to assess the current state of the literature relating to the use of health information technology in residential aged care in terms of outcomes for residents, their families, and the staff who provide care.

The aim of this integrative review was to synthesise the qualitative and quantitative international literature about the use of health information technology for direct care in residential aged care homes. In this review we identified the outcomes of technology use for residents, staff and aged care services, as well as enablers and barriers to implementation and use.

2. Material and methods

This review was informed by the integrative review process described by [17] and conducted in accordance with the PRISMA statement guidelines [18,19]. The review protocol was prospectively registered with the PROSPERO database [20] as per best practice guidelines (CRD42020179902).

2.1. Search strategy

The CINAHL, Cochrane Central Register of Controlled Trials, MEDLINE, ProQuest, PsycINFO, and Scopus databases were searched by an expert health librarian for all relevant publications. No limits were placed on date or language of publication. All database searches were run on 28 April 2020. The search strategy encompassed three broad concepts: "residential aged care homes", "health information systems", and "resident, staff, and facility/system outcomes". For each concept a range of keywords and, where databases permitted, subject headings were used to increase the sensitivity and inclusiveness of the searches. The search terms and strategy employed for each database are summarised in Online Appendix A. All records retrieved by the database searches were exported to Covidence software for de-duplication and the study screening and selection process.

2.2. Screening and selection

Following de-duplication, two of the review authors independently screened all titles and abstracts of records for eligibility against pre-specified inclusion and exclusion criteria. The pre-specified inclusion and exclusion criteria are summarized in Online Appendix B. Following the title and abstract screening, the full text screening involved random allocation by Covidence software to independent review by two authors,

and conflicts were resolved by a third reviewer. The PRISMA diagram illustrating flow of the review is outlined in Fig. 1 [21].

2.3. Data extraction and synthesis

Extraction of data from the full text review was performed in a purpose-built, pre-piloted electronic form using Microsoft Excel 2010 to maximise capture of information from both qualitative and quantitative studies. Data on study characteristics including country of lead author, study design, location, setting, participants, types of technology, data type collected, and study findings were extracted (Online Appendix C). As the focus of the study was on the outcomes examined rather than the measurement, magnitude of change or methodological rigour, quality appraisal was not conducted. Study findings were collated using Excel and NVIVO to aid organisation and synthesis for qualitative analysis. Three researchers independently coded findings. Preliminary themes were independently reviewed then discussed, with conflicts in coding or synthesis resolved by discussion among researchers until consensus reached.

3. Results

Of 3721 references imported for screening, 1017 duplicates were removed and 2,609 excluded leaving 95 papers included in the review.

3.1. Characteristics of the studies

All articles were all published between 1991 and 2022, conducted across a range of self-described high and low care residential aged care homes, and involved over 12,000 participants that were nurses, care assistants and residents (See Online Appendix C). Articles reported studies conducted primarily in the USA (n = 39, 41%), Australia (n = 26, 27.4%), Canada (n = 6, 6.3%), Sweden (n = 5, 5.2%), Norway (n = 4, 4.2%), and Singapore (n = 3, 3.2%); two (2.1%) each from Belgium and Taiwan; single studies from The Netherlands, Hong Kong, Spain, Italy, New Zealand; and two multinational studies. Studies described their sites as nursing homes or residential homes (n = 50, 52.6%; particularly those in USA, Sweden, Norway, Europe and Asia); residential aged care facilities/homes (n = 22, 22.9%; predominantly Australia); long term care/facilities (n = 15, 15.6%; predominantly Canada, USA, Belgium) and other nomenclature (n = 8, 8.3%), including continuing care retirement centre, accredited residential structure for the aged,

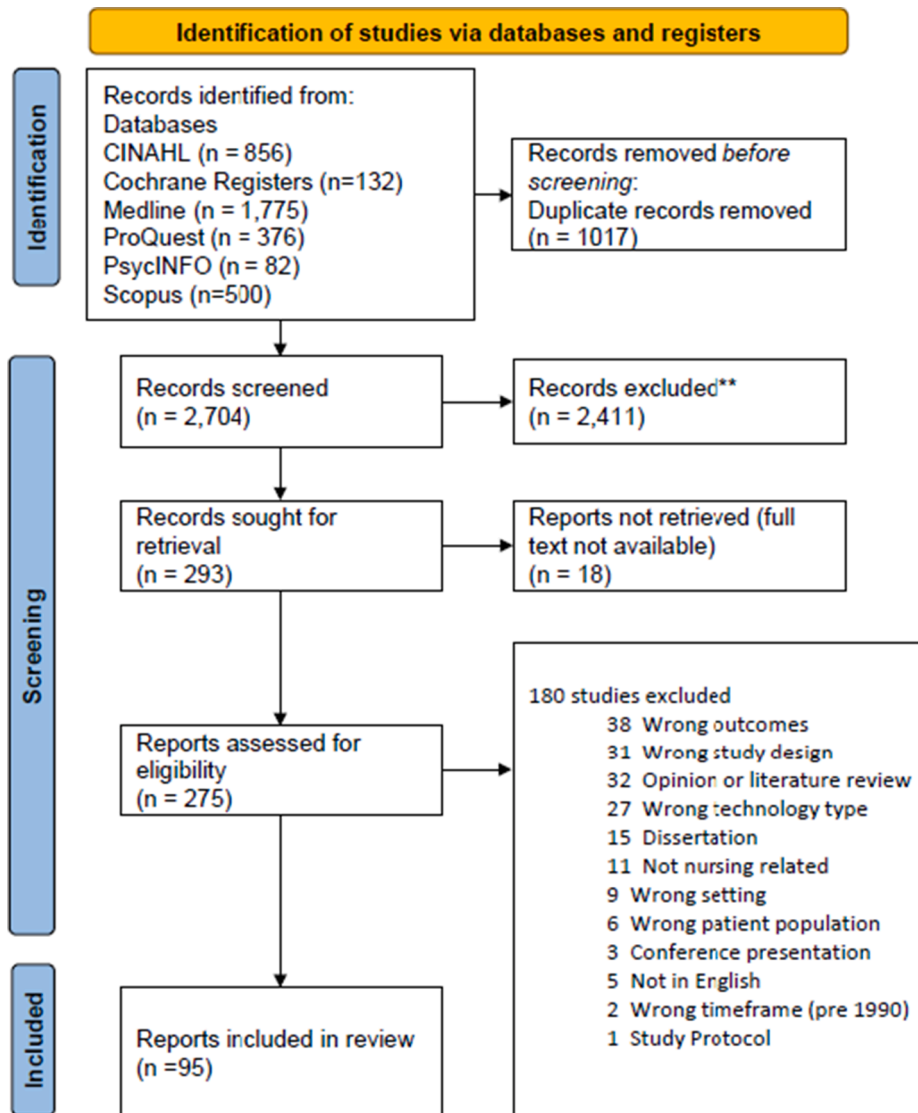


Fig. 1. *. Adapted from [18]

extended care and rehabilitation centre. Nearly 30% (n = 28) of the included studies included assistants in nursing/nursing aides/personal care workers/care staff/certified nursing aides/auxiliary nurses/certified medical technicians as participants.

Study designs were predominantly qualitative (n = 40, 42.1%), mixed methods (n = 26, 27.4%), or quantitative (n = 29, 30.5%, including 1 RCT), and more than half (n = 54, 56.8%) were conducted prospectively. The data collection methods used included interviews (n = 44, 46.3%), surveys (n = 39, 41.1%), focus groups (n = 17, 17.9%), direct observations (n = 24, 25.2%) and audit methods or extraction of data from information systems (n = 16, 16.8%). Half (n = 50, 52.6%) used only one method for data collection, 40% (n = 38) used two and 7.3% (n = 7) used three different methods to collect data. Technologies examined were most commonly a **General** care information system (n = 39, 40.6%) such as an electronic health record, electronic documentation system web-based application, most commonly at a single site, organisation or state; **Medication** management (n = 15, 10.4%); **Skin** management (wounds and/or pressure injuries) (n = 13, 13.5%); **Broad** stakeholder exploration (n = 12, 12.5%) (e.g., multi-site IT sophistication testing, survey of readiness at a state level, exploring standardised terminologies being used); **Communication** focussed (n = 6, 6.3%) (e.g. telehealth, ISBAR program for transitions); **Dementia** specific (n = 3, 3.1%); or **Other** (n = 7, 6.3%) (e.g. risk specific decision support, Incontinence management, adverse event reporting, falls reporting).

Of the 95 articles, 70.5% (n = 67) examined nurse outcomes, 56.3% (n = 54) examined facility level outcomes, and 52.6% (n = 50) examined resident outcomes. Of the 95 studies, 15.8% (n = 15) examined all three (i.e. nurse, facility and resident) outcomes, and 49.5% (n = 47) examined two of the three outcomes. In addition, 68.8% (n = 66) identified barriers, and 74% (n = 71) identified enablers to technology implementation in RACH.

As there was a mix of qualitative, quantitative, and mixed methods studies, with a focus on a range of resident, staff and service outcomes, narrative synthesis was undertaken. Thematic analysis of data extracted from the reports on the outcomes used to examine health information technology use related to acceptability, efficiency, quality of care delivery, and implementation.

3.2. Acceptability

Acceptability was typically reported using three outcomes: decision making about care, satisfaction with the technology and time spent on technology. Technology implementation outcomes related to teamwork and communication to facilitate decisions about resident were common [22–34]. In addition, technology supported care decisions about care decisions and guidance [22,24,26,35–37], care planning [22,35], manager decision-making [22,24,26,38] and risk awareness [33,39].

The most common satisfaction outcomes used to examine technology in aged care included technology user satisfaction [22,24,30,40–56], ease of use or usability [22,30,36,40,42,44,46,47,57–61], user acceptance of the technology [62] and job satisfaction [45,63–65].

Some studies reported poor user perceptions of technology [53,56,66]. Conversely, others reported improved working environments, reduced fatigue and stress, and increased user acceptance [40,41,44,54,62,67]. Infrequent outcomes examined included nurse attitudes [42,68] and psychological distress associated with technology use [45,58,69]. Acceptability was also examined using knowledge and attitudes of healthcare professionals [22,32,57], time pressure [58] and nurse sense of coherence [45].

Worker time using technology was examined in several studies [24,26,42,43,69–73 56], as was time spent on specific care activities [37,74–76], or completing forms [77] which was also linked to efficiency [78] and workload [69]. Some studies reported an increased proportion of time allocated to documentation [27,79] and verifying medications [74] when using technology.

3.3. Efficiency

Efficiency outcomes included resident timeliness of care [26,32,80], care for skin [49,81], medication administration [31], and access to resident information [22,25,26,75,82,83].

Staff efficiency outcomes captured included nurse efficiency [39,84], IT skills [26,38,85], work planning [26,82,83], workflows [30,65,86], removing redundancy [70], work effectiveness [30,86] and integration of complex processes [31,54,65].

A particular focus among studies was documentation processes by nurses [33,59,70,87–91], for example use of standard terminology [51,58,65,92] or processes [46], number of nursing diagnosis, interventions and activities documented [79], comprehensiveness [77,79,82,83,91], errors [76], content and structure [89,91], and overall quality [42,87,89]. In addition, legibility and accuracy [26,53,71,73] were also examined as outcomes of information systems.

Efficiency outcomes also included access to regulatory data [26,27,40,65,69,93,94], and incident reporting [78]. Some studies reported on standardised work processes [39], increase completion of desired interventions [47] or cost [73,78,80,93].

3.4. Quality

Quality outcomes reported were diverse. Technology focussed quality outcomes included completeness of care records [33,76,91], and teamwork, communication [25,37,65], information sharing [25] and virtual collaboration between team members [95]. However, reduced communication was also identified [27]. Use of technology to provide holistic knowledge of the person [22,26,36,52,82,83], access to care processes [22,26,94,96], quality indicators [78,93,97] and increased awareness of resident needs [71] that facilitated resident centered care [22,95] were also identified.

Resident and family focussed outcomes included care quality [22,26,37,38,40,58,66,67,69,71,96,98–100], timeliness of care [22,26,33,53,54] and continuity of care delivered by aged care staff [101]. Some studied family and resident satisfaction with care [24,35,100,102], caregiver and resident experience [22,59], resident privacy [103], resident missed care [76], resident preferences [36,99], resident quality of life [38,45], resident safety [39,78,103] and time with care workers [26,67]. Resident specific quality outcome measures used to evaluate technology included resident activities of daily living function or level of care [79,93,98,100], behaviours [26,79,93,98,100,104], incidence of preventable harms such as delirium [26,79,93,98,100,104], falls [100,103,104], malnutrition [33,105], weight [33,79,98], unnecessary transfers to emergency departments and hospitalizations [32,63,104], incontinence [33,55,85,98], pneumonia [97], mobility [93,98,103], bowels [79,98], mood [93,100], and physical restraint [93]. [85] also identified an associated between increased IT sophistication and improved resident quality outcomes related to seasonal flu vaccination.

A focus on technology interventions has been related to a comprehensive care model [98], enhancing resident care related to medication management [29,56,61,75,76,96,106], including the timeliness of medication administration [31,107], safety of medication-use process [74,76,107,108], reduce/detect medication errors [79,84,96,106,107], and adverse drug events [104]. While technology interventions were to reduce pressure injury incidence/prevalence [23,47,57,77,93,105,109] and promote wound care [24,46,59,86] were most common, other preventable harms common to older people (e.g. pain, continence, falls or mobility loss) [98] were seldom identified.

3.5. Enablers and barriers to implementation

Organisational capability for implementing new technology, emerged as important for long-term sustained effects on care quality, safety of residents [103] and satisfaction with service delivery [101].

Characteristics of aged care facilities, the staff and the technology were found to influence implementation and adoption [101]. Two studies reported implementation success using co-design with staff and residents [22,110].

When faced with difficulties arising from integrating the system into their workflow, many staff became less inclined, or resistant to using the new technology [27,47,49]. For example, staff-reported difficulties with using technologies included perceived job changes, [41,45,62], change in workflow [41,49,71,73,75,82–84], perceived workload increase [36,58,84,111], and additional documentation demand [68,111]. When these studies are examined from a temporal perspective, it appears that there is less evidence of concerns about using software relating to changes in the nature of work and to workflow in recent years. By contrast the issue of additional documentation and workload remains evident in the most recent studies [36,58,107,111].

Perceptions about technology contributions to effectiveness and efficiency gains in nursing care [30,58,81,110–112] and addressing current gaps in practice (e.g. body map, show patient wound pictured) [59,111] were enablers.

Common staff-identified barriers were lack of time [50,84,105,107,111] and availability of hardware [27,47,86,105,107,111–113], although concerns regarding availability of hardware were still evident in the more recent articles [107,111], suggesting this issue may have reduced over time, but is still a problem. Staff also expressed concern about resident perceptions about their work when using technology [30,111], uncertainty about impacts on care [73] and the excessive demands of training and resources required [40,47,101]. Nursing capabilities for technology adoption [23,52,65,85,105,113] including skills and knowledge to use the technology [47,49,51,54,57,71–73,79,82,83,105,107,108,111] were common outcomes identified. Conversely, staff training [22,40,41,43,50,53,72,103,104,108,111,114], trained facilitators [23], specific technical support [23,45,67,80,111,112] and mentor/nurse champion support for technology use [22,30,33,47,71,84,92,108,112] were important enablers for implementation and sustained adoption. Technology-related training had a significant impact on intensity of technology use and may help to alleviate concerns and misconceptions [23,68,112]. Low confidence [105] appeared to be overcome by new employee training, and ongoing support allowed staff time to adjust to using technology [80,112,114].

Organisational outcomes captured both practical and administrative challenges [92]. Organizational climate and attitudes toward technology contributed to implementation success or failure [26,28,30,41,43,62,63,65,84,99,102,103–69]. Other considerations examined were cost [52,60,61,65,67,78,109], manager experience [53,92] and support [112], staff clarity about roles and responsibilities [35,57] and supportive policies for change [65] (e.g. prescribing practices [32], billing [49]). Good communication strategies [23,30,34] appeared to also provide an important enabler.

Practical challenges have been examined and overcome using staff [22,47,58,106] and resident [22,36] engagement or participation in development or implementation, with doctor resistance examined as a particular challenge [61,114] to supporting staff use of technology [58]. In addition, modifications to the work environment [27,28,36] such as availability of infrastructure [60,63,65,90] and feedback loops about performance and progress [30] were examined. For example, staff acceptance and willingness to enter resident's data regularly and accurately appeared to be influenced by how they could make use of the results from the assessments and suggested interventions [105,111]. Practical and work practices were identified to pose barriers to the uniform use of technology [114]. Examinations of staff workarounds [29] and unintended consequences [29,75,76] were infrequent in the residential care setting.

Outcomes such as technology problems and maintenance issues including workflow fit and integrated functionality were reported [41,58,65,72,115,116]. Issues with internet outages, system downtime,

computer glitches, bandwidth and connectivity were common, but mostly concentrated in studies between 2006 and 2013, suggesting this particular problem may be phasing out [27,29,42,60,61,63,71,80,103,112]. Another common outcome was functionality that did not meet need [27,115], which included poor clarity about functionality or specifications embedded in the software [23,54,65,86,111]. Less common outcomes problems were confusion over duplicate paper records [65,111], and passwords [90,114], the precision of language used [82,83], levels of customisation [26,82,83,111] poor screen design [29] and damage to equipment [37,71].

3.6. Synthesis

This review has revealed a substantial amount of the research examining technology use in aged care was focussed on staff and system, rather than resident, outcomes (see table xx). The health information technologies used in residential aged care homes included electronic health records, medication management systems, handheld devices, systems for a specific activities or conditions such as medications or wounds, as well as multi-function systems. Qualitative methods were most common, with a predominant focus on usability and acceptability for staff. Common outcomes examined and described included staff satisfaction with the technology, and efficiency benefits of new technology such as time spent on technology enabled or related activities or tasks, and consistency of work processes. Similarly, many studies examined enablers and barriers to implementation and sustainability of technology systems using staff perspectives. This emphasis on staff experiences, behaviours and attitudes, as well as work processes, and appears driven by a focus on health information technology implementation rather than consequences and outcomes.

In comparison, quality and safety outcomes for residents emerged less often. Relatively few studies examined resident perspectives of care processes or care quality concerns such as completeness of care records, resident quality of life, and quality of sharing of information between residents, staff and other care providers. Even less common were outcomes to capture unintended changes in workflows or workarounds, errors, or resident harm associated with technology use. Further, evidence about redistribution of time savings, from example reduced documentation time to direct care was not available.

In contrast to the review reported by [13] which found no evidence relating to the quality of care or resident health outcomes, this review found a range of resident health outcomes, but rarely was the same outcome reported in multiple studies. For example, more specific measures such as medications, pressure injuries and wounds were examined by multiple authors, but factors that contribute to preventable harms common among older people such as restraint use, independence in activities of daily living, delirium, malnutrition, and unplanned hospitalisation were uncommon.

Monitoring outcomes relating to staff perceptions, experience, use and acceptance of digital care software is unarguably an important enabling step in effective implementation of electronic health care records in residential aged care. It could be expected the staff focus would predominate in the earlier phases of technological innovation, with increasing focus on resident quality of care and quality of life as the field matures. This does not however appear to be the case. The findings of this review support [14] call for research investigating end-user experience of electronic records, recognising that the resident, not the staff are the true end-user, and the primary purpose for health data collection.

4. Discussion

This review identified the predominant focus of the substantial body of literature relevant to the examination of technology for daily resident care in RACH relates to acceptability and efficiency from the perspective

of staff as end users. Further, research examining the role of technology in delivering quality outcomes for residents in RACH was often hindered by use of single technology components and focus on single risk or outcomes that seldom capture the complexity and interrelatedness of care needs for residents in RACH. The findings of the review suggest research examining health information technology use to support direct care for residents in RACH does not capture the complexity of care for residents, or the demands of care delivery by nurses and other direct care workers. Further, there is a gap in understanding of contributions to the quality and safety of resident care.

Over 70% of the included articles reported on staff related outcomes (such as satisfaction and usability of the system) related to health information technology use for direct care of residence in care homes. Comparatively, the role of direct care health information technology to deliver resident specific (52.6%) outcomes, or combined staff, resident and facility outcomes (only 15%) were infrequently examined. This is problematic were systems are used to support care of older people with multiple complex conditions, and high needs for expert health care [2–4]. This finding suggests a lack of sophistication in health information technologies for resident care. Further, the limited focus on single users and outcomes is unlikely to capture the multiple influences on resident care delivery, and increase risk for unintended consequences [27,76,96].

The review clearly demonstrates a dominant focus on usability and acceptability of technology for staff, and staff and facility level issues related to implementation and adoption. As a consequence, findings also focus on barriers to health information technology implementation in RACH that relate to staff, the environment and systems. For example, problems with access to hardware, technology that was not fit for purpose, and workflow issues related to time, documentation burden and staff stress were common, similar to findings reported in broader literature on technology use in healthcare [117,118]. In contrast, many enablers of successful technology implementation were identified. Combinations of staff education and training, mentors, and local champions to provide real-time support emerged as key enablers for staff adoption of technology. Understanding context specific enablers and barriers is key to ensuring interventions and implementation strategies effectively target desired staff behaviours [119–120]. The potential for co-design to engage nursing home staff and residents in system development and implementation to an opportunity highlighted in this review [22,110].

The review finding highlight need to transition from research focus on staff and efficiency (for workplaces) towards better understanding the impact of health information technology used in direct care on resident outcomes related to quality and safety. None of the included studies provided a comprehensive understanding of benefits of digital tools for resident outcomes. Technology tools that support comprehensive, holistic and person-centred care delivery, can also offer the opportunity for measurement of care as a by-product of care delivery. It is important to remember that collecting and analysing resident outcome data may not mean that resident care is improved.

The findings also illustrate the varying stages of technology adoption for residential care within and across countries warrants further exploration. Previous research show adoption has been associated with increased: innovation and information integration [121]; higher levels of licensed nursing staff [122] perceived safety and improved quality of care [123,124]. While many sites advance, the aged care sector remains challenged by low incentivisation, poor options and slow adoption. There is also little realisation of opportunities for fast growing fields such wearable technologies [125] and the internet of things [126] to support direct care for residents, further increasing risks for disparities in achieving health and wellbeing goals for residents [126,127].

4.1. Strengths and limitations

A main strength of this review was the extensive and comprehensive

search strategy that used broad range of search terms and databases to capture literature about health technology use in residential aged care homes across disciplines and countries. Conversely, a key limitation relates to the broad scope of our review that captured a wide range of technology implementations. The heterogeneity of the study types and the single issues examined during implementation limited synthesis within-topic; but the strength of the review lies in collating which studies reporting impacts on acceptability, efficiency and quality. Similarly, a limitation was clear extraction of whether the technology was a new component entirely, or an addition to an existing system of care, as many studies did not make this clear in their descriptions and extraction occurred at face value. Future reporting of participant breakdown of staffing participant qualifications can improve review quality.

In addition, the quality and rigor of the methods and research processes were not appraised as this fell outside the main objective of this review that was focussed on identification of outcomes rather than the rigour of measurement, which should be the target of future focussed research. Future research, including more focussed systematic reviews, can focus on capturing outcome measures and clearly reporting on whether outcome measures are directly observed, a proxy report, ensure inclusion of people with cognitive impairment, and identify changes over time.

5. Conclusion and recommendations

To date, outcomes of health information technology use in residential aged care homes have focussed on the staff and implementation, with limited evidence available about improvements in resident health, well-being, quality and safety. Future research should seek to expand the outcome measures used to judge health technology suitability for residential aged care homes to capture not only the quality and safety of resident care but also the things that matter to residents, their families, and the staff who provide direct care. In addition, there is a need to consider the rigor and consistency of measurements and reporting of staff qualifications and impacts to support understanding of the role of technology in delivering holistic, person-centred care in residential aged care homes, and comparability and benchmarking across the sector.

5.1. What is known

- Health information technology use in residential aged care is increasing with expectations of improved staff efficiency and care quality
- Little is known about outcomes examined and used to evaluate technology benefits, or risks for residents, family, staff and services.

5.2. What this study adds

- Current evidence about using health information technologies in residential aged care homes has predominantly focused on outcomes related to system usability and acceptability for staff, staff work processes and efficiency, and the success of implementation. Outcomes for quality and safety of care outcomes for residents and their families, and staff were less common.
- Further evidence is needed about the contribution of health information technology to resident and staff wellbeing, and unintended consequences such as staff workarounds and adverse events.

6. Compliance with Ethics

The systematic review was conducted in accordance with the Australian National Health and Medical Research Council (updated 2018) guidelines.

CRediT authorship contribution statement

Kasia Bail: Conceptualization, Methodology, Validation, Formal analysis, Writing – original draft, Writing – review & editing. **Diane Gibson:** Conceptualization, Methodology, Validation, Formal analysis, Writing – original draft, Writing – review & editing. **Prativa Acharya:** Conceptualization, Methodology, Validation, Formal analysis, Writing – review & editing. **Julie Blackburn:** Conceptualization, Methodology, Writing – review & editing. **Vera Kaak:** Conceptualization, Methodology, Validation, Writing – review & editing. **Maria Kozlovskaja:** Conceptualization, Methodology, Validation, Writing – review & editing. **Murray Turner:** Conceptualization, Methodology, Validation, Writing – review & editing. **Bernice Redley:** Conceptualization, Methodology, Validation, Formal analysis, Writing – original draft, Writing – review & editing, Supervision.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Kasia Bail, Bernice Redley reports financial support was provided by Humanetix Pty Ltd.

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Appendix A. Supplementary data

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