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The relationship between use of EHR and risk management for resident safety in Australian Aged Care Homes

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The Relationship between Use of EHR and Risk Management for Resident Safety in Australian Aged Care Homes

Thesis for PhD study

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This thesis is presented as part of the requirements for the award of the Degree of Doctor of Philosophy of the University of Wollongong

March 2017
Certification

I, Tao Jiang, declare that this thesis, submitted in fulfillment of the requirements for the award of Doctor of Philosophy, in the School of Computing and Information Technology, University of Wollongong, is entirely my own work unless otherwise referenced or acknowledged. This document has not been submitted for qualifications at any other academic institution.

Tao Jiang

March 2017
Abstract

Background

People living in Residential Aged Care (RAC) homes have higher exposure to various risk factors than their counterparts in the community. Therefore, a risk management approach is essential for client safety. Formal RAC services in Australia are predominantly financed by taxpayers with some user contributions. To protect clients’ safety and quality of life, the Australian government has imposed stringent accreditation standards in RAC services. Therefore, the aged care accreditation program drives the risk management approach in these services.

Various types of information technology solutions have been introduced into RAC services. Among them, electronic health record (EHR) systems are important in supporting the delivery of aged care services and risk management for client safety. To date there is a lack of evidence about the contribution of EHR to the effectiveness of risk management, particularly in supporting the primary risk management goal of meeting accreditation standards. Therefore, this research aimed to explore the contribution of EHR to risk management to meet accreditation standards in RAC homes.

Methods

Secondary research was conducted by text data mining the published aged care accreditation reports. After being automatically downloaded from the government web site, these reports were converted from PDF to computer program readable text format. The relevant information was extracted, loaded and stored. The specific content was labelled for analysis. The relationship between data was explored by quantitative statistical data analysis and data
mining of association rules. Qualitative text data analysis was conducted to further explore
the reasons for the relationship.

**Results**

Only 45 (1.25%) of 3,607 accreditation reports published between 7\textsuperscript{th} March 2011 and 25\textsuperscript{th} March 2015 recorded failure in one or more accreditation outcomes, suggesting only a few RAC homes actually failed aged care accreditation. The three outcomes that the RAC homes most often failed were information systems (58%, 26 homes), clinical care (44%, 20 homes) and medication management (40%, 18 homes).

Six risk indicators for not meeting the information systems outcome were: no access to accurate and appropriate information, failure in monitoring mechanisms, not reporting clinical incidents, insufficient recording of residents’ clinical changes, not providing accurate care plans, and communication processes failure. No significant association was found between failing information systems outcome and the types of information systems to be used, either EHR or paper records.

There were only two significant positive associations between failing the information systems outcome and failing two other outcomes: staff education and development, and clinical care. Failure in the data monitoring mechanism was the common reason for RAC homes to fail in other accreditation outcomes.

**Conclusion**

The EHR systems did not clearly contribute to risk management in meeting other accreditation outcomes. A number of accreditation failures appeared to be linked to organisational deficiencies that could be improved by use of more effective information systems to improve monitoring mechanisms. Future research should explore the possibilities of improving the design and functionality of EHR to fully support aged care services.
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From the depth of my heart, I thank my loving parents who are always understanding and supportive, regardless of whether I have been successful, experiencing hardships or feeling happy or down, during my seven years of studying abroad.
Statements

This thesis is prepared in the style of Thesis by Compilation by the University of Wollongong. Seven articles are included in this thesis: one article has been published in peer-reviewed journals, two articles have been published in peer-reviewed book chapters, one article is in revision as requested by International journal of medical informatics, and one article accepted as student paper by the Medinfo 2017 conference.

I am the first author of all these papers. I contributed to the study design, data collection and analysis and preparation of the manuscripts. Five co-authors are involved in the publications. They are Ping Yu, David Hailey, Jun Ma, Jie Yang, and Siyu Qian. Their contributions are outlined in the co-author contribution declaration forms attached to this thesis.
List of Publications

Published peer-reviewed book chapter:


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Accepted by peer-reviewed conference:


Articles under review by peer-reviewed journals:

List of Abbreviations

Aged Care Accreditation Standards (ACAS)
Aged Care Accreditation reports (ACAR)
Aged Care Quality reports (ACQR)
Australian Aged Care Quality Agency (AACQA)
Aged Care Standards and Accreditation Agency (ACSAA)
Chronic obstructive pulmonary disease (COPD)
Electronic health records (EHR)
Residential aged care homes (RAC homes)
Long-term care (LTC)
Natural language processing (NLP)
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Chapter 1. Introduction

Background

Residential aged care (RAC) homes in Australia are similar to long-term care (LTC) homes in the USA and nursing homes in Britain. They are the facilities that offer 24-hour nursing supervision and a range of, medical, nursing, personal and social services to meet the needs of chronically ill or disabled individuals, mainly older people [1]. With population ageing, the demand for RAC services around the world is steadily increasing.

Associated with the ageing process is an increased level of frailty and chronic diseases, which are the main challenges for nursing staff to provide appropriate care for the older people [1]. People living in RAC homes have higher exposure to various risk factors than their counterparts in the community [2]. These risk factors are related to the care recipient’s health conditions, the health and aged care systems and the human factors from health and aged-care staffs that are responsible to care for the RAC residents. Therefore, a risk management approach is essential for client safety in RAC homes. In the context of aged care nursing ‘risk management’ encompasses many activities undertaken by qualified and non-qualified nursing staff [3].

The whole process of risk management includes identifying risks, assessing the risks, developing risk management plans, implementing risk management actions and re-evaluating risk which have occurred in the process of delivering aged care services [4]. The classical nursing process model, which has been widely used as a theoretical basis for nursing practice and documentation in RAC homes in Australia, as in other healthcare settings [5]. It is indeed a risk management approach to client safety. This model is comprised of five stages: nursing assessment, nursing problem or diagnosis, planning, implementation and evaluation [6, 7]. In
fact, each stage of the nursing process model can be mapped to the relevant stage in the risk management cycle. An important objective of risk management is to reduce adverse events (incidents that under optimal conditions are not a normal consequence of a client’s nursing and personal care) that might lead to negligence claims [8].

Formal RAC services in Australia are predominantly financed by taxpayers with some user contributions [9]. In order to protect care recipients’ safety and quality of life, the Australian government has imposed stringent accreditation standards in RAC services. In order to stay in business any RAC home needs to meet the accreditation standards, which requires a systematic risk management approach to develop and implement the organisational risk management plan [4]. Therefore, the aged care accreditation program drives the risk management approach in Australian RAC services.

To fully understand the risk management approach in Australian RAC services, we need to understand the aged care accreditation system and map it to the risk management approach in RAC homes.

Contemporary accreditation programs have both compliance and quality elements that work in a complementary way to promote quality and safety. Accreditation programs focus on continuous quality improvement strategies. They usually consist of a process that involves self-assessment, review or assessment of performance against predetermined standards by an external independent body, and monitoring of ongoing performance against the standards by the accreditation body [10]. Residential aged care accreditation in Australia follows four standards: 1. management systems, staffing and organizational development; 2. health and personal care; 3. care recipient lifestyle; and 4. physical environment and safe systems [11]. Each standard is measured by a series of expected accreditation outcomes. In total, there are 44 accreditation outcomes across the four standards. An RAC home must comply with all these outcomes at all times in order to meet the accreditation standards.
Aged care accreditation includes an accreditation process and monitoring of ongoing performance against standards [12]. The accreditation process starts with self-assessment, followed by a desk audit, a site audit, and the decision whether or not to accredit the home and the publication of the accreditation report, together with the agency's decision about whether the RAC home meets each of 44 accreditation outcomes. Therefore, the process of aged care accreditation can be viewed as a compulsory process in the first two steps of risk management, identifying risks and assessing the risks. Re-evaluating risks are completed by unannounced visits to monitor continuing compliance with standards by the accreditation agency staff.

Information management is fundamental to health care delivery [13]. As the communication tools for exchange of information between nursing staff and with outside health service providers [14], client health record systems, either in paper or electronic format, are among the most important information systems in RAC homes that support the delivery of aged care services and risk management for client safety. They promote structured, consistent and effective communication between caregivers and facilitate continuity and individuality of care and safety of clients [6, 7]. They are also used for quality assurance, legal purposes, health planning, allocation of resources, nursing development and research.

In order to improve effectiveness and efficiency in information management, various types of information technology solutions have been introduced into RAC services [15]. Among aged care technologies, Electronic Health Record (EHR) systems are most fundamental in supporting the delivery of aged care services and risk management for client safety. Electronic health records are the major clinical information source for nursing care [16], communication, evidence of care delivery and legal documents [17]. They hold the promise of improving the quality and efficiency of documentation so as to comply with nursing and
accreditation standards and to meet legal requirements [18]. Therefore, many RAC services in Australia have introduced EHR to replace the paper-based health records [16].

However, there is a lack of evidence about the contribution of EHR to the effectiveness of risk management for RAC services, particularly in supporting the primary risk management goal of meeting accreditation standards. This has inhibited the further adoption and development of aged care EHR systems. Therefore, the contribution of EHR to risk management for client safety in RAC homes needs to be investigated. Therefore, the aim of this PhD study is to answer the research question

- Does the use of EHR systems improve the capacity of RAC homes to manage risks for client safety in comparison with the use of paper records?

The aged care accreditation reports, for their complete coverage of all areas of activities in the RAC service delivery, provide us with a rich information source to address this research question. However, there is a critical limitation in using aged care accreditation reports to validate the contribution of EHR to risk management for client safety in RAC homes. The accreditation reports only provide the verdict about whether a RAC service met the minimum safety and quality of care standards for clients, and the rationale for the verdict. Nevertheless, no difference in quality of RAC services can be inferred from these reports once an RAC home has met all standards. This is because meeting all standards only provides an indication that all aspects of the RAC services are up to the minimum standards required by the accreditation agency. It does not provide information about the level of quality. Therefore, this study will answer the following two questions in order to address the overall research question:

- Is there any association between failing the information systems outcome and the types of information systems used in an RAC home, either EHR or paper records?
• Is there any association between failing the information system’s outcome and failing other accreditation outcomes?

**Research Hypotheses**

• Use of an EHR can improve the opportunity for an RAC home to meet the information system’s accreditation outcome in comparison with using paper records.

• RAC homes that failed the information systems outcome were more likely to have failed other aged care accreditation outcomes.

It is labor-intensive to identify and analyse the text data from the huge volume of aged care accreditation reports manually. Appropriate, automatic text data mining methods needed to be developed, built on the current advances in data mining technology, to extract the relevant data from the aged care accreditation reports for qualitative and quantitative data analysis.

**Organisation of the thesis**

This thesis is submitted in the form of thesis by compilation. It includes four published papers and two papers that are under review. Following this introduction, Chapter 2 reviews the relevant literature for the research topic. A systematic method of literature search, identification, data analysis and synthesis was followed to identify the risk factors for client safety. The risk management system in Australian RAC services was presented. This is followed by the possible contributions of information systems to risk management, description about the introduction of the EHR systems for improving information systems and the benefits of EHR that have been empirically tested in RAC services. This leads to the identification of research gap and discussion about the source of information that would be used to answer the research questions and a brief introduction of the methods that would be used to extract the relevant information in the accreditation reports. It sets up the research context and identifies the research gap.
Chapters 3 and 4 present the findings from the pilot study that developed a text data mining method to analyse 13 out of 2,754 RAC accreditation reports that failed one or more accreditation outcomes. These reports were published between 27th April 2011 and 3rd December 2013.

Chapter 3 reports the study about the impact of EHR on risk management of information system in RAC homes. The study found that although the proportion of homes that met all accreditation standards was significantly higher for those with EHR than for homes with paper records, the overall contribution of EHR to meeting aged care accreditation standard in Australia was very small. Six risk indicators for not meeting information system standard were identified; including no access to accurate and appropriate information, failure in monitoring mechanisms, not reporting clinical incidents, insufficient recording of residents’ clinical changes, not providing accurate care plans, and communication process's failure.

Chapter 4 focuses on reporting the findings about the relationship between using EHR and meeting accreditation standards for client safety in RAC homes. It aims to identify the benefits of using EHR for client safety.

Chapters 5 and 6 report findings from analysing all the available accreditation reports the government official website. While only 13 RAC reports were eligible for analysis in the study reported in Chapters 3 and 4, a larger pool of sample, 45 RAC homes that failed one or more accreditation outcomes in the entire period of 7th March 2011 and 25th March 2015 were analysed.

Chapter 5 investigates the relationship between failing accreditation outcome for information systems and failing other accreditation outcomes in Australian residential aged care (RAC) homes. It addresses two research questions: (1) In Australian RAC homes, what is the relationship between failing the information systems outcome and failing other accreditation
outcomes? (2) What are the differences in failed outcomes between RAC homes using an EHR and those using paper records?

A critical vulnerable area where risks for client safety might occur in RAC homes is medication management. Therefore, Chapter 6 reports the study that aimed to identify risk factors related to medication management in RAC homes. The research aim is achieved through textual data analysis of aged care accreditation reports.

Chapter 7 is the General Discussion and Conclusion. It presents the key findings of this research, discusses the rationale, limitations of the study and provides recommendations for future research.

References


Chapter 2. Literature Review

This chapter focuses on reviewing the literature about several important, interconnected areas in RAC services that this study aims to research: (1) risk factors for client safety; (2) risk management system in Australian RAC services; (3) the possible contributions of information systems to risk management; (4) the introduction of electronic health record (EHR) systems for improving information systems; (5) the benefits of EHR that have been empirically tested in RAC services; (6) the research gap; (7) the source of information that can be used to answer the research questions; and (8) the methods to extract the relevant information in the accreditation reports.

2.1 Risk factors for client safety in RAC homes

There are three major types of risks for resident safety in RAC services: the person’s health conditions, the performance of the health and aged care systems and human factors of health aged care staff. The risk factors that are related to the person’s health conditions include: loss of cognitive function, depression, disability, allergy to drugs and other substances. The risk factors in the health and aged care systems include system failure or errors, inadequate allocation of human resources for care, sub-optimal processes in medication management and nursing care. Human risk factors of health and aged-care staff include lack of experience or lack of training in providing appropriate care and negligence.

2.1.1 Safety risk factors related to personal health conditions

Many people living in RAC homes have higher exposure to risk than their counterparts in the community [1]. Some suffer from poor health and complex chronic conditions, some are dying, some inclined towards self-harm, some suffer from depression, poor mobility, disability, allergy and mental health issues [2, 3, 4]. These personal health risk factors all
require special care and first aid [5]. If not dealt with in a timely manner, they may lead to medical accident or falls [3]. If a client suffers from depression for a long time without intervention from nursing care, the situation will deteriorate quickly. Allergy to drugs and food often happen to people suffering from chronic obstructive pulmonary disease (COPD) and asthma [4]. In some cases, allergy needs to be controlled by first aid services or requires treatment by drugs [6]. Delayed treatment of allergy can cause harm, even death [4]. In summary, personal health conditions are important internal risk factors that require continuous nursing attention. These safety risk factors exist in both RAC homes and other healthcare settings.

2.1.2 Safety Risk factors related to health and aged care systems

Residential age care services frequently interface with other health care services to provide continuous, holistic, long term care for the clients [7]. Therefore, the risk factors for client safety exist in the whole health and aged care processes. These include environmental risk factors in RAC homes, risk factors in medication and nursing care processes, and risk factors caused by the introduction and use of IT applications.

2.1.3 Safety risk factors related to the unique environment in RAC homes

The environmental risk factors in RAC homes are system failure and errors. The system failure includes inappropriate or wrong methods in treatment, nursing care, meal services and communication. Risk factors in nursing care processes include miscommunication or lack of communication between nursing staff and clients or between aged care staff and other healthcare providers, such as doctors, hospitals and community pharmacies [8]. For example, lack of communication between a pharmacy and an RAC home may lead to errors in medication packaging [8]. It is also found that unhealthy or unclean food can cause malnutrition or health problems [7].
2.1.4 Safety Risk factors in both RAC homes and other health care settings

Safety risk factors in the medication processes include wrong drug, dose, formulation, route, strength and timing [6, 9]. The powerful drugs can lead to high risk by changing personal health condition [6]. Misuse of drugs includes wrong drug and dose for the wrong client and inappropriate use of a drug before or after a meal [9-11]. Adverse drug-drug-interaction often happens when different drugs are used together [6].

Nursing procedural failure is a main risk for care. For example, medication label, patient identification, medication chart and body mass index are often misread and misidentified [8, 12]. Checking and preparation, witness administration, infusion pump set up, dangerous drug register and signing medication chart are all nursing care processes prone to error [8, 12-14]. Inappropriate use of complex technologies can also cause harm to frail people [7, 15, 16]. The adverse effect does not only last during the operation, but also in the care process; thus it requires special attention.

In the situation where IT application is used in nursing care processes, power failure can cause inaccessibility of EHR, without access to personal health information, and appropriate medication management is under risk [16-18]. Portable offline emergency medical record devices are developed and used to deal with this contingency situation [19]. In such case, battery life can be a barrier to a continuous function [19, 20]. In addition, system errors from EHR could cause the misuse of drugs and wrong identification of the client, which was highly risky [11, 19]. Several studies found EHR were not accepted by nurses because the interface design was not friendly and the users felt it was difficult to use the functions of the system [21, 22]. Unfamiliarity with and misuse of the system can reduce the efficiency and may risk client safety [19].
2.1.5 Human factors for client safety in health and aged care systems

Human factors that might cause risk to client safety include the provision of inappropriate care by health and aged care staff, their negligence in care, and slips and mistakes in the process of care delivery [8]. ‘Slip’ in this case means error caused by the incorrect execution of a correct action sequence [23]. ‘Mistake’ is the correct execution of an incorrect action sequence [23].

The possible causes for inappropriate care might be care staff’s lack of knowledge about the risk factors [2, 8], which may reflect their lack of training [2, 24] and limited work experience [2, 25]. Care staff’s negligence in care might be caused by depression or lack of time [2, 26]. These, together with lack of acknowledgement of an unfamiliar or unknown situation [2], may lead to nursing error or failure [7].

**Inappropriate care caused by lack of training and work experience**

Lack of training for staff is a high risk factor for client safety. It can lead to knowledge related mistakes and unintentional slips in care delivery [14], such as error in handling special conditions in first aid situations [7]. In addition, medical technology can be complex and requires nurses to have sufficient training before using it confidently [2]. According to Zhang et al. (2004), incorrect knowledge, incomplete knowledge and misuse of knowledge can lead to execution mistake and evaluation mistake [23]. These risk factors can be alleviated by appropriate and sufficient training.

Lack of work experience can often happen to some new health care workers. It is likely that part-time and less experienced nurses and doctors are more prone to mistakes [18] that are not likely to happen to skillful health care workers [7].
Lack of attention caused by depression or negative feeling or lack of time

In nursing care services, a nurse is required to spend a certain amount of time with each client. Nursing staff with depression or negative feeling are prone to inattention [21]; therefore, a nursing manager needs to pay attention to staff having such feeling so as to prevent harm to clients [8]. Lack of time and inadequate care can harm client safety [27]. Time pressure often happens when there is an emerging issue that draws the nurse’s attention away [28]; or when one nurse attending to more than one client at a time [19]; or through lack of availability of information on time for demand [13].

Overflow of working memory

Nursing staff in RAC homes is often multi-tasking [29]. Multi-tasking can lead to overflow of working memory. This can lead to goal slips and intention slips. Information overload can lead to interpretation slips [23].

Lack of acknowledgement of an unfamiliar or unknown situation

Early acknowledgement of unfamiliar or unknown situations can avoid medical incidents from happening [30]. Part-time and less experienced nurses are more likely to make error in these circumstances [14]. Insufficient information and lack of feedback may lead to action evaluation slips [23]. Therefore, a nurse should be given time and adequate information to know and familiar with a new work place [30].

2.2 Risk management approach in Australian RAC services

A risk management approach is essential for client safety in RAC homes. The whole process of risk management includes identifying risks, assessing the risks, developing risk management plans, implementing risk management actions and re-evaluating risks which have occurred in the process of delivering aged care services [31].
To ensure the effectiveness of the risk management approach in government subsidized RAC services, the Australian government has established the aged care accreditation system to guide and monitor the aged care services in RAC homes; therefore, aged care accreditation system drives the risk management approach in Australian RAC services. To fully understand the risk management approach in Australian RAC services, we need to understand the aged care accreditation system and map it to the risk management approach in RAC homes.

2.3 Aged care accreditation in Australia

‘Accreditation is an internationally recognized evaluation process used in many countries to assess the quality of care and services provided in a range of areas such as health care, long term residential aged care, disability services, and non-health related sectors such as child care’ [37]. Residential aged care accreditation in Australia follows the Quality of Care Principles 1997 [36].

The accreditation follows four standards: 1. management systems, staffing and organizational development; 2. health and personal care; 3. resident lifestyle; and 4. physical environment and safe systems [32]. Each standard is measured by a series of expected accreditation outcomes. Common to all four standards are the outcomes of continuous improvement, regulatory compliance, education and staff development.

For Standard 1, ‘Management systems, staffing and organizational development’, there are nine expected outcomes: 1.1 Continuous improvement, 1.2 Regulatory compliance, 1.3 Education and staff development, 1.4 Comments and complaints, 1.5 Planning and leadership, 1.6 Human resource management, 1.7 Inventory and equipment, 1.8 Information systems and 1.9 External services [37].
For Standard 2, ‘Health and personal care Principle’ there are seventeen expected outcomes:

2.1 Continuous improvement, 2.2 Regulatory compliance, 2.3 Education and staff development, 2.4 Clinical care, 2.5 Specialised nursing care needs, 2.6 Other health and related services, 2.7 Medication management, 2.8 Pain management, 2.9 Palliative care, 2.10 Nutrition and hydration, 2.11 Skin care, 2.12 Continence management, 2.13 Behavioural management, 2.14 Mobility, dexterity and rehabilitation, 2.15 Oral and dental care, 2.16 Sensory loss and 2.17 Sleep [37].

For Standard 3, ‘Resident lifestyle Principle’, there are ten expected outcomes. They are: 3.1 Continuous improvement, 3.2 Regulatory compliance, 3.3 Education and staff development, 3.4 Emotional support, 3.5 Independence, 3.6 Privacy and dignity, 3.7 Leisure interests and activities, 3.8 Cultural and spiritual life, 3.9 Choice and decision-making and 3.10 Resident security of tenure and responsibilities [37].

For Standard 4, ‘Physical environment and safe systems Principle’, there are ten expected outcomes: 4.1 Continuous improvement, 4.2 Regulatory compliance, 4.3 Education and staff development, 4.4 Living environment, 4.5 Occupational health and safety, 4.6 Fire, security and other emergencies 4.7 Infection control, 4.8 Catering, cleaning and laundry services [37].

The continuous improvement, regulatory compliance, and education and staff development outcomes are common to all four standards.

The goal of Standard 1, management systems is to be ‘responsive to the needs of residents, their representatives, staff and stakeholders, and the changing environment in which the service operates’.
The goal for Standard 2 Health and personal care is that care recipients’ physical and mental health will be promoted and achieved at the optimum level in partnership between each care recipient (or his or her representative) and the health care team.

The goal for Standard 3 care recipient lifestyle is for care recipients retain their personal, civic, legal and consumer rights, and to be assisted to achieve active control of their own lives within the residential care service and in the community.

The goal for Standard 4 physical environment and safety systems is for residents to live in a safe and comfortable environment that ensures the quality of life and welfare of residents, staff and visitors.

Before 2014, the Australian government implemented its accreditation system through the Aged Care Standards and Accreditation Agency, Ltd, an Australian company reporting to the responsible Minister. The agency determined whether the aged care services provided by an RAC home meet the relevant safety standards. Since 2014, the Australian government has taken over the function of the agency and has directly implemented its accreditation system through a statutory agency called the Australian Aged Care Quality Agency (AACQA) [32].

2.4 Aged care accreditation drives the risk management approach in RAC services in Australia

The process of aged care accreditation starts with self-assessment of the home, followed by a desk audit, a site audit, the decision whether or not to accredit the home and the publication of the accreditation report (see Figure 2.1) [37]. Self-assessment is an internal process whereby an RAC home looks at how it does things and what it achieves. It is part of the home’s application for accreditation [37]. Desk audit is a review by the accreditation agency of the results of the self-assessment and supporting documents (including certification status),
prudential arrangements, the ratio of concessional residents and complaint matters. Site audit consists of an accreditation team enter the RAC home, interviewing residents, their families, staff and management, and auditing nursing records and organisational documents. Based on the accreditation team’s findings, any submission for the RAC home and any other relevant information, the accreditation agency will decide whether or not to accredit the home. If a home meets all the accreditation requirements, it is normally accredited for a period of three years. The accreditation report is published on the agency's website together with the agency's decision on each of the 44 outcomes. Re-application for accreditation needs to be conducted before the expiry date of the facility’s existing period of accreditation.

Accreditation Steps

1: Self-assessment is conducted by the aged care home providers.

2: Desk audit is a review of the self-assessment and supporting documents and information.

3: Site Audit is interviews with residents, their families, staff and management.

4: Team’s finding: any submission from the approved provider and any other relevant information.

5: The Accreditation Agency will decide whether or not to accredit the service.

6: Homes met or not met the 44 standards of aged care accreditations.

7: Accredited for a period of 3 years.

8: Accreditation report to be published on the Agency’s Web site.

9: Re-application before expiry of the facility’s existing accreditation.
Figure 2.1. The process of accreditation for an RAC home (Revised from Australian Aged Care Quality Agency Website: https://www.aacqa.gov.au/).

The process of aged care accreditation corresponds to the stages of identifying risks, assessing the risks and re-evaluating risks in the risk management cycle in RAC homes. This is because self-assessment, desk audit, and site audit all require the RAC homes to be concerned to identify the risk areas and risk factors [31]. The accreditation report published online, which gave the decision of the Agency about whether the home met the 44 expected outcomes or not was the verdict of the AACQA about whether the RAC service met the minimum level of standards for client safety and quality of life.

For any RAC home to pass the accreditation, they must follow a systematic risk management approach to develop and implement a risk management plan [31]. Figure 2.2 shows the risk management process in RAC homes and the contribution of aged care accreditation to this process.
1: Self-assessments are conducted by aged care providers.

(1) Identify the Risk Areas

(2) Assess the Risks

(3) Develop risk management Plans

(4) Implement risk management actions

(5) Re-evaluate the risks

9: Re-application: expiry of the facility exists periods of accreditation

2: Desk audit is a review of the self-assessment and supporting documents information.

3: Site Audit is interviews with residents, their families, staff and management.

4: Team’s finding: any submission from the approved provider and any other relevant information.

5: The accreditation agency decides whether or not to accredit the service.

6: Home met or not met the 44 standards of aged care accreditations

7: Accredited for a period of 3 years

8: Accreditation report and decision published on official web

9: Re-application: expiry of the facility exists periods of accreditation
Figure 2.2. Mapping the risk management process in RAC homes with the relevant process in Aged Care Accreditation. (Revised from Australian Aged Care Quality Agency website: https://www.aacqa.gov.au/)

2.5 The potential contributions of information systems to risk management in RAC homes

Information management is fundamental to health care delivery [39]. Effective collection and use of information in RAC services support a variety of organizational processes and purposes, including administrative, financial, regulatory compliance [33], care provision and have the potential to improve the quality and efficiency of systems of care and health outcomes [40]. Accurate and complete information about the client health status and lifestyle is important for continuity and coordination of care and minimizing the risk of adverse outcomes for older people across care settings [41]. Therefore, high-quality routinely collected data, which are fit for purpose and meaningful, are the foundation of sound client health information management.

The importance of accurate data and robust information systems is well recognized. A variety of information systems, such as a client registration system, billing system and client health record system, have been established in RAC homes. As the communication tool for exchanging information between nursing staff and with outside health service providers [42], client health record systems, either in paper or electronic format, are among the most important information systems in RAC homes that support the delivery of aged care services and risk management for client safety. Due to the limitations of paper-based record management, such as illegibility and substantial administrative burden associated with accessing, producing, storage and retrieving information from paper records, there is a trend
to introduce electronic health record (EHR) systems in Australian RAC [43], as in other health sectors.

2.5.1 The definition of aged care EHR

Based on a publication of the US Institute of Medicine, we define aged care EHR in this study as a repository of aged care service recipients’ data in digital form [44]. Aged care EHR contains retrospective, concurrent, and prospective longitudinal electronic health and aged care service information pertaining to a care recipient. EHR are generated and maintained by aged care service providers with the primary purpose of giving continuing, efficient and safe health and aged care for their clients [45, 46]. The functionality of aged care EHR may include demographic information, admission assessment, care planning, ongoing assessment, nursing charts, progress and incident reporting and medication management [26]. They are accessible by multiple authorized users.

Increasing numbers of RAC homes in Australia have been introducing EHR systems over the last decade [43]. The motives are to promote structured, consistent and effective communication between caregivers and facilitate continuity and individuality of care and safety of clients and improve the quality and efficiency of information management [47]. These changes are expected to increase the quality adjusted life years of the older people and improve health decision-making, and access to patients’ medical history. EHR systems are also expected to provide better evidence that care services meet nursing and accreditation standards, accreditation and funding requirements [48-53].

2.5.2 The benefits of EHR that have been empirically tested

Despite the potential of EHR systems to significantly improve the quality of information management in comparison with paper-based records [44, 54, 55], there are limited reports about the realised benefits of EHR in RAC. In a qualitative research study to focus-group
data collection, Cherry et al. found that the managers in long-term care homes with EHR usage experience perceived these systems to be more efficient than paper records, giving an improved quality and accuracy of documentation. They provide easier access to charts and resident care information [56]. They also improve management ability to monitor resident care activities and initiate improvement actions, and better resident outcomes related to improved documentation quality.

After using EHR systems for up to two years, care staff in nine Australian RAC homes perceived the benefits of EHR to them included quick data entry and retrieval, improved format and content of records, facilitating internal and external communication, and better understanding of residents’ requirements [43]. Unintended adverse consequences included difficulties for some staff in data entry and information retrieval, resistance to using the system, increased complexity of information management, and end user concerns about access. Reasons included the nature of the EHR systems and the ways the systems were implemented and used by nursing staff [20].

A nursing documentation audit in seven Australian RAC homes provided information on key differences between the electronic and paper record formats [48, 49]. Nursing care plans in the EHR system documented more signs and symptoms of resident problems and evaluation of care than the paper-based plans, but had a lower mean quality score. The EHR plans contained fewer problem or diagnosis statements, contributing factors and resident outcomes than the paper-based system. Both types of nursing care plan were weak in documenting measurable and concrete resident outcomes. The overall quality of documentation content for the nursing process was no better in the electronic system than in the paper-based system.
2.6 The research gap

Despite the potential of EHR to significantly improve the quality of information management in comparison with paper-based records [3, 24, 51], there are limited reports of the actual benefits of EHR in managing risks to client safety in RAC. Therefore, the first research question is:

Does the use of EHR improve the capacity of RAC homes to manage risks for client safety in comparison with using paper-based practice?

In theory, effective information systems support the provision of multi-disciplinary aged care and a variety of organizational purposes, including regulatory compliance, quality, funding, communication and continuity of care [47, 58]. Therefore, having effective information systems is one of the requirements in aged care accreditation [36]. However, the existing information systems in RAC homes were found to have poor data quality and limitations on collection, access, availability and reporting of aged care data across multiple programs and providers [8, 14, 57-59]. Therefore, if we cannot find any significant different impacts of RAC services between the RAC homes using an EHR or paper-based records, a drawback question that needs to be answered is whether an information system has any significant incremental impact on RAC services.

2.7 The data source to address the research questions

The Australian Government Department of Health collects two sets of data from the government subsidised RAC homes on regular basis: Aged Care Funding Instrument (ACFI) data and aged care accreditation data.
2.7.1 ACFI data

The Australian government routinely collected information about care needs of individual clients in RAC homes using the Aged Care Funding Instrument (ACFI) [60]. As the purpose of this data collection is for measuring the average cost of care in longer stay environments, the ACFI questions only provided basic information that is related to fundamental care need areas. This data set did not provide any indication about quality of aged care services in RAC homes; therefore, the data can not be used to address the research questions.

2.7.2 Aged care accreditation reports

The risk factors for client safety are all covered in the accreditation reports that are published on a government web site [37]. First, the aged care accreditation reports can be used to identify the reasons why an RAC home did not met the standards. For example, one home failed to meet accreditation outcome 1.8 Information systems because the information to assist nursing staff was not consistently accurate or current, and there was a lack of effective policies and procedures in information systems [31]. This home also failed accreditation outcomes 2.7 medication management, 2.8 pain management and 2.10 nutrition and hydration. The reasons for failing in accreditation outcome 2.7 medication management was ‘clinical staff do not monitor the effectiveness of medication as required and medication audits are not completed regularly and deficiencies identified are not always acted on’. ‘Assessments to monitor effectiveness of pain strategies are not always reassessed or evaluated’ is the reason why this home failed in outcome 2.8 pain management..

Three types of risk factors for client safety in RAC homes are clients’ personal health conditions, health and aged care systems serving a client and human factors regarding care staff. These risk factors are all addressed in the relevant items in the accreditation reports. These include the information about whether the risk factors are managed well (according to
the accreditation standards), or whether the RAC home failed in managing certain risk factors. Table 2.1 maps the five types of the risk factors to some of the 44 expected outcomes of aged care accreditation.

**Table 2.1.** Mapping the 44 expected outcomes of aged care accreditation to the five major types of risk factors in RAC services.

<table>
<thead>
<tr>
<th>Risk factors related to residential aged care</th>
<th>44 expected outcomes of accreditation related to safety related risk</th>
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| **Safety risk factors related to personal health conditions:**  
1: Poor health and complex chronic conditions  
2: Dying  
3: Some inclined towards self-harm  
4: Depression  
5: Poor mobility  
6: Disability  
7: Allergy and mental health issues | 1.6 Human resource management  
1.8 Information systems  
2.2 Regulatory compliance  
2.3 Education and staff development  
2.4 Clinical care  
2.5 Specialised nursing care needs  
2.6 Other health and related services  
2.7 Medication management  
2.8 Pain management  
2.9 Palliative care  
2.11 Skin care  
2.13 Behavioural management  
2.14 Mobility, dexterity and rehabilitation  
2.15 Oral and dental care  
2.16 Sensory loss  
2.17 Sleep  
4.7 Infection control |
| **Safety Risk factors related to health and aged care systems:**  
1: Power failure  
2: EHR system was not accessible  
3: System errors from EHR  
4: Difficult to use the functions  
5: Not familiar with the system and misuse of the system | 1.3 Education and staff development  
1.7 Inventory and equipment  
1.8 Information systems  
2.3 Education and staff development  
2.4 Clinical care  
2.7 Medication management  
3.3 Education and staff development |
| **Safety risk factors related to the unique environment in RAC homes:**  
1: Lack of communication between nursing staff and residents or between health and aged care staff.  
2: Lacking of communication between a pharmacy and a residential aged care facility  
3: Unhealthy or unclean food, system failure and errors in RAC homes  
4: Inappropriate or wrong methods in treatment, nursing care, meal services | 1.5 Planning and leadership  
1.7 Inventory and equipment  
1.8 Information systems  
1.9 External services  
2.10 Nutrition and hydration  
4.4 Living environment  
4.5 Occupational health and safety  
4.6 Fire, security and other emergencies  
4.7 Infection control  
4.8 Catering, cleaning and laundry services |
and communication.

<table>
<thead>
<tr>
<th>Safety Risk factors in both RAC homes and other healthcare settings:</th>
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<tbody>
<tr>
<td>1: Wrong drug</td>
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<td>2: Wrong dose</td>
</tr>
<tr>
<td>3: Wrong formulation</td>
</tr>
<tr>
<td>4: Wrong route</td>
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<tr>
<td>5: Wrong strength</td>
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<tr>
<td>6: Wrong timing</td>
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<tr>
<td>7: Procedural failure: medication label, patient identification, medication chart, body mass index are often misread and misidentified</td>
</tr>
<tr>
<td>8: Nursing care processes prone to error: checking and preparation, witness administration, infusion pump set up, dangerous drug register and sign medication chart.</td>
</tr>
<tr>
<td>9: Inappropriate use of complex technologies</td>
</tr>
</tbody>
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<table>
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<tr>
<th>Human factors for client safety in health and aged care systems:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Lack of knowledge</td>
</tr>
<tr>
<td>2: Lack of work experience</td>
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<tr>
<td>3: Lack of training</td>
</tr>
<tr>
<td>4: Lack of acknowledgement</td>
</tr>
<tr>
<td>5: Unfamiliar or unknown situation</td>
</tr>
<tr>
<td>6: Negligence in care (depression, lack of time)</td>
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</table>

The limitations of collecting data from the aged care accreditation reports to address the research questions are that is a document for the purpose of delivering funding to the homes providing RAC services. The Aged care accreditation reports only provide a verdict about
whether a RAC service meets the minimum safety and quality of care standards for clients, and the rationale for the verdict. Therefore, no difference in quality of RAC services can be inferred from the accreditation reports once an RAC home has met all standards. In other words, meeting all standards only provides indication that all aspects of the RAC services are up to the minimum standard required by the accreditation agency, it does not provide indication about the level of quality once the minimum standard has been reached. There is gap in evidence about (1) in comparison with paper-based records, whether using EHR as information systems can significantly improve the potential of an RAC home to manage risks for client safety, thus improving their ability to meet other accreditation outcomes. If the answer is not, then we need to understand (2) whether there is any relationship between an RAC home’s accreditation performance in information systems and in other areas; from this, we can infer the impact of information systems to risk management for client safety in RAC homes.

2.6 Methods to extract the relevant information in accreditation reports to address the research questions

Text mining refers to the process of deriving high-quality information from text [70]. Text mining uses techniques from natural language processing, knowledge management, data mining and machine learning to efficiently process large collection of documents in order to support information retrieval, document classification, information extraction, terminology extraction, named entity recognition, etc [70, 71]. Text data mining include: text segmentation, summary extraction, feature selection, term association, cluster generation, topic identification, and information mapping [71]. Text segmentation is the process of dividing the written text into meaningful units [70, 72]. Concept mining is an activity that results in the extraction of concepts from artifacts [70, 72].
Solutions to the task typically involve aspects of artificial intelligence and statistics, such as data mining and text mining [70, 71]. Document clustering is an automatic document organization, topic extraction and fast information retrieval or filtering [70, 71, 73, 74]. Automatic summarization is the process of reducing a text document with a computer program in order to create a summary that retains the most important points of the original document [70]. Sentiment analysis refers to the use of natural language processing, text analysis and computational linguistics identify and extract subjective information in source materials [70]. Information mapping is a research-based method used to analyze, organize and present information based on the audience’s needs and the purpose of the information [70].

Text mining is widely used for deriving high-quality information, such as the meanings of patterns and trends, from text [70]. The process of text mining involves structuring the input text, deriving patterns within the structured data, and finally the evaluation and interpretation of the output [71]. From the literature we can see that text data mining has advantages in reducing churn, improving the management of promotions, increasing visibility, increasing productivity, improving product development and refinement [70-75].

Because text mining can be used to find content based on semantic, we used this technology to identify a group of aged care homes, which do not meet the Aged Care Accreditation standards, and to analyse the relationship between the use of EHR and the standards being met. Firstly, RAC reports are highly structured and formatted; so that using text mining can help to extract relevant information. Secondly, we used text mining to identify keywords and the linked semantics. For example, we extracted the content before and after the keyword "not met" to identify the possible reason for RAC homes failed accreditation. Furthermore, text mining technology can be used to identify a group of aged care homes which have not met the Aged Care Accreditation standards. Text mining software can also be used to build
large dossiers of information about specific events [73]. The number of RAC reports is huge; it is unreasonable to go through each individual report. Thus, large datasets based on data extracted from Aged Care Accreditation reports can be easily organised into the database and can be analysed using existing software. However due to the specificity of RAC, manually intervention is required.

References


Chapter 3. Impact of Electronic Health Records on Risk Management of Information Systems


Jiang, T, Yu, P, Hailey, D, Ma, J, Yang, J 2016, ‘The Impact of Electronic Health Records on Risk Management of Information Systems in Australian Residential Aged Care Homes’
Abstract

Objective(s): To obtain indications of the influence of electronic health records (EHR) in managing risks and meeting information system accreditation standard in Australian residential aged care (RAC) homes. The hypothesis to be tested is that the RAC homes using EHR have better performance in meeting information system standards in aged care accreditation than their counterparts only using paper records for information management.

Method: Content analysis of aged care accreditation reports from the Aged Care Standards and Accreditation Agency produced between April 2011 and December 2013. Items identified included types of information systems, compliance with accreditation standards, and indicators of failure to meet an expected outcome for information systems. The Chi-square test was used to identify difference between the RAC homes that used EHR systems and those that used paper records in not meeting aged care accreditation standards.

Results: 1,031 (37.4%) of 2,754 RAC homes had adopted EHR systems. Although the proportion of homes that met all accreditation standards was significantly higher for those with EHR than for homes with paper records, only 13 RAC homes did not meet one or more expected outcomes. 12 used paper records and nine of these failed the expected outcome for information systems. The overall contribution of EHR to meeting aged care accreditation standard in Australia was very small. Risk indicators for not meeting information system standard were no access to accurate and appropriate information, failure in monitoring mechanisms, not reporting clinical incidents, insufficient recording of residents’ clinical changes, not providing accurate care plans, and communication processes failure.

Conclusion: The study has provided indications that use of EHR provides small, yet significant advantages for RAC homes in Australia in managing risks for information
management and in meeting accreditation requirements. The implication of the study for introducing technology innovation in RAC in Australia is discussed.

**KEYWORDS:** Electronic health records, information system, residential aged care, nursing home, long-term care, accreditation, nursing documentation, risk management.

**Introduction**

Despite the potential of electronic health records (EHR) to significantly improve the quality of information management in comparison with paper-based records [1-3], there are limited reports of the actual benefits of EHR for information management in residential aged care. In a qualitative research study with focus-group data collection, Cherry et al. found that the managers in long-term care homes with EHR usage experience perceived these systems to be more efficient than paper records, giving improved quality and accuracy of documentation. They provide easier access to charts and resident care information [1]. They also improve management ability to monitor resident care activities and initiate improvement actions, and better resident outcomes related to improved documentation quality.

Based on a publication of the US Institute of Medicine, we define aged care EHR in this study as a repository of aged care service recipients’ data in digital form [2]. Aged care EHR contains retrospective, concurrent, and prospective longitudinal electronic health and aged care service information pertaining to a care recipient. They are accessible by multiple authorized users. EHR are generated and maintained by aged care service providers with the primary purpose of giving continuing, efficient and safe health and aged care for their clients [4,5]. The functionality of EHR may include demographic information, admission assessment, care planning, ongoing assessment, nursing charts, progress and incident reporting care planning, medication management, ongoing assessment, nursing charts, progress and incident reporting[6].
Residential aged care (RAC) homes in Australia are similar to long-term care (LTC) homes in the USA. They are facilities that offer 24-hour nursing supervision and a range of medical, nursing, personal and social services to meet the needs of chronically ill or disabled individuals.

Increasing number of RAC homes in Australia and the United States have been introducing EHR systems over the last decade. The reasons are to standardise the structure and process of client record keeping, and improve the quality and efficiency of information management. These changes are expected to increase the quality adjusted life years of the older people and improve health decision-making, and access to patients’ medical history, EHR systems should also provide better evidence that care services meet nursing and accreditation standards and legal requirements [7-12].

After using EHR systems for up to two years, care staff in nine Australian RAC homes perceived the benefits of EHR to them include quick data entry and retrieval, improved format and content of records, facilitating internal and external communication, and better understanding of residents’ requirements [5]. Unintended adverse consequences included difficulties for some staff in data entry and information retrieval, resistance to using the system, increased complexity of information management, and end user concerns about access. Reasons included the nature of the EHR systems and the ways the systems were implemented and used by nursing staff [13].

A nursing documentation audit in seven Australian RAC homes provided information on key differences between the electronic and paper record formats [7, 8]. Nursing care plans in the EHR system documented more signs and symptoms of resident problems and evaluation of care than the paper-based plans, but had a lower mean quality score. The EHR plans contained fewer problem or diagnosis statements, contributing factors and resident outcomes
than the paper-based system. Both types of nursing care plan were weak in documenting measurable and concrete resident outcomes. The overall quality of documentation content for the nursing process was no better in the electronic system than in the paper-based system.

However, despite the potential of EHR to significantly improve the quality of information management in comparison with paper-based records [10, 14, 15], there are limited reports of the actual benefits of EHR in RAC. Therefore, the aim of this study was to identify any differences in meeting aged care accreditation requirements between the RAC homes that used EHR for information management and those that used paper records. The hypothesis to be tested is that the RAC homes using EHR have better performance in meeting information system standards in aged care accreditation than those that use paper records for information management. This analysis will help us understand the contribution of EHR in managing risks for information management in Australian residential aged care (RAC) homes.

**Aged care accreditation in Australia**

The Australian government implements a comprehensive accreditation system through the Australian Aged Care Quality Agency (AACQA), which determines whether the aged care services provided by an RAC home meet the relevant safety standards. AACQA commenced operation in 2014, superseding the Aged Care Standards and Accreditation Agency (ACSAA).

The accreditation process in Australia involves self-assessment by RAC homes against the accreditation standards and the submission of an application for accreditation. This is followed by a desk audit and a site audit by a team of registered aged care quality assessors. A person is only qualified as a registered aged care quality assessor after completing approved training and orientation of aged care accreditation [16]. When auditing an RAC home, the assessors are required to observe the Code of Conduct and to have no pecuniary or other interest that may conflict with a proper audit [16]. Given the high standards of
performance and integrity required in aged care accreditation, the report produced by the assessors after a site visit is treated as valid and reliable official report of the AACQA. A decision about the home’s accreditation, either meeting or not meeting the standards, is then made by AACQA based on the self-assessment by the RAC home, desk audit and site audit. Finally, an accreditation certificate is issued, as well as the accreditation report.

According to the Australian Aged Care Act [17], RAC homes are required to meet the accreditation standards at all times and ensure the safe care of residents. When a home fails to meet the standards, AACQA may put the home on a timetable for improvement (TFI), which sets out the required improvements and the maximum time allowed for addressing those expected outcomes that were not met. By the end of the timetable, the AACQA will arrange for assessors to conduct a review audit. If the standards are still not met, the home’s accreditation will be varied or revoked. The Department of Health may also decide to impose sanctions on the home. Therefore, meeting aged care accreditation standards is the basic safety requirement imposed by the Australian government on an RAC home in aged care service provision.

There are four RAC accreditation standards in Australia: 1- Management systems, staffing and organizational development; 2- Health and personal care; 3- Care recipient lifestyle; and 4- Physical environment and safe systems [18]. Each standard includes a series of expected outcomes. There are 44 of these outcomes across the four standards with which an RAC home must comply at all times in order to meet accreditation requirements [19]. Common to all four standards are the outcomes of continuous improvement, regulatory compliance, education and staff development. The Principle of Standard One is to be responsive to the needs of residents, their representatives, staff and stakeholders, and the changing environment in which the service operates. The six outcomes that are specific to Standard One are comments and complaints, planning and leadership, human resource management, inventory
and equipment, information systems and external services. The requirement for outcome 1.8, information systems, which was a focus for this study, is that ‘Effective information management systems are in place’.

The publicly available RAC accreditation reports provide the most objective and authoritative information on whether an RAC home meet the accreditation outcome of 1.8 information systems. The reports also contain information about the type of records used in an RAC home, being EHR or a paper records-based system. By analyzing the information in Section 1.8 of the accreditation reports, it is possible to infer which indicators of ‘effective information management systems’ were used by the accreditation agency and whether these had differed between RAC homes that used EHR and those that had paper-based records. Therefore, our approach to address the research question was to conduct a comprehensive analysis of Australian aged care accreditation reports.

**Methods**

We followed a four-step process to extract and analyze data from these reports: data sourcing and processing, data cleaning, data restructuring and labelling, and analysis.

**Data sourcing and processing**

Data were sourced from the web site of the Aged Care Standards and Accreditation Agency in December 2013. We downloaded 2,754 aged care accreditation reports that were produced from 27 April 2011 to 3 December 2013.

We converted the original reports in PDF format to computer-program readable text formats (e.g. .txt files) using software Adobe Acrobat Pro. We extracted the relevant sections in all reports, including 44 expected accreditation outcomes (Figure 3.1a) and Outcome 1.8 Information Systems (Figure 3.2a) into text files (Figures 3.1b and 3.2b).
### Most recent decision concerning performance against the Accreditation Standards

**Standard 1: Management systems, staffing and organisational development**

**Principle:**
Within the philosophy and level of care offered in the residential care service, management systems are responsive to the needs of residents, their representatives, staff and stakeholders, and the changing environment in which the service operates.

<table>
<thead>
<tr>
<th>Expected outcome</th>
<th>Accreditation Agency decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Continuous improvement</td>
<td>Met</td>
</tr>
<tr>
<td>1.2 Regulatory compliance</td>
<td>Met</td>
</tr>
<tr>
<td>1.3 Education and staff development</td>
<td>Met</td>
</tr>
<tr>
<td>1.4 Comments and complaints</td>
<td>Met</td>
</tr>
<tr>
<td>1.5 Planning and leadership</td>
<td>Met</td>
</tr>
<tr>
<td>1.6 Human resource management</td>
<td>Met</td>
</tr>
<tr>
<td>1.7 Inventory and equipment</td>
<td>Met</td>
</tr>
<tr>
<td>1.8 Information systems</td>
<td>Not met</td>
</tr>
<tr>
<td>1.9 External services</td>
<td>Met</td>
</tr>
</tbody>
</table>

---

**Figure 3.1a**- An example of the expected accreditation outcomes for Standard 1 in the original accreditation report in PDF format.
The first author manually compared the converted text files with the original PDF documents for 2,754 reports. The incorrect character encoding was concentrated on list characters like ‘•’ in PDF format. These were converted to ‘?’ or ‘????’ in txt format. Otherwise, the errors did not influence reading the content.

Data restructuring and labelling

Data were labeled according to two criteria: failing to meet one or more aged care accreditation outcomes, and using some form of EHR. First we identified the RAC homes that
failed to meet one or more aged care accreditation outcomes by searching the content such as that presented in Table 1b using the key word ‘not met’.

To identify the RAC homes that used an EHR system and those used paper records, first we read through 50 copies of the accreditation reports and found that different terms were used to describe an electronic record system. Based on the terms we identified, we developed a list of keywords that was used to identify whether an RAC home used an EHR system or paper records. They included *electronic clinical plan, electronic clinical documentation, electronic clinical information, electronic documentation, electronic care plan, electronic care documentation, electronic care information and electronic health record*.

We scanned section 1.8 Information Systems in the reports (see Figure 2b), and a list of documents that an RAC home submitted to the accreditation agency for desk audit. Based on this, we used a program to automatically structure the name of an RAC home (from document name), frequency of matching the keywords and details of matching (e.g. 30 characters before and after each keyword) into an Excel spreadsheet (Table 1). The reliability of the labels in Table 1 was further validated by manual checking against the original documents.
Table 3.1. An example of the list of RAC homes that matched keywords ‘electronic care plan’

<table>
<thead>
<tr>
<th>Homes</th>
<th>Matching times</th>
<th>Details of matching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Valley</td>
<td>1</td>
<td>…uality improvement plan 2012 Contractor database Electronic care planning, assessment and documentation program Emergen…</td>
</tr>
<tr>
<td>Sunset Village</td>
<td>2</td>
<td>…tion calendar, attendance and evaluation records Electronic care planning system Emergency evacuation plans and… … evaluation, care plans are now completed on the electronic care planning system. Clinical staff are satisfied the …</td>
</tr>
<tr>
<td>Smith House</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Afterwards, we aggregated all RAC homes into four groups: Group 1 – meeting all accreditation standards and using EHR, Group 2 – meeting all accreditation standards and using paper records, Group 3 – not meeting one or more accreditation standards and using EHR, and Group 4 – not meeting one or more accreditation standards and using paper records.

Data analysis

Both quantitative and qualitative data analyses were conducted in this study. Pearson’s Chi-square test was used to identify differences between the four groups of the RAC homes those that used EHR systems or used paper records in meeting or not meeting aged care accreditation standards. The level of significance was set at $p = 0.05$.

Qualitative content analysis was conducted to identify and classify the indicators for not meeting accreditation Outcome 1.8 Information Systems. This enabled us to identify the statements that described the reasons for failing to meet this outcome. We compared these
statements with the contributions of EHR to residential aged care suggested by the previous studies.

Results

Thirteen RAC homes were found to not meet one or more accreditation standards. These RAC homes and the relevant accreditation outcomes that at least one RAC home did not meet are listed in Table 2.

Table 3.2. The accreditation outcomes that at least one of 13 RAC homes did not meet (Red cell: not meet an expected accreditation outcome).

<table>
<thead>
<tr>
<th>RAC Home</th>
<th>Expected Accreditation Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.1 1.2 1.3 1.4 1.6 1.8 2.1 2.3 2.4 2.5 2.6 2.7 2.8 2.10 2.11 2.12 2.13 2.14 2.16 3.1 3.2 3.4 3.6 4.1 4.4 4.5 4.6 4.7 4.8</td>
</tr>
<tr>
<td>2</td>
<td>Red cell</td>
</tr>
<tr>
<td>3</td>
<td>Red cell</td>
</tr>
<tr>
<td>4</td>
<td>Red cell</td>
</tr>
<tr>
<td>5</td>
<td>Red cell</td>
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<tr>
<td>6</td>
<td>Red cell</td>
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<tr>
<td>7</td>
<td>Red cell</td>
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<tr>
<td>8</td>
<td>Red cell</td>
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<td>9</td>
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<td>10</td>
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<tr>
<td>11</td>
<td>Red cell</td>
</tr>
<tr>
<td>12</td>
<td>Red cell</td>
</tr>
<tr>
<td>13</td>
<td>Red cell</td>
</tr>
</tbody>
</table>

Difference in meeting accreditation standards between RAC homes using EHR and those using paper records

Of the 2,754 RAC homes audited, 1,031 (37.4%) used an EHR system for client health and personal care information management and 1,723 (62.6%) used only paper records. Only 13 homes (0.5%) failed to meet one or more of the 44 accreditation outcomes. One of these homes used an EHR system and met requirements for Outcome 1.8. Of the twelve homes that used paper records, nine failed in Outcome 1.8 (see Figure 3).
Figure 3.3. An outline of the RAC homes that used EHR or paper records, met or did not meet the accreditation outcomes, and whether they met or did not meet the accreditation Outcome 1.8 Information Systems

The result of the Chi square test suggested that the proportion of RAC homes using EHR that met accreditation standards (99.9%) was significantly higher than that of their counterparts using paper records (99.3%, p = 0.026).

Risk indicators for failure to meet Outcome 1.8 Information Systems

Six risk indicators were identified in the reports for the nine RAC homes using paper records that failed to meet the information system outcome (Table 3). Staff in six homes did not have access to accurate and appropriate information (R1). Monitoring mechanisms were not effective in identifying deficiencies in information systems in four homes (R2). Two homes did not always report clinical incidents (R3). There were insufficient records of residents’ clinical changes in two homes (R4). One home failed to produce accurate care plans (R5) and one home’s communication processes were not effective (R6). These deficiencies led the agency to conclude that these RAC homes did not have effective information systems.
Table 3.3. Risk indicators in reports for RAC homes using paper records that failed the information system outcome.

<table>
<thead>
<tr>
<th>Homes</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>F</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H2</td>
<td>F</td>
<td></td>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H3</td>
<td>F</td>
<td>F</td>
<td></td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>H4</td>
<td></td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H5</td>
<td>F</td>
<td>F</td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H6</td>
<td></td>
<td>F</td>
<td></td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H7</td>
<td></td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H8</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H9</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

F = Fail information system accreditation outcome. R1: No access to accurate and appropriate information. R2: Monitoring mechanisms were not effective in identifying deficiencies in information systems. R3: Not reporting clinical incidents. R4: Insufficient recording of residents’ clinical changes. R5: Not providing accurate care plans. R6: Communication processes were not effective.

Discussion

This study aimed at identifying the contribution of EHR to managing risks for information system accreditation in RAC homes. We found that EHR systems had already been adopted by 37.4% of 2754 RAC homes. Thirteen RAC homes did not meet all expected outcomes in the Australian standards. Of these, nine out of 12 that used paper-based records failed the outcome for information systems. Through analysis of the records for these nine homes, we identified six risk indicators in information systems, which were used by the accreditation agency to decide that the information system accreditation outcome had not been met. This provided insight about the areas of information system management to which RAC homes may need to pay attention and continuously improve.

The study findings indicate that the overall contribution of EHR to meeting aged care accreditation standards in Australia was very small. Only 9 (0.3%) RAC homes failed the information system outcome. This may cause stagnation in the adoption of EHR by the rest
62.6% of RAC homes that were still using paper records by the end of 2013. The further adoption of EHR in Australian RAC sector needs to be continuously followed. However, none of the RAC homes that used EHR for information management failed to meet that outcome. Also, the proportion of RAC homes using EHR that met all accreditation standards was significantly higher than that of homes with paper records.

The aged care accreditation system in Australia is established to ensure an RAC service meets the minimum safety standard mandated by the Aged Care Act. It is not a quality ranking system, such as a star ranking system for e-Bay, which is available to the general public, thus providing the pressure and incentive for the aged care service providers to improve services. This explains why only 0.3% of RAC homes in this study failed the standard. Therefore, there is a lack of policy incentive for RAC homes in Australia to further improve quality once the minimum safety standard audited by the aged care accreditation system is met. This may cause inertia in the whole sector and stagnation in innovation, which needs to be further confirmed and studied.

Nevertheless the strength of this study is that it had the advantage of a nationwide overview of the performance of Australian RAC homes in information management and the possible contribution of EHR to this process. We believe it provides some indication of the benefits from EHR in RAC, consistent with those found in previous studies using other methods [21,20,7,8,22].

An inevitable limitation is that what we have reported is an association between EHR and accreditation, rather than decisive evidence that use of EHR is a reason for RAC homes to perform better in accreditation. Also, the sample size for detailed analysis of risk factors for failing to meet accreditation standards is small. Another limitation of the study is it does not
provide information on practice details of the sort obtained from observational studies with small numbers of homes.

**Conclusion**

This study identified six risk indicators for an RAC home to fail the information system accreditation standard in Australia. While a small number of RAC homes that used paper records failed accreditation standard on information systems, those that used EHR fully complied.

**Key points:**

- The proportion of RAC homes that met accreditation standards was significantly higher for those with EHR than for homes with only paper records.
- Six risk indicators for an RAC home to fail the information systems outcome were identified.

**References**


Chapter 4. Relationship between Using Electronic Health Records and Meeting Accreditation Standards


Abstract

This study aims to identify the benefits of using electronic health records (EHR) for client safety in residential aged care (RAC) homes. The aged care accreditation reports published between 27 April 2011 and 3 December 2013 were downloaded and analysed. It could be seen from these reports that only 1,031 (37.4%) RAC homes in Australia had adopted an EHR system by 2015. 15 RAC homes failed one or more accreditation standards. Only one of these was using an EHR system and this one met the accreditation standards on information systems. Our study provides empirical evidence to suggest that adopting and using EHR can be one of the effective organizational mechanisms to meeting accreditation standards in RAC homes.

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Abstract.

This study aims to identify the benefits of using electronic health records (EHR) for client safety in residential aged care (RAC) homes. The aged care accreditation reports published between 27th April 2011 and 3rd December 2013 were downloaded and analyzed. It could be seen from these reports that only 1,031(37.45%) RAC homes in Australia had adopted an EHR system by 2013. 13 RAC homes failed one or more accreditation standards. Only one of these was using an EHR system and this one met the accreditation standards on information systems. Our study provides empirical evidence to suggest that adopting and using EHR can be one of the effective organizational mechanisms to meeting accreditation standards in RAC homes.

Keywords. Electronic health records, EHR, nursing documentation, safety, risk, residential aged care, long term care, nursing home

Introduction

According to the International Organization for Standardization (ISO), EHR is a repository of patient data in digital form, stored and exchanged securely, and accessible by multiple authorized users. It contains retrospective, concurrent, and prospective information and its primary purpose is to support continuing, efficient and quality integrated healthcare [1]. Many residential aged care (RAC) homes have introduced electronic health record (EHR) systems [2] to standardize the structure and process of nursing documentation in order to improve the quality and efficiency of documentation, to comply with nursing and accreditation standards and to meet legal requirements [2].

Although there appears to be a high potential for EHR to contribute to improving client safety in aged care, empirical evidence is required in order to validate this claim. Previous studies
have found a number of benefits of EHR, which may indirectly contribute to resident safety [3-6]: They can provide health care workers with faster access to enter data and retrieve health information than traditional paper based records [7], a benefit that is particularly useful in emergency situations [5]. They can improve communication between nurses and residents and among care staff, facilitate compliance with nursing procedure and improve efficiency in information management and education [2]. An EHR system that integrates decision support functions and guidelines can provide support for treatment and care [7]. It can also provide easy access to test results in order to alert nurses to possible risks to residents’ health [8]. An EHR system with an alert function about adverse drug interactions can reduce medication errors [9]. This study aims to provide the empirical evidence necessary to validate the relationship between EHR and client safety.

The Australian government implements its accreditation system through the Aged Care Standards and Accreditation Agency, Ltd, an Australian company limited by guarantee by the Minister for Mental Health and Ageing [10]. Accreditation is the internationally recognized evaluation process used in many countries to assess the quality of care [10]. Accreditation reports provide a relatively comprehensive and authoritative coverage of the performance of an RAC home by auditing whether the aged care services in the home meet the safety standard established by the Australian government [11]. The accreditation standards in Australia are detailed in the Quality of Care Principles 1997 [10]. According to the Australian Institute of Health and Welfare, the definition of safety is “avoidance or reduction to acceptable limits of actual or potential harm from health care management or the environment in which health care is delivered” [12]. Homes which want to pass aged care accreditation are required to have: effective information management systems, accurate and appropriate or required information, timely information, monitoring mechanisms, an evaluation system to monitor changes, and an appropriate care plan. It must be able to
identify gaps in resident care and/or in the communication process [11]. As these factors are all related to client safety, this enabled this study to use the results of aged care accreditation reports as indicators as to whether the aged care services in an RAC home are safe or not.

**Materials and methods**

This study takes the approach of secondary research using the published aged-care accreditation reports at the website of the Aged Care Accreditation Agency (www.accreditation.org.au). The primary accreditation reports were produced between 27th April 2011 and 3rd December 2013.

In order to identify whether an RAC home had one or more items which failed to meet accreditation standards, the key words ‘not met’ were used to search each report.

In order to identify whether an RAC home used EHR or not, the following key words were used in Section 1.8. Information Systems. In the documents an RAC home submitted to the Accreditation Agency the search terms used were: ‘electronic clinical plan’, ‘electronic clinical documentation’, ‘electronic clinical information’, ‘electronic documentation’, ‘electronic care plan’, ‘electronic care documentation’, ‘electronic care information’ and ‘electronic health record’.

In order to aggregate the information, the reports were grouped into four categories: met all the standards and used EHR, met all the standards but did not use EHR, did not meet the standards but used EHR, and did not meet the standards and did not use EHR.

A chi square test was used to identify whether there was a statistically significant difference in meeting accreditation standards among the above four groups of RAC homes. SPSS version 21.0 (SPSS inc., Chicago, IL, USA) was used to conduct the analysis. A detailed in-text analysis was conducted on the RAC homes that did not meet one or more accreditation standards.
Results

The difference in meeting accreditation standards between the RAC homes that used an EHR system and those which only used paper records

2,741(99.5%) of the 2,754 RAC reports which were audited by the accreditation agency during the period of January 2nd to December 3rd, 2,013 met the 44 accreditation standards. Of them, 1,031(37.4%) used an EHR system for client health and personal care information management. The remaining 1,710(62.59%) used paper for information management.

Only 13 (0.5%) RAC homes failed to meet one or more accreditation outcomes, and only one (7.7%) of these 13 RAC homes used an EHR system for client health and personal care information management. The remaining 12 (92.3%) of the 13 RAC homes relied on paper-based systems. The result of a Pearson Chi-Square test shows that the RAC homes that had EHR in place were significantly more likely to meet accreditation standards than those that did not (p = 0.026). This evidence supports the claim that EHR can contribute to meeting aged care accreditation standards.

The accreditation outcomes that the RAC home that used EHR fail to meet and the reasons for the failure

Although the only RAC home using an EHR system failed to meet more than one accreditation outcomes, it did not fail in information systems, but in Accreditation Outcome 1.6 Human Resource Management and Outcome 2.4 Clinical Care.

The reason for the first failure was that the management had difficulty replacing staff on sick-leave or absence, causing a lack of adequately and appropriately skilled and qualified staff. The reason for the second failure might also relate to their deficiency in human resource management because of a lack of effective mechanisms to monitor staff work practices.
The accreditation outcomes that 12 RAC homes that only used paper records failed and the reasons for the failure

Of the 12 RAC homes that used paper records, nine failed in Accreditation Outcome 1.8 Information Systems. Six failed in 2.4 Clinical Care, 2.7 Medication Management, or 2.13 Behavioral Management. Five failed in 2.8 Pain Management or 2.10 Nutrition and Hydration. There were also six homes which failed in 1.6 Human Resource Management.

The three homes that failed to meet certain accreditation outcomes but met the standard on information systems all failed 2.13 Behavioral Management. In addition, one home failed other two outcomes: 2.4 Clinical Care and 2.8 Pain Management.

For the nine RAC homes that failed Accreditation Outcome 1.8 Information Systems, five also failed in 1.6 Human Resource Management, or 2.4 Clinical Care, or 2.7 Medication Management, or 2.10 Nutrition and Hydration, or 2.13 Behavioral Management. Four homes failed in 2.8 Pain Management.

The reasons for these failures are a lack of effective information management, accurate, appropriate or required information, and inappropriate care planning. The required information was not provided in time. A lack of an effective evaluation system fails to monitor changes in residents' health status in time. One home did not complete incident reports, or failed in monitoring mechanisms and audit systems. Some homes could not identify gaps in resident care or communication process failure.

The inferior practices identified for the RAC homes that used an EHR system and met the accreditation standards.

1,030 RAC homes that used an EHR system did meet age care accreditation standards. Three (0.29%) of these homes, however, received negative comments about performance. One of them was requested to develop and implement effective monitoring systems, suggesting the
usage of EHR did not automatically improve the monitoring mechanism in an RAC home. Some inferior practices were identified in RAC homes that used paper records and met the accreditation standards.

There were 1,698 RAC homes which used paper records and met aged care accreditation standards. Ten of these homes, however, were requested to improve their monitoring mechanisms. It appears that more RAC homes (0.58%) that used paper did not have effective monitoring mechanisms than their peers which used an EHR system (0.10%). The possible reason is that the ‘alert’ functions in the common commercial EHR systems designed for RAC can effectively remind the nursing staff about the timeline for the re-assessment of healthcare needs of a resident and the development of new care plans. This overcomes the challenges in monitoring residents’ health status and does so better than paper-based systems.

**Discussion**

This research has synthesized the results of 2754 accreditation reports published between 27\textsuperscript{th} April 2011 and 3\textsuperscript{rd} December 2013 in order to identify the potential relationship between use of EHR and resident safety. We found that EHR systems had already been adopted as information systems by 37.4% of RAC homes in Australia by 3\textsuperscript{rd} December 2013. The RAC homes which had adopted EHR were significantly less likely to fail the accreditation standards. This provides the empirical evidence to support our proposition that EHR contributes to resident safety.

Paper-based nursing documentation is time-consuming and records are often illegible. Often, data must be entered several times, and this has the potential to cause inconsistency and/or error. It is also not easy to retrieve or update such data. Such difficulties have been identified as a major cause of stress and dissatisfaction among nurses in aged care [1]. These challenges might also be the root cause for the failed performance in information management by the
RAC homes that used a paper-based information system. For example, inaccurate and inappropriate information might be caused by inadequate information capture, which would hinder nursing judgment and cause inappropriate care planning. The substantially better performance in aged care accreditation by RAC homes that used EHR suggests that many problems associated with paper-based records can be resolved by the use of well-designed EHR systems.

The literature shows that EHR systems have great potential to mitigate or avoid risk factors and enhance client safety [3-6]. For example, the ability to quickly enter and retrieve data at multiple computers scattered over an aged care facility will motivate busy nursing staff to enter more data [1], and this will lead to an improvement in the accuracy and timeliness of information. This will again lead to an information system that can provide more accurate feedback, and improve communication among care staff. An alert in an EHR system can remind nursing staff of changes in resident status and help them to follow up with these changes. These benefits will obviously facilitate compliance with nursing procedure and improve efficiency in information management and education.

The limitation of this study was the nature of any secondary study, with all the findings drawn from analysis of Aged Care Accreditation reports. We can only identify information about whether an EHR system was used in an RAC home in the accreditation reports, but we cannot ascertain the nature and extent of usage of the EHR system by nursing staff. As only 13(0.5%) of the RAC homes failed the accreditation standard, the relationship between the use of EHR systems and the quality of aged care services cannot be determined by evidence collected from this information source alone.
Conclusion

There is a paucity of research evidence on the impact of EHR on the performance of RAC homes. By synthesizing the accreditation results of 2,754 RAC homes between 27th April 2011 and 3rd December 2013, this study has proved that the use of EHR can improve the opportunity for an RAC home to meet accreditation standards for information systems. Although the quality of aged care is determined by strategies used in many different areas of the home, our research suggests that the use of EHR can contribute greatly to quality care.

References

Chapter 5. Relationship between Failing the Accreditation Outcomes for Information Systems and Failing Other Outcomes

Abstract

**Purpose:** To investigate the relationship between failing accreditation outcome for information systems and failing other accreditation outcomes in Australian residential aged care (RAC) homes.

**Methods:** We analysed 45 aged care accreditation reports produced between 7th March 2011 and 25th March 2015 that recorded failure of at least one of the 44 accreditation outcomes in RAC services. We grouped the reports into four categories according to two criteria: (1) whether the home used electronic health records (EHR) or paper records, and (2) whether the home failed or passed the information systems outcome. Statistical data analysis was conducted to find whether there was any significant difference in failure of meeting other accreditation outcomes between the RAC homes using EHR and those using paper records. A data mining apriori (Weka 3.6) was used to identify any significant association between failing the information systems outcome and failing other accreditation outcomes. Qualitative content analysis was conducted on these accreditation reports to understand why an RAC home had failed a specific accreditation outcome.

**Results:** There was no significant difference in failing other accreditation outcomes between the RAC homes using EHR and those using paper records. Information systems, clinical care and medication management were the three outcomes that the RAC homes were most likely to fail. The 19 RAC homes that met the information systems outcome failed an average of 2 other accreditation outcomes. This was significantly less than the average failure of 7 other outcomes for 26 homes which failed the information systems outcome (p < 0.01). There were significant positive associations (p < 0.05) between failing the information systems outcome and failing two other outcomes: staff education and development, and clinical care.
Qualitative analysis indicated that ineffective monitoring mechanism was a key criterion for failure in many accreditation outcomes.

Conclusions: The study findings suggest that although using EHR made no significant difference in meeting other accreditation outcomes in an RAC home, better information systems contribute to improved overall performance in meeting aged care accreditation requirements. This may include improving monitoring mechanism, an important indicator of risk management. A number of accreditation failures appeared to be linked to organisational deficiencies that could be improved by use of more effective information systems.

Key words: Electronic health records, information system, residential aged care, accreditation, standard, risk management

Introduction

Residential aged care (RAC) services in Australia provide accommodation, meals, nursing, and social care services for the frail older people by skilled and unskilled nursing staff [1]. Associated with the ageing process are increased levels of frailty and chronic diseases, which are the main challenges for nursing staff to provide appropriate and safe care [1]. Generally, people living in RAC homes have higher exposure to various risk factors than their counterparts in the community [2]. These can be grouped into three categories: risk factors related to clients’ personal health conditions, those related to the health and aged care systems serving a client and human factors from the medical and nursing staff [3].

Risk management approach in RAC homes

A risk management approach to effectively control the risk factors for client safety and wellbeing has to be taken in RAC homes in order to comply with the legislative requirements in Australia, which are in accordance with international themes in health and personal
services [4]. The process of risk management includes identifying risks, assessing the risks, developing risk management plans, implementing risk management actions and re-evaluating risks which have occurred in the aged care processes [5].

An important objective of RAC services is minimizing risks to the individual, their family and to society [6], which requires managing the safety risk factors related to client health conditions. The classical nursing process model, which has been widely used as a theoretical basis for nursing practice and documentation in RAC homes in Australia, is a risk management approach to client safety. This model is comprised of five stages: nursing assessment, nursing problem or diagnosis, planning, implementation and evaluation [7, 8]. Each stage of the model echoes the relevant stage in the risk management cycle. In the context of aged care nursing ‘risk management’ encompasses many of the activities undertaken by qualified and non-qualified nursing staff [25]. An important objective of risk management in nursing practice is to reduce adverse events, incidents that under optimal conditions are not a normal consequence of a client’s nursing and personal care, that might lead to negligence claims [9].

To ensure the effective function of the risk management system and client safety, Australian government has implemented the aged care accreditation program to guide and monitor the risk management approach in registered RAC services. Therefore, aged care accreditation drives the risk management system in RAC services in Australia. The following sections introduce the aged care accreditation process and information systems in Australia, their relationships with risk management in RAC services.

**Aged care accreditation**

Accreditation is an evaluation process used in many countries to assess the quality of care and services provided in a range of health and non-health related areas [10]. To ensure the
effective function of the RAC risk management system and client safety, the Australian government implements an aged care accreditation system through the Australian Aged Care Quality Agency (AACQA), which determines whether the services provided by an RAC home meet the relevant safety standards. AACQA commenced operation in 2014, superseding the Aged Care Standards and Accreditation Agency (ACSAA). AACQA makes use of the same four accreditation standards as its predecessor, which follows the Quality of Care Principles 2014 [11], made under the Aged Care Act 1997 [12]. The format of accreditation reports is also the same. The four RAC accreditation standards are 1- Management systems, staffing and organizational development; 2- Health and personal care; 3- Care recipient lifestyle; and 4- Physical environment and safe systems [13]. Each standard includes a series of expected outcomes [16]. There are 44 outcomes across the four standards. Common to all four standards are the outcomes of continuous improvement, regulatory compliance, education and staff development.

The Australian Aged Care Act [17] specifies that RAC homes are required to meet the accreditation standards and their outcomes at all times and ensure the safe care of their residents. Aged care accreditation is the mechanism for the government to provide guidance on the risk management system and to monitor its effectiveness in RAC services.

The process of aged care accreditation

The process of aged care accreditation in Australia includes self-assessment by each RAC home against the accreditation standards and the submission of an application for accreditation. This is followed by a desk audit and a site audit of the home by a team of registered aged care quality assessors. The report produced by the assessors after a site visit is treated as an official document of the AACQA. A decision about the home’s accreditation is then made by AACQA based on the self-assessment and the audits. Finally, the accreditation
certificate is issued, when appropriate, and an accreditation report to be published on AACQA’s web site [14].

The process of aged care accreditation corresponds to the stages of identifying risks, assessing the risks and re-evaluating risks in the risk management cycle in RAC homes.

**Information systems in RAC homes**

Information management is fundamental to healthcare delivery [15]. A variety of information systems, covering client registration, billing and client health records, have been established in Australian RAC homes to support a variety of organisational purposes and functions, including administrative, financial, regulatory compliance, care delivery and quality assurance. As the communication tool for exchange of information between nursing staff and with outside health service providers [16], the client health record system, either in paper or electronic format, is the most important information system in RAC homes. It supports the delivery of aged care services and risk management for client safety, promotes effective communication between caregivers, and facilitates continuity and individuality of care of clients [7, 8].

By the end of 2014, 1,031 (37.4%) of 2,756 accredited RAC homes in Australia had introduced electronic health record (EHR) systems to manage client health and lifestyle information [17]. This had been done in order to improve effectiveness and efficiency in information management. EHR systems are a major technology to support the delivery of aged care services and risk management for client safety in RAC homes in Australia. However, the rate of EHR adoption appeared to stagnate since 2014 according to our analysis of aged care accreditation reports. It appears that the contribution of EHR to the effectiveness of risk management for RAC services is yet to be validated.
The research questions

While the aged care accreditation program in Australia makes a successful contribution to risk management, it is limited in that it is established to ensure that RAC homes meet the standards required by the accreditation agency. The system checks that all aspects of an RAC service are up to the minimum standard required by the accreditation agency, but does not provide any further indication about the level of quality. In this study we aimed to gain some insight into further aspects of safety in RAC homes. The approach taken was to consider the relationship between failing the information systems outcome and failing other accreditation outcomes.

The research questions were:

- In Australian RAC homes, what is the relationship between failing the information systems outcome and failing other accreditation outcomes?
- What are the differences in failed outcomes between RAC homes using EHR and those using paper records?

Methods

We followed a four-step process to extract and analyse data from the accreditation reports: (1) data sourcing and processing, (2) development, test and usage of a computer program for data extraction, (3) data labelling, and (4) data analysis (Figure 1).
Step 1. Data sourcing and processing
2. Converting reports from PDF to text files, checking and fixing conversion errors.
3. Loading the content of the converted reports to PostgreSQL database, in total 3,607 records.

Step 2. Development, test and use of a computer program for data extraction
1. Developing a computer program to extract the specific information (e.g. electronic clinical plan).
2. Testing the validity and reliability of the computer program.
3. Using the program to extract specific information from the 3,607 records in the PostgreSQL database.

Step 3. Data labelling
Grouping reports of the RAC homes that failed in one or more expected outcomes in the last five years according to three criteria:
   a. ACSAA or AACQA report.
   b. Using EHR or paper records as information systems.
   c. Failing or meeting the information systems accreditation outcome.

Step 4. Data analysis
1. Descriptive analysis of the number of expected outcomes that the RAC homes failed.
2. Chi-square test to compare the numbers of failed expected outcomes by the three criteria.
3. Chi-square test to test the association between failure in information systems outcome and failure in other expected outcomes.
4. Use of a data mining algorithm (Weka 3.6) to discover associations between failure in information systems outcome and failure in other expected outcomes.
5. Qualitative analysis of the reports to identify reasons for failure in a particular outcome.
**Figure 5.1.** The four step process to extract and analyse data from the accreditation reports.

**Data sourcing and processing**

Data were sourced from AACQA website ([www.aacqa.gov.au](http://www.aacqa.gov.au)). All reports were in PDF format and each was about 24 pages long.

These reports were converted from PDF to text files. Errors generated during conversion such as mis-spelling, broken line and unnecessary symbol were fixed by the first author who manually compared the converted text files with the original PDF documents. The incorrect character encoding was concentrated on list characters like ‘•’ in PDF format. These characters were converted to ‘?’ or ‘????’ in the txt format. Other errors did not influence reading the content.

Information about jurisdiction name, assessment date, the name of an RAC home and location, and comments and recommendations on the 44 expected outcomes was extracted and loaded into a designed PostgreSQL database for storage and further analysis. 3,607 records were stored in the database.

**Development, test and usage of a computer program for data extraction**

There were two types of information that were critical for this study and needed to be extracted from the database. The first was whether an RAC home used an electronic information system or paper records. The second was whether an RAC home failed or passed an expected accreditation outcome.

A computer program was developed to automatically extract the two types of information by keywords from the accreditation reports. For the first type of information, the identifying keywords included ‘electronic clinical plan’, ‘electronic clinical documentation’, ‘electronic clinical information’ and ‘electronic care plan’. For the second, the identifying keywords included ‘not met’.
The computer program was tested with a set of 100 records randomly selected from the database. The testing results showed that the program was effective. It was then applied to the 3,607 records to extract the two types of information.

**Data labelling**

Reports that recorded the RAC homes had failed one or more expected outcomes were selected for further analysis. They were grouped according to three criteria: 1. whether they were ACSAA or AACQA reports, 2. if they used EHR or paper records, 3. whether they met the expected outcome in information systems.

**Data analysis**

Statistical analysis was conducted using SPSS version 21.0. This included a descriptive analysis of the number of expected outcomes that the RAC homes failed (see Table 1). A Chi-square test was conducted to compare the numbers of RAC homes categorised by the three criteria that had failed an expected outcome (comparing ACAR and ACQR reports, RAC homes using EHR and paper records, and homes meeting and not meeting accreditation outcome in information systems). A data mining apriori Weka 3.6 was used to discover any association rules in the dataset.

A qualitative data analysis of the accreditation reports was conducted to understand why the RAC homes failed in specific expected outcomes, and whether this had any relationship with the type of information system used (EHR or paper records). To identify reasons for failure, specific focus was given to report content describing why an RAC home failed the specific accreditation outcome. First, comments given by accreditation agency to each RAC home were read thoroughly to gain a sense of the whole. Then each sentence was carefully read to understand why an RAC home had failed the accreditation outcome and to identify reasons
for failure. The identified reasons were labelled and constantly compared to classify them. Finally we counted the number of homes with EHR or paper records.

Results

Comparison of the proportion of RAC homes failing the accreditation standards between the ACSAA and AACQA reports

In total, 3,607 aged care accreditation reports were downloaded. 927 copies of AACQA reports were produced between 25th February 2014 and 25th March 2015. 351 (37.9%) of these RAC homes used EHR systems. The rest, 2,682 copies of ACSAA reports, were published between 7th March 2011 and 24th February 2014.

Forty five of the 3,607 reports recorded failure in one or more accreditation outcomes. Thirty three were ACSAA and 12 were AACQA reports. The 33 ACSAA reports failed an average of 5.5 outcomes per report (SD = 1.35). The 12 AACQA reports failed an average of 3.3 outcomes per report (SD = 0.42). There was no statistically significant difference in the proportion of RAC homes failing one or more standards between the two types of reports; therefore, the two types of reports were amalgamated for further analysis.

The accreditation outcomes that the RAC homes failed

Information about the accreditation outcomes that more than 20% of the 45 RAC homes failed is shown in Table 1. For seven of the outcomes, homes with EHR had a lower proportion of failures than those with paper records. Homes with paper records had lower proportions for three relating to important clinical areas (clinical care, pain management and continence management). Proportions were similar for the groups in two other outcomes.
The three outcomes that these RAC homes most often failed were 1.8 information systems (58%, 26 of 45 homes), 2.4 clinical care (44%, 20 of 45 homes) and 2.7 medication management (40%, 18 of 45 homes).

Fourteen (31%) of these homes used EHR and 31 (69%) used paper records. Homes using EHR failed an average of 4.1 outcomes (SD = 0.53). Homes that used paper records failed an average of 5.3 outcomes (SD = 1.24). However, we did not find a significant difference between the RAC homes using EHR and those using paper records in the number of accreditation outcomes failed. On average, an RAC home failed 4.91 outcomes (SD =1.66).

**Table 5.1. Number (%) of RAC homes that failed a specific accreditation outcome.**

<table>
<thead>
<tr>
<th>Accreditation outcome</th>
<th>45 (%) RAC homes</th>
<th>14 (%) with EHR</th>
<th>31 (%) with paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8 Information systems</td>
<td>26 (58)</td>
<td>7 (50)</td>
<td>19 (61)</td>
</tr>
<tr>
<td>2.4 Clinical care</td>
<td>20 (44)</td>
<td>7 (50)</td>
<td>13 (42)</td>
</tr>
<tr>
<td>2.7 Medication management</td>
<td>18 (40)</td>
<td>4 (29)</td>
<td>14 (45)</td>
</tr>
<tr>
<td>1.6 Human resource management</td>
<td>13 (29)</td>
<td>4 (29)</td>
<td>9 (29)</td>
</tr>
<tr>
<td>2.1 Continuous improvement</td>
<td>11(24)</td>
<td>1 (7)</td>
<td>10 (32)</td>
</tr>
<tr>
<td>2.8 Pain management</td>
<td>10 (22)</td>
<td>4 (29)</td>
<td>6 (10)</td>
</tr>
<tr>
<td>2.13 Behavioural management</td>
<td>10 (22)</td>
<td>2 (14)</td>
<td>8 (26)</td>
</tr>
<tr>
<td>3.6 Privacy and dignity</td>
<td>10 (22)</td>
<td>3 (21)</td>
<td>7 (23)</td>
</tr>
<tr>
<td>2.10 Nutrition and hydration</td>
<td>9 (20)</td>
<td>1 (7)</td>
<td>8 (26)</td>
</tr>
<tr>
<td>2.3 Education and staff</td>
<td>7 (16)</td>
<td>0</td>
<td>7 (23)</td>
</tr>
<tr>
<td>development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 Specialised nursing care</td>
<td>6(13)</td>
<td>1(7)</td>
<td>5(16)</td>
</tr>
<tr>
<td>2.12 Continence management</td>
<td>3 (7)</td>
<td>3 (21)</td>
<td>0</td>
</tr>
</tbody>
</table>

**Association between not meeting information system’s outcome and not meeting other accreditation outcomes**

Twenty six (58%) RAC homes failed 1.8 information systems outcome and 19 (42%) met this outcome. The RAC homes that failed this outcome failed other seven accreditation
outcomes (SD = 1.45), significantly higher than the 19 RAC homes that met this outcome, which failed an average of 2 other accreditation outcomes (SD = 0.4, p < 0.01).

Statistically significant associations were discovered between failure in 1.8 information systems outcome and both failure in 2.3 education and staff development (p < 0.05) and failure in 2.4 clinical care outcomes (p < 0.05). No other significant associations were found between failure in 1.8 information systems outcome and failure in other outcomes.

In use of a data mining algorithm Weka 3.6 to discover associations between failure in information systems outcome and failure in other expected outcomes, we found with 100% confidence that all the RAC homes failed in 2.3 education and staff development used paper records. Other than that, we did not find any other correlations between failing one accreditation outcome with failing the other.

**Reasons for the RAC homes not meeting outcomes 1.8 information systems, 2.3 education and staff development, and 2.4 clinical care**

Six criteria were used in the accreditation reports to determine that an RAC home did not meet accreditation outcome 1.8 information systems (Table 2). The most frequently mentioned criterion for the RAC homes to fail this outcome, for both EHR and paper records, was that staff did not have access to accurate and appropriate information. The second most frequently reported criteria were failure in monitoring mechanisms for RAC homes using EHR systems and failure in communication processes for those using paper records. For the two most common reasons the proportions of EHR homes were higher than those for homes with paper records.

**Table 5.2.** Criteria for the RAC homes not meeting accreditation outcome 1.8 information systems

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Number (%) of homes</th>
</tr>
</thead>
</table>
Seven RAC homes did not meet outcome 2.3 education and staff development. All these used paper records and all failed outcome 1.8 information systems (Table 3).

**Table 5.3.** Criteria for RAC homes with paper records not meeting accreditation outcome 2.3 education and staff development.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management and staff did not have appropriate knowledge and skills.</td>
<td>6 (86)</td>
</tr>
<tr>
<td>Education provided to other nursing staff was not effective in maintaining or developing their skills and knowledge.</td>
<td>5 (74)</td>
</tr>
<tr>
<td>Staff did not have appropriate knowledge and skills to perform their roles.</td>
<td>4 (57)</td>
</tr>
<tr>
<td>System failures impacted results for resident health and personal care.</td>
<td>2 (29)</td>
</tr>
<tr>
<td>Failure in monitoring key staff knowledge and skills in relation to the performance of their roles.</td>
<td>1(14)</td>
</tr>
<tr>
<td>Deficits in information management do not support staff to perform their roles effectively</td>
<td>1(14)</td>
</tr>
</tbody>
</table>

Fifteen (75%) RAC homes failed both 2.4 clinical care and 1.8 information systems outcomes, the other five homes failed 2.4 clinical care but passed 1.8 information systems.

There were eight criteria for these RAC homes to fail the clinical care outcome (see Table 4). The first two criteria were related to information systems. The RAC homes that met information systems outcome also met these two criteria. Criteria 3 to 6 were to assess nursing processes and actions. The RAC homes that met the information systems outcome all met criterion 5, which was about inconsistent implementation of the processes for
assessment. Criteria 7 and 8 assessed nursing outcomes from the perspective of the clients and the organisation. None of the RAC homes that met information systems outcome failed in criterion 7, which assessed client satisfaction with care services.

Table 5.4. Criteria for the RAC homes to fail outcome 2.4 clinical care, either meeting or not meeting outcome 1.8 information systems.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>5 RAC homes, all met outcome 1.8. 4 used EHR, 1 used paper. N (%)</th>
<th>15 RAC homes, all failed outcome 1.8. 3 used EHR, 12 used paper. N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information was not always current.</td>
<td>0 (0)</td>
<td>4 (26)</td>
</tr>
<tr>
<td>Information systems did not support the provision of appropriate clinical care on an ongoing basis and when residents had a change in their health status.</td>
<td>0 (0)</td>
<td>3 (20)</td>
</tr>
<tr>
<td>Monitoring mechanisms had not identified deficiencies in the delivery of residents' clinical care in relation to assessment of nursing care, pain management and behaviour management.</td>
<td>3 (60)</td>
<td>6 (40)</td>
</tr>
<tr>
<td>Regular assessment of the residents' clinical care needs was not conducted and documented.</td>
<td>2 (40)</td>
<td>4 (26)</td>
</tr>
<tr>
<td>Processes for assessment were not being implemented consistently.</td>
<td>0 (0)</td>
<td>3 (20)</td>
</tr>
<tr>
<td>Strategies on care plans were not always being implemented consistently.</td>
<td>2 (40)</td>
<td>3 (20)</td>
</tr>
<tr>
<td>Residents report clinical care was not provided according to their needs and/or preferences.</td>
<td>0 (0)</td>
<td>4 (26)</td>
</tr>
<tr>
<td>Home was not able to demonstrate residents were receiving appropriate clinical care.</td>
<td>2 (40)</td>
<td>6 (40)</td>
</tr>
</tbody>
</table>

Criteria for the RAC homes to fail other accreditation outcomes

Failure in monitoring mechanisms was a common cause for an RAC home to fail many accreditation outcomes listed in Table 1. A failure in monitoring mechanism to ensure a safe and secure medication management was one of the major reasons for 13 RAC homes not
meeting outcome 2.7 medication management. All 10 RAC homes that failed outcome 1.6 human resource management did not have effective monitoring systems in place to identify deficits in staff skills and practices. Due to the monitoring mechanisms not being effective in ensuring residents' pain needs, six homes failed outcome 2.8 pain management. Seven RAC homes had problems in identification and reporting of episodes of challenging behaviours, causing failure in meeting outcome 2.13 behavioural management. Five RAC homes failed the outcome of privacy and dignity because of a lack of an effective system to monitor the maintenance in this area. Four RAC homes failed outcome 2.10 nutrition and hydration because of a lack of consistent monitoring of residents' weights as required by the care plan. In an RAC home that failed outcome 2.5 specialised nursing, the registered nurses did not monitor residents’ specialised nursing care needs, causing a failure in information systems to identify the change in a resident’s health status.

The other causes for failure in medication management outcome included: (1) residents’ medications were not managed safely and correctly; (2) medications were not consistently administered in accordance with medical officer prescription; (3) processes were not effective in ensuring maintenance of sufficient stock of regular medications and timely commencement of short term medications; and (4) monitoring processes did not identify incorrectly stored medications.

Discussion

Accreditation is a mandatory, government regulatory mechanism to ensure safety and minimum standards of RAC services in Australia. It produces systematic, standardised national data about an RAC home’s status in meeting minimum aged care service standards. We used aged care accreditation reports to analyse the relationship between failing the information systems outcome and failing other aged care accreditation outcomes. From this,
we hoped to obtain insight about the contribution of information systems to risk management in RAC services.

Of 3,607 aged care accreditation reports published between 7th March 2011 and 25th March 2015, 45 RAC homes failed at least one accreditation outcome. There was no significant difference between the homes with EHR and those with paper records in the number of outcomes that were not met.

This finding is consistent with those of previous pre- and post-comparative nursing records audit studies of EHR and paper records in seven RAC homes [1, 18, 19]. Those studies found that although nursing care plans in the EHR systems documented more signs and symptoms of client problems and evaluation of care than the paper-based plans, they had a lower mean quality score. This is because the EHR plans contained fewer problems or diagnosis statements, contributing factors and resident outcomes than the paper-based systems. Both types of nursing care plans were weak in documenting measurable and concrete client outcomes. The overall quality of documentation content for the nursing process was no better in the electronic system than in the paper-based system [22]. A lack of substantial improvement in quality of nursing documentation in EHR systems might be the reason why there was no significant difference between homes using EHR or paper records in the numbers of failed accreditation outcomes.

Although it is reasonable to expect that failure in the information systems outcome would lead to failure in other accreditation outcomes, there was only a significant direct association with failure in two other outcomes, education and staff development, and clinical care.

Seven RAC homes, all using paper records, failed the education and staff development outcome, a failure in the aged care system. The major reason for this failure was a lack of appropriate knowledge and skills in management and staff, reflecting a failure in staff
education and training. This might be the reason for failure in monitoring and delivering care services. An RAC home that suffered from these organisational deficiencies would also be likely to fail the information systems outcome. This might explain the significant association found between failure in education and staff development and information systems outcomes.

The first two criteria for an RAC home to fail clinical care outcome were related to information systems. The RAC homes that met information systems outcome all met these two criteria. A further four criteria were related to failure in nursing processes and actions. None of the RAC homes that met the information systems outcome failed of inconsistent implementation of processes for assessment. The last two criteria were the negative consequences of failure in both information systems and nursing processes. There was no report of clients on care needs and/or preferences not being met for the RAC homes that met the information systems outcome.

Even though the nursing staff might have provided the appropriate clinical care to the residents, if the nursing action was not appropriately documented, the RAC home would not be able to demonstrate to the accreditation agency that it had provided appropriate clinical care to their clients. Therefore, we would expect a positive association between information systems and clinical care outcomes.

We would not have expected that meeting the information systems outcome did not make a significant difference to whether an RAC home met or failed another eight accreditation outcomes. Possibly the accreditation evaluation was not sensitive enough to unveil the effect of the information systems on these outcomes, with the same performance being recorded whether or not the information systems outcome was met. Another possibility is the performance in these eight areas of aged care services did not directly relate to information systems, but were found to be indirectly related by the monitoring mechanism.
Observational studies in Australian RAC found that oral communication was the most frequently observed activity in RAC homes and was the major communication channel between nursing staff, with clients and outside service providers [20-23]. About two-thirds of activities of nursing staff had duration of one minute or less [20-23]. Therefore, nursing staff were busy switching within or between oral communications for information sharing. They rarely had time to consult nursing records in the process of care delivery [24]. Even in conducting the activity of medication management, a potentially high risk activity for client safety that requires clear information, the nursing staff only spent very little time, one to two minutes, on reading clients’ records in a three-hour long round [25].

Information processing is comprised of generation, storage, manipulation and communication of client-related data, information and knowledge within an institution [26]. The purpose of generating information is to use it. The results from these observational studies suggest that client record systems may not be actually used by nursing staff in delivering aged care services to clients. This is consistent with our finding that information systems accreditation outcome did not have significant association with the other accreditation outcomes except education and staff development, and clinical care. A similar result was obtained in a US study, which found a lack of accurate and useful information about the daily care processes within nursing homes [27]. Although information systems were available, there was little incentive for staff to use these systems.

We found that the RAC homes were most likely to fail three accreditation outcomes: information systems, clinical care and medication management. Whilst an RAC home that failed information systems outcome had a significantly higher probability of failing clinical care outcome, we did not find such an association between failing information systems and failing medication management. This may be explained by the failure in nursing process being the main cause for the RAC homes to fail the medication management outcome.
Although information system is only a key component, not the whole package of an effective monitoring mechanism in an RAC home, lessons learned from other health care sectors suggest that properly designed, well implemented information system can facilitate the implementation of efficient monitoring mechanism by providing real-time, targeted reminders to nursing staff whenever there were any changes in a resident’s health status or needs. Such reminders are likely to be effective in improving professional practice if they can provide the right information at the right time [28]. However, the quality of nursing records in RAC homes has to be improved to achieve this. An observational study also suggests that there is scope for improving the support provided by EHR systems through incorporation of functions to support collaborative nursing care [29].

Therefore, improving the utility of EHR systems would contribute to the improvement in the monitoring mechanism, thus the capability of an RAC home to meet the other accreditation outcomes. The impact of information systems on other aged care services was also suggested by the fact that the RAC homes that failed information systems outcome failed significantly more other accreditation outcomes than otherwise.

**Limitations**

This was a secondary study, with all the findings drawn from analysis of the accreditation reports. We could only investigate the relationship between failing the accreditation outcomes for information systems and other outcomes, not the contribution of information systems to accreditation success because these reports did not provide an indication about the level of quality once the minimum standard was achieved. Such a study does not provide information on practice details of the sort that can be obtained from observational studies.

As only 45 RAC homes failed one or more expected outcomes, the evidence collected from this information source is limited. Also, the association between failure in information
systems and failure in clinical care or education and staff development outcomes is not decisive evidence of causal relationships. Nevertheless the strength of the study is that it provides a nationwide overview of why Australian RAC homes failed accreditation outcomes in information systems and other service areas. It gives some insights into aspects of safety-related issues in RAC homes which may be helpful for future studies on the links between information system performance and failures in other areas of care or training covered by accreditation outcomes.

**Conclusion**

There was no significant difference in failing other accreditation outcomes between the RAC homes using EHR and those using paper records. Information systems, clinical care and medication management were most frequently reported areas for RAC homes failing accreditation. Two significant, direct associations were found between failure in information systems and failure in clinical care, and in education and staff development. The RAC homes that met accreditation outcomes in information systems failed in significantly fewer other outcomes than homes that did not pass information system requirements. Improving information systems would contribute to the improvement in the RAC homes’ monitoring mechanism, thus improving their capability in meeting other accreditation outcomes.

**Summary points**

What is already known about the topic?

- Information management is fundamental to health and aged care service delivery.
- The introduction of EHR systems can improve information management for RAC services.

What this paper adds:
• There was no difference in performance in other accreditation outcomes between the RAC homes using EHR and paper records.

• There was a significant association between failing the information systems outcome and failing two other outcomes: staff education and development, and clinical care.

• Monitoring mechanisms failure is a critical factor for failing other accreditation outcomes in RAC homes.

• Good information systems can contribute to improving monitoring mechanism and good performance in other areas of aged care accreditation.

References


Chapter 6. Text Mining of Aged Care Accreditation Reports to Identify Risk Factors in Medication Management

Abstract

This study aimed to identify risk factors in medication management in Australian residential aged care (RAC) homes. Only 18 out of 3,607 RAC homes failed aged care accreditation standard in medication management between 7th March 2011 and 25th March 2015. Text data mining methods were used to analyse the reasons for failure. This led to the identification of 25 risk indicators for an RAC home to fail in medication management. These indicators were further grouped into ten themes. They are overall medication management, medication assessment, ordering, dispensing, storage, stock and disposal, administration, incident report, monitoring, staff and resident satisfaction. The top three risk factors are: “ineffective monitoring process” (18 homes), “noncompliance with professional standards and guidelines” (15 homes), and “resident dissatisfaction with overall medication management” (10 homes).

Keywords:
Risk, medication management, residential aged care.

Introduction

With population aging, the demand for aged care services around the world is increasing. Associated with the aging process is an increased level of frailty and chronic diseases, which pose major challenges to RAC services [1]. Residential aged care homes in Australia provide accommodation, nursing care and personal care services for the frail older people [2]. Previous research suggests that people living in RAC homes have a higher exposure to various risk factors than their counterparts in the community [1]. Long-term and complex chronic conditions associated with the aging process are the main challenges for nursing staff to provide appropriate care to these people [2]. The high demands for appropriate care and regulatory compliance have led to high cost and burden for aged care services [3].
aged care services in Australia are predominantly financed by taxpayers with some contributions from service users [4]. In order to protect residents’ safety and enhance the quality of the services, the Australian government has imposed stringent accreditation and safety standards through its aged care accreditation program administered by Australian government Aged Care Quality Agency (ACQA).

The aged care accreditation program in Australia focuses on continuous quality improvement strategies [5]. It includes an accreditation process and monitoring of ongoing performance against standards [5]. It is an effective approach to risk management and quality improvement of government-subsidized RAC homes [4]. In Australia, RAC homes are required to meet the accreditation standards at all times to ensure a high standard of care and services [6]. If a home fails in the accreditation, a timetable for improvement with a deadline will be developed by the ACQA [7]. Meanwhile, the agency monitors the home’s progress in making improvements. If the home does not meet all the requirements before the deadline, the agency may conduct a review audit which may result in the home’s accreditation certification being revoked and the home will lose legibility for receiving government subsidy.

**Risk management process in Australian RAC homes**

The aged care accreditation system is established to manage potential risks in RAC homes. The accreditation process starts with self-assessment, followed by a desk audit, a site audit, the decision whether or not to accredit the home and the publication of the accreditation report [4].

Self-assessment, desk audit and site audit can help the RAC homes to identify the risk areas and risk factors [7]. The accreditation teams’ findings, the decision of the accreditation agency about whether an RAC home has met the 44 expected outcomes is the official verdict about the home’s risk management system. Therefore, a risk management approach is essential for RAC homes to pass the accreditation [7].
The whole process of risk management includes identifying risks, assessing the risks, developing risk management plans, implementing risk management actions and re-evaluating risks which have occurred in the process of delivering aged care services [7]. A vulnerable area where risks for resident safety might occur in RAC homes is medication management.

**Medication safety is an important risk area in RAC homes**

Residential aged care homes must support and safely manage each resident’s medication need [8]. It is reported that residents take an average of seven to nine medications [9-12]. As medication management is a complex process involving prescription, ordering, delivery, administration, monitoring, evaluation and documentation [13], errors detrimental to medication safety may occur in any stage [14]; including wrong drug, wrong dose, wrong route and wrong resident [14]. The error rate is between 28% and 40% [15; 16]. The occurrence of these errors may be increased by nurses’ high physical and mental load [17] and large amount of medication to be administered under time pressures [18]. Therefore, this research aimed to identify the risk factors related to medication management in RAC homes.

**Methods**

We followed a three-step process to extract the data from the aged care accreditation reports in Australia: 1) report collection, 2) section/ paragraph extraction, and 3) keywords/terminology identification (see Figure 1).
Figure 6.1. The three-step process to extract and analyse data from the accreditation reports.

**Step 1. Report collection**

Data were sourced from the website of the Australian ACQA [19]. 3,607 copies of aged care accreditation reports published between 7th March 2011 and 25th March 2015 were downloaded, all in PDF format and each was about 24 pages in length.

The reports were converted from PDF to txt files. Errors generated during conversion, such as mis-spellings, broken lines and unnecessary symbols were fixed. The first author manually compared the converted text files with the original PDF documents, finding that the incorrect character encoding was concentrated on list characters like ‘•’ in PDF format. These characters were converted to ‘?’ or ‘????’ in the txt format. Otherwise, the errors did not influence reading the content.
Step 2. Section/paragraph extraction

Text data in the collected reports were classified and labelled with the representative keywords. For example, the text in comments and recommendations about medication management was labelled with the keyword “medication management”. Text about whether the home met or not met the accreditation outcome of medication management was labelled with “met” or “not met”. Following this labelling rule, information labelled included state name, assessment date, the name of a RAC home, its location, and comments on each of the 44 expected outcomes.

The text data were stored in a database. Information about report name, name of an RAC home, location, and comments and recommendations on the outcomes was extracted and loaded into a designed PostgreSQL database for storage and further analysis. In total, 3,607 records were stored. Each record contained the text data extracted from the section about medication management in the original accreditation reports.

Step 3. Keywords/terminology identification

Records showing that a home failed in medication management were selected for qualitative analysis.

To help us get a sense of the key issues discussed in the report, we used the application Apache OpenNLP to build a word cloud to highlight the most frequently used words in the text (see Figure 2).
The extracted words did not provide indication about the risk factors. Investigation of the existent data mining methods suggested that these methods were not sophisticated enough to be useful for our purpose. Therefore, we followed a manual process to constantly analyse and compare the semantics of sentences from the section of the accreditation report for medication management. This process led to the classification of all the risk factors. The process was concluded until no further risk factors were identified.

Then each sentence in the section of medication management was carefully read to understand the reason for failure, which was recorded as a risk factor for medication management. This was labelled and stored in the PostgreSQL database. Constant comparison was made with the labels among the records to classify or amalgamate them. This led to the generation of a classification table (see Table 1). Finally the number of times that a risk factor was mentioned in the reports was also counted.
Results

Only 18 out of 3,607 RAC homes (0.5%) did not meet medication management outcome. Twenty-five risk factors for the RAC homes to fail in medication management were identified. These factors were grouped into 10 categories: overall medication management, medication assessment, ordering, dispensing, stocking, administration, monitoring, incident reporting, staff satisfaction and resident satisfaction (Table 1).

Table 6.1. Risk factors for RAC homes to fail in accreditation standard of medication management

<table>
<thead>
<tr>
<th>Issue</th>
<th>Risk factors</th>
<th>No. of homes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall medication management</td>
<td>Non compliance</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Inconsistent policies</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Irregular medication review</td>
<td>1</td>
</tr>
<tr>
<td>Assessment not done</td>
<td>Medication are not assessed</td>
<td>4</td>
</tr>
<tr>
<td>Medication ordering</td>
<td>Non compliance with medical officer’s directives</td>
<td>1</td>
</tr>
<tr>
<td>Dispensing</td>
<td>No pre-packed medication system</td>
<td>1</td>
</tr>
<tr>
<td>Medication stocking</td>
<td>Insufficient or unavailable stock</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Insecure storage and disposal</td>
<td>5</td>
</tr>
<tr>
<td>Medication administration</td>
<td>Incomplete information</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Inconsistent timing and practice</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Use of controlled medication for other residents</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Use of unordered medication</td>
<td>2</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Ineffective process</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Staff practice not monitored</td>
<td>4</td>
</tr>
<tr>
<td>Incidents</td>
<td>Incident not identified and acted upon</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Inconsistent follow up</td>
<td>2</td>
</tr>
<tr>
<td>Staff satisfaction</td>
<td>Lack of competent assessment</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Insufficient staffing</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Lack of education</td>
<td>1</td>
</tr>
<tr>
<td>Resident satisfaction</td>
<td>Dissatisfied with medication management</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Dissatisfied with medication administration</td>
<td>2</td>
</tr>
</tbody>
</table>

There were two risk factors in the overall medication management. 15 (83% of the failed) RAC homes received the feedback of non-compliance with professional standards and
guidelines. Two (11% of) RAC homes did not have consistent policies and procedures to
 guide staff, or did not adequately review these policies and procedures. In one RAC home, the
 medical officers and pharmacist did not regularly evaluate and review residents’ medication
 needs and preferences regularly.

Three RAC homes did not assess residents who self-administered medications or received
PRN medication. The risk factor for the ordering process was not actioned upon residents’
medication orders in accordance with medical officer directives, which happened in one RAC
home. Again, one RAC home did not have in place a pre-packed medication system from a
pharmacist in medication dispensing. Two RAC homes did not have adequate stock, or
medications ran out. Four RAC homes did not store medications safely and securely. One
RAC home did not dispose medications appropriately.

There were four risk factors in medication administration process: (1) medication charts did
not contain complete and sufficient information in three RAC homes; (2) in eight RAC
homes, medications were not consistently administered safely and correctly; e.g., at
appropriate intervals, not following prescribed orders, or inconsistent administration process;
(3) in one RAC home, controlled medications prescribed for individual residents were used
for other residents; and (4) in two RAC homes, medications being administered were not
ordered by a medical officer.

The two risk factors for monitoring included (1) monitoring processes were not in place or
were not effective; which happened in all failed RAC homes; and (2) four RAC homes did
not monitor staff practice.

There were three risk factors for incident reporting: (1) medication incidents were not
identified, analysed and acted upon (2 RAC homes); (2) Medication incidents were not
collated and reviewed (1 RAC home); and (3) medication incidents were not consistently
followed up with the relevant parties (2 RAC homes).
The risk factors for staff and resident satisfaction was further separated into the ones impacting staff and ones impacting resident satisfaction.

There were three factors for staff satisfaction. These included (1) not conducting competency assessment (3 RAC homes); (2) insufficient staffing (1 RAC home); and (3) not providing education to staff in relation to medications (1 RAC home).

There were two risk factors for resident satisfaction. First, residents were not satisfied with medication management (10 RAC homes); and residents were not satisfied with the way medications were given (2 RAC homes). The top risk factor was “ineffective monitoring process” which occurred in all 18 failed RAC homes. The second frequently stated risk factor was “noncompliance with professional standards and guidelines”, occurring in 15 failed homes (83%). “Resident “dissatisfaction about overall medication management” was the number three risk factor, happened in 10 failed RAC homes (56%). Risk factors about staff practice were also quite often mentioned in the reports. These included “inconsistency in staff practice” to administer medication (8 homes, 44%) and “unmonitored staff practice” (4 homes, 22%).

Discussion

This study identified 25 risk factors for the RAC homes to fail in medication management in accreditation. It contributes in the knowledge area of aged care risk management.

A medication management process includes prescription, ordering, dispensing, administration, recording and review, storage and disposal [20]. For resident safety, the whole medication management process requires monitoring. We found that “ineffective monitoring process” is the biggest risk factor for the RAC homes to fail in medication management. Our finding is in line with that of another study which found that 70% of
adverse drug events in RAC homes were caused by inadequate monitoring of the medication management process [21].

The second major risk factor in medication management is “noncompliance” with professional standards and guidelines. Another notable finding is that staff practice at each stage of medication management is important for medication safety. For example, checking the package of medication will ensure the expired medication would not be administered to a resident. Therefore, developing an effective monitoring system is of critical importance for safe medication management in the RAC homes.

The limitation of this study was the nature of any secondary study, with all the findings drawn from analysis of the accreditation reports. As only 18 out of 3,607 ACAR reports reported failure in medication management for an RAC home, evidence collected from this information source might be limited. In addition, these publicly available reports only summarised high level information. There was inadequate details about what exactly leaded to failure in medication management. Therefore, we cannot infer how risks happened and what can be done to prevent and control these risks.

The strength of the study is, for the first time, providing a nationwide overview of the reasons for the Australian RAC homes to fail accreditation outcomes in medication management. It gives some insight into aspects of safety-related issues in RAC homes, which may be helpful for future studies. The future work will focus on exploring the possibilities of using standardized terminology and template to collect nursing data, instead of using free text, with limited re-usability.

**Conclusion**

Using text data mining method, this study identified 25 risk factors for the RAC homes in Australia to fail in medication management accreditation standards. These risk factors fell
into 10 categories: overall medication management, medication assessment, ordering, dispensing, storage, stock, disposal, administration, incident report, monitoring, staff and resident satisfaction. The future research can be focused on how to best implement monitoring mechanism to improve medication safety and resident satisfaction with the process.

References


Chapter 7. General Discussion and Conclusion

7.1 Aged care accreditation drives risk management approach to client safety

Due to their increased level of frailty and chronic diseases, many people living in Australian RAC homes rely on nursing care to complete activities of daily living. They have higher exposure to various risk factors than their counterparts in the community. Therefore, a risk management approach is essential for client safety in RAC homes.

To protect clients’ safety and quality of life, the Australian government has established mandatory aged care accreditation system to guide and evaluate compliance with quality standards in RAC services. In order to receive government funding, any Government subsidised RAC homes must meet the accreditation standards at all times. This requires a systematic risk management approach to develop and implement the organisational risk management system [1]. Therefore, the aged care accreditation program drives the risk management approach in Australian RAC services.

7.2 The research questions

To our knowledge, there is a lack of evidence about the contribution of EHR to the effectiveness of risk management for RAC services, particularly in supporting the primary risk management goal of meeting accreditation standards. In order to promote innovation in information management in RAC services, this PhD study aimed to answer the research question:

**Does the use of EHR systems improve the capacity of RAC homes to manage risks for client safety in comparison with the use of paper records?**
Limited by the accreditation reports only provide information about whether an RAC home is up to the minimum regulatory standards, we can only draw meaningful inference from the accreditation reports that recorded failure in one or more accreditation outcomes to answer the following two questions in order to address the overall research question:

- Is there any association between failing the information system’s outcome and the types of information systems used in an RAC home, either EHR or paper records?
- Is there any association between failing the information system’s outcome and failing other accreditation outcomes?

**The associated research hypotheses are:**

- Use of EHR can improve the opportunity for an RAC home to meet the information system’s accreditation outcome in comparison with using paper records.
- RAC homes that failed information systems outcome were more likely to have failed other aged care accreditation outcomes.

### 7.3 The evolving process of developing text data mining technology in this PhD project

It is labour intensive to manually identify and extract the useful data from the huge volume of aged care accreditation reports. This difficulty may have led to under-utilization of the accreditation reports for risk management and quality improvement initiatives in RAC homes in Australia. In order to fully utilize the government investment in aged care accreditation to improve the aged care services, we developed the methods to enable automatic extraction of data in the accreditation reports based on text data mining technique (Table 7.1).
Table 7.1. Advantages and disadvantages of various text data acquisition methods developed in this PhD project.

<table>
<thead>
<tr>
<th>Chapter that describes the method</th>
<th>General steps to acquire data</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 4</td>
<td>Download the reports, identify whether EHR is used, and if the RAC home “met” or “not met” an accreditation outcome</td>
<td>Data were accurate. Suitable for analysing a small number of reports.</td>
<td>Time-consuming and inefficient for gathering data from a large amount of reports.</td>
</tr>
<tr>
<td>Chapter 3</td>
<td>1. Data sourcing and processing, 2. Data cleaning, 3. Data restructuring and labelling, and 4. Data analysis.</td>
<td>Efficient, automatic, fast, and accurate.</td>
<td>Process requires converting the original PDF documents to text and this process may lead to error.</td>
</tr>
<tr>
<td>Chapter 5</td>
<td>1. Data sourcing, processing and cleaning, 2. Development, test and use of a computer program for data extraction 3. Data labeling, and 4. Data analysis.</td>
<td>1. Efficient, automatic, fast, and accurate. 2. Use PostgreSQL database for storing a large volume of data. 3. Can extract association rules in data sets.</td>
<td>Requirement to correct misspellings, join broken lines, and remove unnecessary symbols in text files one by one.</td>
</tr>
<tr>
<td>Chapter 6</td>
<td>1. Report collection, 2. section/paragraph extraction, and 3. keywords/terminology identification.</td>
<td>1. Efficient, automatic, fast, and accurate. 2. Specific for analysing small number of failed expected outcomes. 3. Automatically highlights the most frequently used keywords in each aged care accreditation report.</td>
<td>Requirement to correct misspellings, join broken lines, and remove unnecessary symbols in text files one by one.</td>
</tr>
</tbody>
</table>

Chapter 4 followed a traditional data acquisition process to acquire the useful data from the aged care accreditation reports. We download the published aged care accreditation reports on the website of the AACQA Then we identified whether an RAC home had one or more items which failed an accreditation outcome and whether EHR was used by reading through
the reports. Although this simple method is easy to use and accurate for the acquisition of data, it has several disadvantages: the reports are in PDF format and we had to search the keywords one by one to make sure they did not meet one or more accreditation outcomes. We also need to develop a list of keywords to check if EHR is used or not, which is time-consuming and inefficient.

The major improvement in the data acquisition method for the study reported in Chapter 3 was the conversion of the original reports in PDF format to the computer-program readable text formats (e.g. .txt files) using software Adobe Acrobat Pro. As errors occurred in the conversion process, manual cleaning was needed to correct the errors. Compared with the research method in Chapter 4, this research process has advantages in being efficient, automatic, fast, and accurate.

For the study reported in Chapter 5, the major improvement in methods of data acquisition was development, testing and use of a computer program for data extraction instead of the commercial software Adobe Acrobat Pro. As there were only 45 failed reports, the sample size was reasonable for the manual process of correcting misspellings, joining broken lines, and removing unnecessary symbols in the data sourcing, processing and cleaning step. Another improvement was the convenience of using the PostgreSQL database for data storage. A computer program was written to automatically extract the data by keywords from the accreditation reports, and this computer program was tested with a set of 100 records randomly selected from the database.

The process of data labelling and data analysis was similar in Chapter 3 and Chapter 5. SPSS version 21.0 was used to conduct the Chi-square tests. The difference is that the study reported in Chapter 5 used Weka 3.6 to identify whether there was any association between failing the accreditation standards among the following three groups: aged care accreditation
report and aged care quality report; use of EHR or paper-based records; and passed or failed in information systems.

Based on the research methods on Chapters 3 and 5, we developed another process to identify and analyse expected outcomes in Chapter 6. This research process reduced 4 steps into 3 similar steps.

The difference for Chapter 6 is that we used the application Apache OpenNLP to build a word cloud to highlight the most frequently used keywords in each aged care accreditation report in order to browse and get a sense of the key issues discussed in the report. However we found NLP may not be suitable to analyse a complex sentence.

**The text mining software to be tested and used**

In this study, we tested the following text mining software and statistical analysis software, the advantages and disadvantages will be discussed below.

**RapidMiner**

At the beginning of this research, we tried to use RapidMiner, is a popular open source data science platform. It provides an integrated environment for machine learning, data mining, text mining, predictive analytics and business analytics; therefore can be used to prepare data, create models, and embed in business processes [2]. However, it was found that it is not easy to use RapidMiner for analysing the aged care accreditation reports and the aged care quality reports. Firstly, all the reports are in PDF format and Rapidminer need to analyse the data from the database; thus cannot be directly used. The business models embedded in RapidMiner are not suitable for analysing the reports in this study.
Natural language processing (NLP)

NLP is a field of computer science, artificial intelligence, and computational linguistics that is concerned with the interactions between computers and human (natural) languages [3]. Modern NLP algorithms are based on machine learning, especially statistical machine learning [3]. At the beginning of this research, we used this technology to analyse the complex sentences from the aged care reports. However, the semantic analysis is a challenge for our reports, and the results automatically produced by the system was not usable; therefore, the technique was not used in this study.

Weka 3.6

Weka is a collection of machine learning algorithms for data mining tasks. The algorithms can either be applied directly to a dataset or called from your own Java code. Weka contains tools for data pre-processing, classification, regression, clustering, association rules, and visualization [4]. It is also well suited for developing new machine learning schemes [4]. However, based on the structure and content of aged care accreditation or quality reports, we only found this technology can be used to identify whether there was any association rules in failing the accreditation standards.

SPSS version 21.0

SPSS version 21.0 was used for statistical analysis in this research. We used Pearson’s Chi-square test for normally distributed data and U-test for non-parametric data. Two by two tables are the typical data structure for an aged care accreditation report, which provided us with the opportunity to conduct statistical analysis and measures of association. A Chi-square test (significant level of 0.05) was used to identify whether there was a statistically significant difference between failing any accreditation standards for two groups.
7.4 The association between failing accreditation outcomes and the types of information systems

In 45 aged care accreditation reports produced between 7th March 2011 and 25th March 2015 that recorded failure of at least one of the 44 accreditation outcomes, 14 (31%) used EHR and 31 (69%) used paper records. Seven RAC homes using EHR systems (50%) failed the information system’s outcome; 19 using paper records (61%) failed this outcome. There was no significant association between failing information system’s outcome and the types of information systems to be used, either EHR or paper records.

This finding was contradictory to that presented in Chapter 3, which suggested the use of EHR could improve the opportunity for an RAC home to meet accreditation outcome for information systems. This difference in the findings was caused by the difference in sample size. In the pilot study reported in Chapter 3, as only one out of 13 RAC homes that failed one or more accreditation outcomes used an EHR system, the finding was not representative. It was over-ridden by the finding from the larger scoped study presented in Chapter 5.

Six risk indicators for not meeting information systems outcome were identified. They were no access to accurate and appropriate information, failure in monitoring mechanisms, not reporting clinical incidents, insufficient recording of residents’ clinical changes, not providing accurate care plans, and communication process failure. This provides insight about the areas of information management to which RAC homes need to pay attention to and continuously improve.

There were slight differences in the criteria for failure in information systems between the two types of RAC homes, using EHR or paper records. The most frequently mentioned criterion for all RAC homes to fail this outcome was that staff did not have access to accurate and appropriate information. The second most frequently reported criterion were failures in

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monitoring mechanisms for RAC homes using EHR systems and failures in communication processes for those using paper records.

The above evidence did not provide direct support to the first hypothesis: use of an EHR can improve the opportunity for an RAC home to meet the information system’s accreditation outcome in comparison with using paper records. No difference was found in an RAC home to meet information system’s accreditation outcome, whether EHR or paper records are used.

**The accreditation outcomes that the RAC homes were most likely to fail**

The three outcomes that the RAC homes most often failed were 1.8 information systems (58%, 26 homes), 2.4 clinical care (44%, 20 homes) and 2.7 medication management (40%, 18 homes).

**Association between not meeting information system and other failing accreditation outcomes**

In the 45 RAC homes that failed one or more accreditation outcomes, 42% (19/45) met the information system’s outcome, but failed an average of 2 other accreditation outcomes. This was significantly less than the average failure of 7 other outcomes for the rest 58% (26/45) homes which failed the information systems outcome (p < 0.01).

There were significant positive associations (p < 0.05) between failing the information systems outcome and failing two other outcomes: 2.3 staff education and development, and 2.4 clinical care. No other significant associations were found between failure in 1.8 information systems outcome and failure in other outcomes.
The reasons for the RAC homes not meeting outcomes 2.3 education and staff development, and 2.4 clinical care

Seven RAC homes (16%) that used paper records failed outcome 2.3 education and staff development. The major criterion for this failure was management and staff did not have the appropriate knowledge and skill; thus could not conduct effective monitoring and delivering care services. These failures were more likely to be a failure in the aged care system because the home did not provide appropriate education and training to staff. Any RAC home that suffered from these organizational deficits was likely to fail other accreditation outcomes including information systems.

Eight criteria were identified for failing accreditation outcome 2.4 clinical care. The first two criteria were related to information systems: (1) information was not always current; and (2) information systems did not support the provision of appropriate clinical care on an ongoing basis and when clients had had a change in their health status. As the RAC homes that met information systems outcome all met these two criteria, it suggests that effective information systems did support the information needs for clinical care.

The other four criteria were directly related to failure in nursing processes and actions: monitoring mechanism failure; not conducting and documenting regular assessment of the residents’ clinical care needs; processes for assessment not being implemented consistently; and strategies on care plans not being implemented consistently. Even though the staff might have provided the appropriate clinical care to the residents, if the nursing action was not appropriate documented, the RAC home would not be able to demonstrate to the accreditation agency that appropriate nursing processes have been followed. Therefore, information systems would also contribute to the success or failure in these four criteria.
The last two criteria were the negative consequences of failure in both information systems and nursing processes.

The above evidence supports the strong association between information systems and clinical care. It demonstrates the importance of information systems for clinical care.

Therefore, the evidence supports the second hypothesis: RAC homes that failed information systems outcome were more likely to have failed other aged care accreditation outcomes.

**The indirect relationship between failure in information systems and failure in another nine accreditation outcome**

Failure in the monitoring mechanism was the common reason for an RAC home to fail in another nine accreditation outcomes with more than 20% of failure rate in the 45 RAC homes. They were 2.7 medication management, 1.6 human resource management, 2.1 continuous improvement, 2.8 pain management, 2.13 behavioural management, 3.6 privacy and dignity, 2.10 nutrition and hydration, 2.5 specialised nursing care, and 2.12 continence management.

The information system is a key component of the monitoring mechanism. Although no direct association was found between failure in information systems and fail in these nine outcomes, there was an indirect link through the monitoring mechanism. However, there did not appear to be an obvious improvement in monitoring mechanism by using EHR in the RAC homes that we analysed.

**Reasons for failure in medication management**

As mentioned in the section above, “ineffective monitoring process” is the top reason for all 18 RAC homes to fail accreditation outcome for medication management. The other two major risk criteria were “noncompliance with professional standards and guidelines” and “resident dissatisfaction about overall medication management”. As the major reason for
failure was the nursing process failure, which led to resident dissatisfaction, no doubt that failure in medication management did not have a significant direction relationship with information systems. However, a properly designed information system that provides a good monitoring mechanism would contribute to improvement in medication management.

7.5 The final answer to the overall research question

**Does the use of EHR systems improve the capacity of RAC homes to manage risks for client safety in comparison with the use of paper records?**

The study findings suggest that use of EHR systems made no significant difference from using paper records in meeting other accreditation outcomes in an RAC home. However, better information systems contributed to improvement in overall performance in meeting aged care accreditation requirements. This may include improving monitoring mechanism, an important indicator of risk management. A number of accreditation failures appeared to be linked to organisational deficiencies that could be improved by the use of more effective information systems.

7.6 Significance of the research

For the first time, this study conducted a systematic analysis of the publicly available accreditation reports to identify the potential risk factors for client safety in RAC in Australia. It contributes to the knowledge about the contribution of information systems to risk management for client safety and the association between meeting information systems accreditation outcome and use of different forms of records, electronic or paper.

**Implications for use of EHR as an information system for RAC homes**

No direct contribution to meeting other accreditation outcome was found in using EHR or paper records as an information system in an RAC home. However, as failure in the
monitoring mechanism was the major identified reason for an RAC home to fail other accreditation outcome; properly designed EHR systems with sound monitoring mechanism can contribute to risk management for meeting aged care accreditation standards.

7.7 Limitations of the study

The first limitation of the study is its nature of secondary study, with all the findings drawn from analysis of the published accreditation reports. Instead of collecting evidence to demonstrate the contribution of EHR for accreditation success, the accreditation reports only provided us with the opportunity to investigate the association between failing accreditation outcomes for information systems and failing other accreditation outcomes; and drilled down to compare any difference in effect between the use of EHR and use of paper records in an RAC home.

The sensitivity of the findings is confined by the sensitivity of the accreditation process. Possibly the accreditation evaluation was not sensitive enough to unveil the effect of information systems on another accreditation outcomes, causing us to only identify two strong associations between failing accreditation outcome for information systems and failing other accreditation outcomes.

As only 45 RAC homes failed one or more accreditation outcomes in the entire 10-year period up to 2015, the evidence is comprehensive in terms of coverage of the national data for 10-year time frame; yet limited by the small sample size. The association between failure in information systems and failure in clinical care or education and staff development outcomes is not decisive evidence of causal relationships.

The strength of the study is, for the first time, providing a nationwide overview of the reasons for the Australian RAC homes to fail accreditation outcomes in information systems and
other aged care services. It gives some insight into aspects of safety-related issues in RAC homes which may be helpful for future studies in the links between information system performance and failures in other areas of care or training covered by accreditation outcomes.

7.8 Future directions

The research findings point to the limitation of the current EHR systems in RAC homes. Despite the high investment in this IT innovation, the potential of EHR to support risk management for aged care services is yet to be realized. To our knowledge, standardized nursing language is yet to be adopted by the nursing profession in Australia. Without standardized nursing language, the terminology in the EHR systems is ad-hoc, making interoperability of systems impossible to achieve. Even the same data collected for different purposes in one system might not be able to be identified and re-used. The negative consequences are not only double data entry, but also inability to build an automatic monitoring function, the advantage that the EHR has over paper-based records.

Therefore, the future study can be focused on exploring the possibilities of using standardized terminology and template to collect nursing data, instead of using free text, with limited re-usability. Based on the standardized nursing language, automatic alert functions can be developed to improve the utility of EHR systems; making the system really support nursing care, not just the administration.

Research should also be focused on strategies and practices on improving the organizational management and nursing processes in RAC homes to improve their capacity in risk management for client safety.

This study presents a systematic method to analyse the publicly available aged care accreditation reports to understand the relationship between use of EHR and risk management
for resident safety in Australian residential aged care homes. The methods and approach, and lessons learned are applicable to other research initiatives that rely on analyzing big documents to identify relationships between data sets, which are increasingly the case with the increasing use of internet for information sharing in the modern society.

7.9 Conclusion

Only 45 (1.25%) of 3,607 accreditation reports published between 7th March 2011 and 25th March 2015 recorded failure in one or more accreditation outcomes, suggesting only a few RAC homes actually failed aged care accreditation. The three outcomes that the RAC homes most often failed were 1.8 information systems (58%, 26 of 45 homes), 2.4 clinical care (44%, 20 of 45 homes) and 2.7 medication management (40%, 18 of 45 homes). The failure in information systems is related to failure in clinical care. It appears that the failure in medication management is caused by other mechanisms than information systems.

Six risk indicators for not meeting information systems outcome were identified in this study. They were no access to accurate and appropriate information, failure in monitoring mechanisms, not reporting clinical incidents, insufficient recording of residents’ clinical changes, not providing accurate care plans, and communication process failure. No significant association was found between failing information systems outcome and the types of information systems to be used, either EHR or paper records. In other word, the use of EHR made no significant difference for an RAC home to meet information systems accreditation outcome.

Two significant, direct associations were found between failure in information systems and failure in clinical care, and in education and staff development. The RAC homes that met accreditation outcomes in information systems failed in significantly fewer other outcomes than homes that did not pass information system requirements. Improving information
systems would contribute to the improvement in the RAC homes’ monitoring mechanism, thus improving their capability in meeting other accreditation outcomes.

A number of accreditation failures appeared to be linked to organisational deficiencies that could be improved by use of more effective information systems to improve monitoring mechanism. Residential aged care homes need to make great effort in monitoring staff practice and maintaining resident satisfaction for improvement of medication management in RAC homes.

References


Appendix A. Comparison of the 45 RAC Homes That Failed a Specific Accreditation Outcomes

Table A1. Comparison of the 45 RAC homes that failed a specific accreditation outcome between (1) RAC homes using EHR and using paper-based records; and (2) RAC homes that met information system standards and those failed information system standards.

<table>
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<tr>
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<th>EHR %</th>
<th>Paper %</th>
<th>p</th>
<th>1.8=P %</th>
<th>1.8=F %</th>
<th>p</th>
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<tbody>
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<td>3</td>
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<td>6.452</td>
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<td>0</td>
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<td>4.66</td>
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<td>19</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Total of failed outcomes in average</td>
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<td>7</td>
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</table>

EHR: using EHR, Paper: using paper-based record, 1.8=P: Met 1.8 Information System, 1.8=F: Not met 1.8 Information System. \( p = p \) value from chi-squared test, \( * \)= statistically significant.
Appendix B. Indicators Used to Demonstrate that RAC Homes Met Outcome 1.8 (unpublished part in Chapter 3).

The antonyms of the six risk indicators were used in the accreditation reports to demonstrate that an RAC home met the same accreditation outcome (Table B2). They provide positive indicators that effective information management systems are in place. There were significantly more RAC homes using EHR than those solely using paper records receiving the positive appraisal of ‘Providing accurate or appropriate information’ and ‘Monitoring mechanisms in place’ in the accreditation reports.

**Table B2.** Difference between the homes with EHR and those with paper records in the presence of positive indicators for meeting outcome 1.8

<table>
<thead>
<tr>
<th>Antonyms of the risk indicators</th>
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<th>Homes with paper records</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
</tr>
<tr>
<td>Providing accurate or appropriate information</td>
<td>506</td>
<td>49</td>
<td>753</td>
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<tr>
<td>Monitoring mechanisms in place</td>
<td>285</td>
<td>27.6</td>
<td>366</td>
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<tr>
<td>Reporting clinical incidents</td>
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<td>12.2</td>
<td>217</td>
</tr>
<tr>
<td>Recording residents’ clinical changes</td>
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<tr>
<td>Accurate care plans</td>
<td>265</td>
<td>25.7</td>
<td>496</td>
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<tr>
<td>Improving communication processes</td>
<td>717</td>
<td>69.5</td>
<td>1169</td>
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</table>

*p* = p value from chi-square test, *=* statistically significant.
Appendix C. Statement of Contribution of Others
This thesis is prepared in the style of Thesis by Compilation by the University of Wollongong. Five articles are included in this thesis. I am the first author of all these papers. Five co-authors are involved in the publications. They are Ping Yu, David Hailey, Jun Ma, Jie Yang, and Siyu Qian. Their percentage of contribution is indicated in the publications listed below. This is followed by the signed co-author contribution declaration forms.

Published peer-reviewed book chapters:

1. Tao Jiang (80%), Ping Yu (20%) 2015. The Impact of Electronic Health Records on Client Safety in Aged Care Homes, Studies In Health Technology And Informatics, vol. 201, pp. 116-123.


Published peer-reviewed journal articles:


Articles accepted by peer-reviewed conference:

4. Tao Jiang (80%), Ping Yu (10%), Jun Ma (4%), David Hailey (5%), Siyu Qian(1%). Text data mining of aged care accreditation reports to identify risk factors in medication management in Australian residential aged care homes, Medinfo 2017 (accepted)

Articles in 1st round revision as requested by peer-reviewed journals:
5. Tao Jiang (80%), Ping Yu (10%), Jun Ma (4%), David Hailey (5%), Siyu Qian (1%). The relationship between failing the expected outcomes for information system and failing other expected outcomes in Australian residential aged care homes, *International journal of medical informatics* (under review)

Signature  

Date: 22/03/2017

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Date: 22/03/2017

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Date: 22/03/2017

Signature  

Date: 22/03/2017

Signature  

Date: 22 March 2017

Signature  

Date: 22 March 2017

Signature  

Date: 24/03/2017
5. Tao Jiang (80%), Ping Yu (10%), Jun Ma (4%), David Hailey (5%), Siyu Qian(1%). The relationship between failing the expected outcomes for information system and failing other expected outcomes in Australian residential aged care homes, *International journal of medical informatics* (under review)

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The Impact of Electronic Health Records on Client Safety in Aged Care Homes

Tao JIANG and Ping YU1
Health Information Technology Research Center, School of Information Systems and Technology, University of Wollongong, Wollongong, NSW 2522, Australia

Abstract. This study collects and critically reviews the published literature to synthesize the risk factors for client safety in residential aged care and the potential contributions of electronic health records to reducing these risks. Three major types of risk factors for client safety were identified: risk factors related to the person’s health; those related to the health and aged care system serving the person and those related to human error. Multiple strategies at all levels of an aged care organization are needed to reduce risks and improve client safety. Electronic health records can be one of the effective organizational mechanisms because it improves access to better information and integrates intelligent functions to support point-of-care decision making.

Keywords. Electronic health records, EHR, nursing documentation, patient safety, risk, residential aged care, long term care, nursing home

Introduction

With the population ageing, the demands for residential aged care services around the world are steadily increasing. Residential aged care services in Australia provide accommodation, meals and care services for the frail elderly, with assistance from skilled and unskilled nursing services [1]. Associated with the ageing process is increased levels of frailty and chronic diseases, which are the main challenges for nursing staff to provide appropriate and safe care [1]. Generally, people living in residential aged care homes (RACHs) have higher exposure to various risk factors than their counterparts in the community [2].

Nursing documentation is a major clinical information source in aged care [3]. Many RACHs in Australia have introduced electronic health records (EHR) [3] for the purposes of improving the quality and efficiency of client records, to comply with nursing and accreditation standards and to meet legal requirements [3]. However, the relationship between EHR and client safety is yet to be validated in RACHs, and this is the aim of this study.

As little research has investigated the impact of EHR on client safety, in order to establish the relationship between EHR and client safety, we must first review the risks factors for client safety, then the impact of EHR on these risk factors, and then whether EHR can alleviate or eliminate these risk factors. Because the risk factors for client

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safety can be caused by medical treatment, clinical procedures or nursing care practices, the study took a broad view to include inter-professional practices with the care recipients confined to clients in RACHs, without limiting the scope to nursing practices.

1. Materials and Methods

This study takes the approach of secondary research of the published literature. It was conducted during the period between April and September, 2013. The key words used for search include: electronic health record/EHR, risk, client/resident/patient safety, residential aged care/long term care/nursing home. The databases searched were: Health Reference Center, Informit Health Collection, MEDLINE, Pub Med Central, Science Direct, Web of Science, IEEE Xplore, CINAHL, and Google Scholar. The inclusion criteria included: (1) peer-reviewed studies published during the period of 2000 to 2013, (2) risk factors for client safety in RACHs and potential contributions of EHR to client safety and (3) articles written in English. Exclusion criteria were: (1) no reasonable definition of risk for client safety, (2) not considering risk factors for client safety, (3) not peer reviewed, (4) not published in English and (5) not in the setting of RACHs, nursing home or long term care. The articles were grouped into two categories: risk factors for client safety in RACHs and the impact of EHR on reducing the risk factors for client safety. An established cognitive taxonomy of medical errors was applied to classify the risks for client safety caused by human factors [4].

The primary search was manually conducted by the first author. Reference lists from high quality articles were also screened to identify the relevant articles. The classification of risk factors and the contributions of EHR were reached through group discussion and consensus.

2. Results

In total, 172 abstracts were identified, 132 of them were excluded and 34 articles were reviewed [1-34]. 24 papers addressed the risk factors for client safety. 12 discussed the contributions of EHR to reducing risks for client safety. 6 covered both topics. 24 studies were only conducted in RACHs and 14 covered both RACHs and other healthcare settings. In the rest of the paper, first the risk factors for client safety are discussed in detail in three groups: risk factors related to personal health conditions, those related to the health and aged care systems serving a client and human factors regarding care staff. For each group, the risk factors are discussed in terms of the settings of occurrence, either uniquely in RACHs or both in RACHs and other healthcare settings. Afterwards, the contributions of EHR to reducing these risk factors and improving client safety are analyzed.

2.1. Safety risk factors related to personal health conditions

Some clients have a higher possibility of exposure to risk than others. These include those who suffer from poor health conditions [5], those who are dying [5], those inclined towards self-harm [11], those suffering from depression [11], poor mobility [5], disability [5], allergy [34] and mental health issues [11]. These all require special care
and first aid [25]. If not dealt with in a timely manner, it may lead to medical accident or falls [11]. If a client suffers from depression for a long time without intervention from nursing care, the situation will deteriorate quickly. Allergy to drug and food also often happen to people suffering from chronic obstructive pulmonary disease (COPD) and Asthma [34]. In some cases, allergy needs to be controlled by first aid services or requires treatment by drugs [22]. Delayed treatment of allergy can cause harm, even death [34]. In summary, personal health conditions are important internal risk factors that require continuous nursing attention. These safety risk factors exist in both RACHs and other healthcare settings.

2.2. Safety Risk factors related to health and aged care systems

Residential age care services frequently interface with other healthcare services to provide continuous, holistic, long term care for the clients [7]. Therefore, the risk factors for client safety exist in the whole health and aged care processes. These include environmental risk factors in RACHs, risk factors in medication and nursing care processes, and risk factors caused by the introduction and use of IT applications.

2.2.1. Safety risk factors related to the unique environment in RACHs

The environmental risk factors in RACHs are system failure and errors. The system failure includes inappropriate or wrong methods in treatment, nursing care, meal services and communication. Risk factors in nursing care processes include miscommunication or lack of communication between nursing staff and clients or between aged care staff and other healthcare providers, such as doctors, hospitals and community pharmacies [29]. For example, lack of communication between a pharmacy and a RACHS lead to errors in medication packaging [29]. It is also found that unhealthy or unclean food can cause malnutrition or health problems [7].

2.2.2. Safety Risk factors in both RACHs and other healthcare settings

Safety risk factors in the medication processes include wrong drug, wrong dose, wrong formulation, wrong route, wrong strength and wrong timing [22, 32]. The powerful drugs can lead to high risk by changing personal health condition [22]. Misuse of drugs includes wrong drugs and wrong dose for the wrong client and inappropriate use of a drug before or after a meal [16, 21, 32]. Adverse drug-drug-interaction often happens when different drugs are used together [22].

Nursing procedural failure is a main risk for care. For example, medication label, patient identification, medication chart and body mass index are often misread and misidentified [17, 29]. Checking and preparation, witness administration, infusion pump set up, dangerous drug register and signing medication chart are all nursing care processes prone to error [17, 29-31]. Inappropriate use of complex technologies can also cause harm to frail people [7, 15, 23]. The adverse effect does not only last during the operation, but also in the care process; thus it requires special attention.

In the situation where IT application is used in nursing care processes, power failure can cause inaccessibility of EHR, without access to personal health information, appropriate medication management is under risk [6, 8, 15]. Portable offline emergency medical record devices are developed and used to deal with this contingent situation [9]. In such case, battery life can be a barrier to continuous function [9, 33]. In addition, system errors from EHR could cause misuse of drugs and wrong identification of client,
which was highly risky [9, 16]. Several studies found EHR were not accepted by nurses because the interface design was not friendly and the users felt difficult to use the functions of the system [13, 28]. Not familiar with the system and misuse of the system can reduce the efficiency and may risk client safety [9].

2.3. Human factors for client safety in health and aged care systems

Human factors that might cause risk to client safety include the provision of inappropriate care by health and aged care staff, their negligence in care, and slips and mistakes in the process of care delivery [29]. ‘Slip’ in this case means error caused by the incorrect execution of a correct action sequence [4]. ‘Mistake’ is the correct execution of an incorrect action sequence [4]. The possible causes for inappropriate care might be care staff’s lack of knowledge about the risk factors [5, 29], which may reflect their lack of training [5, 12] and lack of work experience [5, 18]. Care staff’s negligence in care might be caused by depression or lack of time [5, 20]. These, together with lack of acknowledgement of unfamiliar or unknown situation [5], may lead to nursing error or failure [7].

2.3.1. Inappropriate care caused by lack of training and work experience

Lack of training for staff is a high risk factor for client safety. It can lead to knowledge related mistakes and intentional slips in care delivery [31], such as error in handling special conditions in fist aid situation [7]. In addition, medical technology can be complex and requires nurses to have sufficient training before using it confidently [5]. According to Zhang et al. (2004), incorrect knowledge, incomplete knowledge and misuse of knowledge can lead to execution mistake and evaluation mistake [4]. These risk factors can be alleviated by appropriate and sufficient training.

Lack of work experience can often happen to some new health care workers. It is likely that part-time and less experienced nurses and doctors are more prone to mistakes [8] that are not likely to happen to skillful health care workers [7].

2.3.2. Lack of attention cased by depression or negative feeling or lack of time

Nursing staff with depression or negative feeling is prone to inattention [13]; therefore, a nursing manager needs to pay attention to staff having such feeling so as to prevent harms to clients [29]. In nursing care services, a nurse is required to spend a certain amount of time with each client.

Lack of time and inadequate care can harm client safety [10]. Time pressure often happens when there is an emerging issue that draws the nurse’s attention away [27]; or one nurse attending to more than one client at a time [9]; or lack of availability of information on time and demand [30].

2.3.3. Overflow of working memory

Nursing staff in RACHs are often multi-tasking [24]. Multi-tasking can lead to overflow of working memory. This can lead to goal slips and intention slips. Information overload can lead to interpretation slips [4].
2.3.4. Lack of acknowledgement of unfamiliar or unknown situation

Early acknowledgement of unfamiliar or unknown situation can avoid medical incident from happening [14]. Part-time and less experienced nurses are more likely to make error in these circumstances [31]. Insufficient information and lack of feedback may lead to action evaluation slips [4]. Therefore, a nurse should be given time and adequate information to know and familiar with a new work place [14].

2.4. The possible contributions of EHR to client safety

Although there is a high potential for EHR to contribute to improving client safety in aged care, empirical evidence is required to validate this claim. We will first present the empirical findings about the contributions of EHR to client safety in RACHs, and describe the potential contributions delineated by other studies.

2.4.1. Benefits of EHR that have been empirically tested

2.4.1.1. Improving information management and allowing nurses fast access to enter data and retrieve health information

When adequate number of computers are placed in the appropriate place to give the healthcare workers and nursing staff access to enter data or retrieve information by keyword search when needs arise, this saved time and improved efficiency in information retrieval [33]. The flow-on benefit was facilitating nurse following up of care when needs arose. It has contributed to avoid the risks of sub-optimal care or wrong procedures [33]. Helping with the development of better care plans was another advantage of EHR for client safety [15]. By saving time for nurses in managing information [15], this EHR system had contributed to improving efficiency and relieving time pressure of nursing care. It thus gave nurses more time to spend with a client to improve the quality of care [15].

2.4.1.2. Improving communication among nurses and between nurses and clients

Communication breakdown could be a serious system failure in aged care. Better communication in nursing care always requires a nurse to acquire feedback from a client and record observation about the person’s condition in EHR on time [19]. The feedback from a client and from a nurse’s observation could be put into EHR system and be classified. This had led to improved communication among nurses to avoid medical error and inappropriate care for a client [19].

2.4.1.3. Facilitating nursing compliance with procedure

Electronic health records can provide the detail information about the steps of nursing care processes [18]. This can provide in-time support for nurses to comply with the right procedure. It was found that the health care workers made fewer mistakes with the suggestion and support from an EHR with such functions [15, 19].

2.4.1.4. The educational benefit of EHR

For new health care workers such as part-time nurses, an EHR system could provide practical cases for learning to deliver nursing care. It helped the nursing staff to enhance their skills and practice [15]. It also provided an opportunity of peer learning among nurses and facilitated the development of better care plans for various problems [33] with decision support functions [26].
2.4.1.5. Clinical decision support (CDS) in EHR can support care decision making
Decision support is a potential solution for intention mistake and action specification mistake [4] which might lead to medical error. In addition to its use in normal condition, clinical decision support (CDS) functionality that facilitates fast care decision making is particularly useful in emergency situation. For example, in Kawamoto’s study, CDS provided suggestions to nurses about what was the right interaction with client in first aid situation [15]. Menachemi found that clinical support offered by a CDS system in medical treatment had helped to avoid the incorrect medical procedure [19] by providing guidelines for treatment and care [16].

2.4.2. The potential contributions of EHR for improving client safety

2.4.2.1. Electronic health records may provide guidelines for treatment and care
Memory aid is the potential solution of preventing interpretation slips, action evaluation slips, and action execution slips which can lead to medical errors [4]. An EHR system can provide clinical guidelines or memory aid for health care workers and nurses [33] to relieve their burden to remember all the detail care procedures [33]. For example, the special guidelines for caring of clients with diabetics could be useful for the provision of safe care [33].

2.4.2.2. Electronic health records may alert nurses about vital test results
Bell’s research shows that body mass index such as blood pressure and heart rate, which relate to client safety, can be recorded in the EHR systems [30]. When an EHR system provides alert of the dangerous level of body mass index, the risk such as heart attack can be avoided [30].

2.4.2.3. Electronic health records may reduce medication mistake or slips
By recording data about adverse drug interactions in an EHR system and providing alerts to the users when the high probability situation occurs, the risk of medication mistake, which can lead to allergenic reaction, can be reduced. Westbrook suggests that misuse of drug often happens when health care workers handle ‘sound-like’ or ‘look-like’ drugs [32] and these safety risk factors might be reduced by memory aid [4] or coding drugs in certain numbering system [34]. An EHR system with photo of a client who takes the medication will also help with identification of the right client [13].

3. Discussion

This research synthesized three major types of risk factors for client safety in residential aged care: risk factors from the personal health conditions, from the health and aged care systems and the human factors from health and aged care staff serving the clients. The risk factors that are related to the personal health conditions include loss of cognitive function, depression, disability, allergy to drugs, etc. The risk factors from the health and aged care systems include system failure or errors generated from inadequate allocation of human resources for care, sub-optimal processes in medication management and nursing care, etc. Human factors from health and aged care staff include lack of experience in providing appropriate care, negligence, possibly caused by time pressure in delivery of care. The cause for inappropriate and unsafe care may be a lack of training, thus no knowledge about a care procedure to client’s safety.
As an important structural component for aged care service delivery, EHR systems have great potential to mitigate or avoid the risk factors and enhance client safety. For example, it can provide fast access to enter data and retrieve health information, and better support for care decision making. Otherwise, it can improve feedback and communication among care staff, facilitate compliance with nursing procedure, and improve efficiency in information management and education. Test results easily found in EHR can alert nurses about resident’s risk health conditions. An EHR system with alert function about adverse drug interaction can reduce medication error.

4. Conclusion

There is a paucity of research evidence on the impact of EHR on client safety in residential aged care. By synthesizing the research literature, this study has identified three major types of risk factors for client safety in residential aged care. It documented the identified impacts of EHR to reduce risk factors and improve client safety. Multiple strategies at all levels of an aged care organization are required to improve client safety. Electronic health record is one of these essential, effective organizational mechanisms.

References


The Relationship between Using Electronic Health Records and Meeting Accreditation Standards for Client Safety in Residential Aged Care Homes

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Abstract. This study aims to identify the benefits of using electronic health records (EHR) for client safety in residential aged care (RAC) homes. The aged care accreditation reports published between 27 April 2011 and 3 December 2013 were downloaded and analysed. It could be seen from these reports that only 1,031 (37.45%) RAC homes in Australia had adopted an EHR system by 2013. 13 RAC homes failed one or more accreditation standards. Only one of these was using an EHR system and this one met the accreditation standards on information systems. Our study provides empirical evidence to suggest that adopting and using EHR can be one of the effective organisational mechanisms to meeting accreditation standards in RAC homes.

Keywords. Electronic health records, EHR, nursing documentation, safety, risk, residential aged care, long term care, nursing home

Introduction

According to the International Organisation for Standardisation (ISO), EHR is a repository of patient data in digital form, stored and exchanged securely, and accessible by multiple authorised users. It contains retrospective, concurrent, and prospective information and its primary purpose is to support continuing, efficient and quality integrated healthcare [1]. Many residential aged care (RAC) homes have introduced electronic health record (EHR) systems [2] to standardise the structure and process of nursing documentation in order to improve the quality and efficiency of documentation, to comply with nursing and accreditation standards and to meet legal requirements [2].

Although there appears to be a high potential for EHR to contribute to improving client safety in aged care, empirical evidence is required in order to validate this claim. Previous studies have found a number of benefits of EHR, which may indirectly contribute to resident safety [3-6]: They can provide healthcare workers with faster access to enter data and retrieve health information than traditional paper based records [7], a benefit that is particularly useful in emergency situations [5]. They can improve communication between nurses and residents and among care staff, facilitate compliance with nursing procedure and improve efficiency in information management and education [2]. An EHR system that integrates decision support functions and
guidelines can provide support for treatment and care [7]. It can also provide easy access to test results in order to alert nurses to possible risks to residents’ health [8]. An EHR system with an alert function about adverse drug interactions can reduce medication errors [9]. This study aims to provide the empirical evidence necessary to validate the relationship between EHR and client safety.

The Australian government implements its accreditation system through the Aged Care Standards and Accreditation Agency, Ltd, an Australian company limited by guarantee by the Minister for Mental Health and Ageing [10]. Accreditation is the internationally recognised evaluation process used in many countries to assess the quality of care [10]. Accreditation reports provide a relatively comprehensive and authoritative coverage of the performance of a RAC home by auditing whether the aged care services in the home meet the safety standard established by the Australian government [11]. The accreditation standards in Australia are detailed in the Quality of Care Principles 1997 [10]. According to the Australian Institute of Health and Welfare, the definition of safety is “avoidance or reduction to acceptable limits of actual or potential harm from healthcare management or the environment in which healthcare is delivered” [12]. Homes which want to pass aged care accreditation are required to have: effective information management systems, accurate and appropriate or required information, timely information, monitoring mechanisms, an evaluation system to monitor changes, and an appropriate care plan. It must be able to identify gaps in resident care and/or in the communication process [11]. As these factors are all related to client safety, this enabled this study to use the results of aged care accreditation reports as indicators as to whether the aged care services in a RAC home are safe or not.

1. Materials and Methods

This study takes the approach of secondary research using the published aged-care accreditation reports at the website of the Aged Care Accreditation Agency (www.accreditation.org.au). The primary accreditation reports were produced between 27 April 2011 and 3 December 2013.

In order to identify whether a RAC home had one or more items which failed to meet accreditation standards, the key words ‘not met’ were used to search each report. In order to identify whether a RAC home used EHR or not, the following key words were used in Section 1.8. Information Systems. In the documents a RAC home submitted to the Accreditation Agency the search terms used were: ‘electronic clinical plan’, ‘electronic clinical documentation’, ‘electronic clinical information’, ‘electronic documentation’, ‘electronic care plan’, ‘electronic care documentation’, ‘electronic care information’ and ‘electronic health record’.

In order to aggregate the information, the reports were grouped into four categories: met all the standards and used EHR, met all the standards but did not use EHR, did not meet the standards but used EHR, and did not meet the standards and did not use EHR.

A chi square test was used to identify whether there was a statistically significant difference in meeting accreditation standards among the above four groups of RAC homes. SPSS version 21.0 (SPSS inc., Chicago, IL, USA) was used to conduct the analysis. A detailed in-text analysis was conducted on the RAC homes that did not meet one or more accreditation standards.
2. Results

2.1. The Difference in Meeting Accreditation Standards between the RAC Homes that Used an EHR System and Those which Only Used Paper Records

2,741(99.5%) of the 2,754 RAC reports which were audited by the accreditation agency during the period of January 2 to December 3, 2013 met the 44 accreditation standards. Of them, 1,031(37.4%) used an EHR system for client health and personal care information management. The remaining 1,710(62.59%) used paper for information management.

Only 13 (0.5%) RAC homes failed to meet one or more accreditation outcomes, and only one (7.7%) of these 13 RAC homes used an EHR system for client health and personal care information management. The remaining 12 (92.3%) of the 13 RAC homes relied on paper-based systems. The result of a Pearson Chi-Square test shows that the RAC homes that had EHR in place were significantly more likely to meet accreditation standards than those that did not (p = 0.026). This evidence supports the claim that EHR can contribute to meeting aged care accreditation standards.

2.2. The Accreditation Outcomes that the RAC Home that Used EHR Fail to Meet and the Reasons for the Failure

Although the only RAC home using an EHR system failed to meet more than one accreditation outcomes, it did not fail in information systems, but in Accreditation Outcome 1.6 Human Resource Management and Outcome 2.4 Clinical Care.

The reason for the first failure was that the management had difficulty replacing staff on sick-leave or absence, causing a lack of adequately and appropriately skilled and qualified staff. The reason for the second failure might also relate to their deficiency in human resource management because of a lack of effective mechanisms to monitor staff work practices.

2.3. The Accreditation Outcomes that 12 RAC Homes that Only Used Paper Records Failed and the Reasons for the Failure

Of the 12 RAC homes that used paper records, nine failed in Accreditation Outcome 1.8 Information Systems. Six failed in 2.4 Clinical Care, 2.7 Medication Management, or 2.13 Behavioral Management. Five failed in 2.8 Pain Management or 2.10 Nutrition and Hydration. There were also six homes which failed in 1.6 Human Resource Management.

The three homes that failed to meet certain accreditation outcomes but met the standard on information systems all failed 2.13 Behavioral Management. In addition, one home failed other two outcomes: 2.4 Clinical Care and 2.8 Pain Management.

For the nine RAC homes that failed Accreditation Outcome 1.8 Information Systems, five also failed in 1.6 Human Resource Management, or 2.4 Clinical Care, or 2.7 Medication Management, or 2.10 Nutrition and Hydration, or 2.13 Behavioral Management. Four homes failed in 2.8 Pain Management.

The reasons for these failures are a lack of effective information management, accurate, appropriate or required information, and inappropriate care planning. The required information was not provided in time. A lack of an effective evaluation system fails to monitor changes in residents’ health status in time. One home did not complete
incident reports, or failed in monitoring mechanisms and audit systems. Some homes could not identify gaps in resident care or communication process failure.

2.4. The Inferior Practices Identified for the RAC Homes that Used an EHR System and Met the Accreditation Standards

1,030 RAC homes that used an EHR system did meet age care accreditation standards. Three (0.29%) of these homes, however, received negative comments about performance. One of them was requested to develop and implement effective monitoring systems, suggesting the usage of EHR did not automatically improve the monitoring mechanism in a RAC home. Some inferior practices were identified in RAC homes that used paper records and met the accreditation standards.

There were 1,698 RAC homes which used paper records and met aged care accreditation standards. Ten of these homes, however, were requested to improve their monitoring mechanisms. It appears that more RAC homes (0.58%) that used paper did not have effective monitoring mechanisms than their peers which used an EHR system (0.10%). The possible reason is that the ‘alert’ functions in the common commercial EHR systems designed for RAC can effectively remind the nursing staff about the timeline for the re-assessment of healthcare needs of a resident and the development of new care plans. This overcomes the challenges in monitoring residents’ health status and does so better than paper-based systems.

3. Discussion

This research has synthesised the results of 2754 accreditation reports published between 27 April 2011 and 3 December 2013 in order to identify the potential relationship between use of EHR and resident safety. We found that EHR systems had already been adopted as information systems by 37.4% of RAC homes in Australia by 3 December 2013. The RAC homes which had adopted EHR were significantly less likely to fail the accreditation standards. This provides the empirical evidence to support our proposition that EHR contributes to resident safety.

Paper-based nursing documentation is time-consuming and records are often illegible. Often, data must be entered several times, and this has the potential to cause inconsistency and/or error. It is also not easy to retrieve or update such data. Such difficulties have been identified as a major cause of stress and dissatisfaction among nurses in aged care [1]. These challenges might also be the root cause for the failed performance in information management by the RAC homes that used a paper-based information system. For example, inaccurate and inappropriate information might be caused by inadequate information capture, which would hinder nursing judgment and cause inappropriate care planning. The substantially better performance in aged care accreditation by RAC homes that used EHR suggests that many problems associated with paper-based records can be resolved by the use of well-designed EHR systems.

The literature shows that EHR systems have great potential to mitigate or avoid risk factors and enhance client safety [3-6]. For example, the ability to quickly enter and retrieve data at multiple computers scattered over an aged care facility will motivate busy nursing staff to enter more data [1], and this will lead to an improvement in the accuracy and timeliness of information. This will again lead to an information system that can provide more accurate feedback, and improve communication among
care staff. An alert in an EHR system can remind nursing staff of changes in resident status and help them to follow up with these changes. These benefits will obviously facilitate compliance with nursing procedure and improve efficiency in information management and education.

The limitation of this study was the nature of any secondary study, with all the findings drawn from analysis of Aged Care Accreditation reports. We can only identify information about whether an EHR system was used in a RAC home in the accreditation reports, but we cannot ascertain the nature and extent of usage of the EHR system by nursing staff. As only 13(0.5%) of the RAC homes failed the accreditation standard, the relationship between the use of EHR systems and the quality of aged care services cannot be determined by evidence collected from this information source alone.

4. Conclusion

There is a paucity of research evidence on the impact of EHR on the performance of RAC homes. By synthesising the accreditation results of 2,754 RAC homes between 27 April 2011 and 3 December 2013, this study has proved that the use of EHR can improve the opportunity for a RAC home to meet accreditation standards for information systems. Although the quality of aged care is determined by strategies used in many different areas of the home, our research suggests that the use of EHR can contribute greatly to quality care.

References

The Impact of Electronic Health Records on Risk Management of Information Systems in Australian Residential Aged Care Homes

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Abstract To obtain indications of the influence of electronic health records (EHR) in managing risks and meeting information system accreditation standard in Australian residential aged care (RAC) homes. The hypothesis to be tested is that the RAC homes using EHR have better performance in meeting information system standards in aged care accreditation than their counterparts only using paper records for information management. Content analysis of aged care accreditation reports from the Aged Care Standards and Accreditation Agency produced between April 2011 and December 2013. Items identified included types of information systems, compliance with accreditation standards, and indicators of failure to meet an expected outcome for information systems. The Chi-square test was used to identify difference between the RAC homes that used EHR systems and those that used paper records in not meeting aged care accreditation standards. 1,031 (37.4%) of 2,754 RAC homes had adopted EHR systems. Although the proportion of homes that met all accreditation standards was significantly higher for those with EHR than for homes with paper records, only 13 RAC homes did not meet one or more expected outcomes. 12 used paper records and nine of these failed the expected outcome for information systems. The overall contribution of EHR to meeting aged care accreditation standard in Australia was very small. Risk indicators for not meeting information system standard were no access to accurate and appropriate information, failure in monitoring mechanisms, not reporting clinical incidents, insufficient recording of residents’ clinical changes, not providing accurate care plans, and communication processes failure. The study has provided indications that use of EHR provides small, yet significant advantages for RAC homes in Australia in managing risks for information management and in meeting accreditation requirements. The implication of the study for introducing technology innovation in RAC in Australia is discussed.

Introduction

Despite the potential of electronic health records (EHR) to significantly improve the quality of information management in comparison with paper-based records [1–3], there are limited reports of the actual benefits of EHR for information management in residential aged care. In a qualitative research study with focus-group data collection, Cherry et al. found that the managers in long-term care homes with EHR usage experience perceived these systems to be more efficient than paper records, giving improved quality and accuracy of documentation. They provide easier access to charts and resident
Based on a publication of the US Institute of Medicine, we define aged care EHR in this study as a repository of aged care service recipients’ data in digital form [2]. Aged care EHR contains retrospective, concurrent, and prospective longitudinal electronic health and aged care service information pertaining to a care recipient. They are accessible by multiple authorized users. EHR are generated and maintained by aged care service providers with the primary purpose of giving continuing, efficient and safe health and aged care for their clients [4, 5]. The functionality of EHR may include demographic information, admission assessment, care planning, ongoing assessment, nursing charts, progress and incident reporting care planning, medication management, ongoing assessment, nursing charts, progress and incident reporting [6].

Residential aged care (RAC) homes in Australia are similar to long-term care (LTC) homes in the USA. They are facilities that offer 24-hour nursing supervision and a range of medical, nursing, personal and social services to meet the needs of chronically ill or disabled individuals.

Increasing number of RAC homes in Australia and the United States have been introducing EHR systems over the last decade. The reasons are to standardise the structure and process of client record keeping, and improve the quality and efficiency of information management. These changes are expected to increase the quality adjusted life years of the older people and improve health decision-making, and access to patients’ medical history. EHR systems should also provide better evidence that care services meet nursing and accreditation standards and legal requirements [7–12].

After using EHR systems for up to two years, care staff in nine Australian RAC homes perceived the benefits of EHR to them include quick data entry and retrieval, improved format and content of records, facilitating internal and external communication, and better understanding of residents’ requirements [5]. Unintended adverse consequences included difficulties for some staff in data entry and information retrieval, resistance to using the system, increased complexity of information management, and end user concerns about access. Reasons included the nature of the EHR systems and the ways the systems were implemented and used by nursing staff [13].

A nursing documentation audit in seven Australian RAC homes provided information on key differences between the electronic and paper record formats [7, 8]. Nursing care plans in the EHR system documented more signs and symptoms of resident problems and evaluation of care than the paper-based plans, but had a lower mean quality score. The EHR plans contained fewer problem or diagnosis statements, contributing factors and resident outcomes than the paper-based system. Both types of nursing care plan were weak in documenting measurable and concrete resident outcomes. The overall quality of documentation content for the nursing process was no better in the electronic system than in the paper-based system.

However, despite the potential of EHR to significantly improve the quality of information management in comparison with paper-based records [10, 14, 15], there are limited reports of the actual benefits of EHR in RAC. Therefore, the aim of this study was to identify any differences in meeting aged care accreditation requirements between the RAC homes that used EHR for information management and those that used paper records. The hypothesis to be tested is that the RAC homes using EHR have better performance in meeting information system standards in aged care accreditation than those that use paper records for information management. This analysis will help us understand the contribution of EHR in managing risks for information management in Australian residential aged care (RAC) homes.

**Aged Care Accreditation in Australia**

The Australian government implements a comprehensive accreditation system through the Australian Aged Care Quality Agency (AACQA), which determines whether the aged care services provided by an RAC home meet the relevant safety standards. AACQA commenced operation in 2014, superseding the Aged Care Standards and Accreditation Agency (ACSAA).

The accreditation process in Australia involves self-assessment by RAC homes against the accreditation standards and the submission of an application for accreditation. This is followed by a desk audit and a site audit by a team of registered aged care quality assessors. A person is only qualified as a registered aged care quality assessor after completing approved training and orientation of aged care accreditation [16]. When auditing an RAC home, the assessors are required to observe the Code of Conduct and to have no pecuniary or other interest that may conflict with a proper audit [16]. Given the high standards of performance and integrity required in aged care accreditation, the report produced by the assessors after a site visit is treated as valid and reliable official report of the AACQA. A decision about the home’s accreditation, either meeting or not meeting the standards, is then made by AACQA based on the self-assessment by the RAC home, desk audit and site audit. Finally, an accreditation certificate is issued, as well as the accreditation report.

According to the Australian Aged Care Act [17], RAC homes are required to meet the accreditation standards at all times and ensure the safe care of residents. When a home fails to meet the standards, AACQA may put the home on a timetable for improvement (TFI), which sets out the required improvements and the maximum time allowed for addressing those expected outcomes that were not met. By the end of the timetable, the AACQA will arrange for assessors to
conduct a review audit. If the standards are still not met, the home’s accreditation will be varied or revoked. The Department of Health may also decide to impose sanctions on the home. Therefore, meeting aged care accreditation standards is the basic safety requirement imposed by the Australian government on a RAC home in aged care service provision.

There are four RAC accreditation standards in Australia: 1- Management systems, staffing and organizational development; 2- Health and personal care; 3- Care recipient lifestyle; and 4- Physical environment and safe systems [18]. Each standard includes a series of expected outcomes. There are 44 of these outcomes across the four standards with which an RAC home must comply at all times in order to meet accreditation requirements [19]. Common to all four standards are the outcomes of continuous improvement, regulatory compliance, education and staff development. The Principle of Standard One is to be responsive to the needs of residents, their representatives, staff and stakeholders, and the changing environment in which the service operates. The six outcomes that are specific to Standard One are comments and complaints, planning and leadership, human resource management, inventory and equipment, information systems and external services. The requirement for outcome 1.8, information systems, was a focus for this study, is that ‘Effective information management systems are in place’.

The publicly available RAC accreditation reports provide the most objective and authoritative information on whether an RAC home meet the accreditation outcome of 1.8 information systems The reports also contain information about the type of records used in an RAC home, being EHR or a paper records-based system. By analyzing the information in Section 1.8 of the accreditation reports, it is possible to infer which indicators of ‘effective information management systems’ were used by the accreditation agency and whether these had differed between RAC homes that used EHR and those that had paper-based records. Therefore, our approach to address the research question was to conduct a comprehensive analysis of Australian aged care accreditation reports.

Methods

We followed a four-step process to extract and analyze data from these reports: data sourcing and processing, data cleaning, data restructuring and labelling, and analysis.

Data Sourcing and Processing

Data were sourced from the web site of the Aged Care Standards and Accreditation Agency in December 2013. We downloaded 2,754 aged care accreditation reports that were produced from 27 April 2011 to 3 December 2013.

We converted the original reports in PDF format to computer-program readable text formats (e.g. .txt files) using software Adobe Acrobat Pro. We extracted the relevant sections in all reports, including 44 expected accreditation outcomes (Fig. 1a) and Outcome 1.8 Information Systems (Fig. 2a) into text files (Figs 1b and 2b).

Data Cleaning

The first author manually compared the converted text files with the original PDF documents for 2,754 reports. The incorrect character encoding was concentrated on list characters like ‘*’ in PDF format. These were converted to ‘?’ or ‘????’ in txt format. Otherwise, the errors did not influence reading the content.

Data Restructuring and Labelling

Data were labeled according to two criteria: failing to meet one or more aged care accreditation outcomes, and using some form of EHR. First we identified the RAC homes that failed to meet one or more aged care accreditation outcomes by searching the content such as that presented in Table 1b using the key word ‘not met’.

To identify the RAC homes that used an EHR system and those used paper records, first we read through 50 copies of the accreditation reports and found that different terms were used to describe an electronic record system. Based on the terms we identified, we developed a list of keywords that was used to identify whether an RAC home used an EHR system or paper records. They included electronic clinical plan, electronic clinical documentation, electronic clinical information, electronic documentation, electronic care plan, electronic care documentation, electronic care information and electronic health record.

We scanned section 1.8 Information Systems in the reports (see Fig. 2b), and a list of documents that a RAC home submitted to the accreditation agency for desk audit. Based on this, we used a program to automatically structure the name of an RAC home (from document name), frequency of matching the keywords and details of matching (e.g. 30 characters before and after each keyword) into an Excel spreadsheet (Table 1). The reliability of the labels in Table 1 was further validated by manual checking against the original documents.

Afterwards, we aggregated all RAC homes into four groups: Group 1 – meeting all accreditation standards and using EHR, Group 2 – meeting all accreditation standards and using paper records, Group 3 – not meeting one or more accreditation standards and using EHR, and Group 4 – not meeting one or more accreditation standards and using paper records.
Fig. 1  a- An example of the expected accreditation outcomes for Standard 1 in the original accreditation report in PDF format. b- An example of the processed text format of the content presented in Figure 1a

<table>
<thead>
<tr>
<th>Expected outcome</th>
<th>Accreditation Agency decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Continuous improvement</td>
<td>Met</td>
</tr>
<tr>
<td>1.2 Regulatory compliance</td>
<td>Met</td>
</tr>
<tr>
<td>1.3 Education and staff development</td>
<td>Met</td>
</tr>
<tr>
<td>1.4 Comments and complaints</td>
<td>Met</td>
</tr>
<tr>
<td>1.5 Planning and leadership</td>
<td>Met</td>
</tr>
<tr>
<td>1.6 Human resource management</td>
<td>Met</td>
</tr>
<tr>
<td>1.7 Inventory and equipment</td>
<td>Not met</td>
</tr>
<tr>
<td>1.8 Information systems</td>
<td>Met</td>
</tr>
<tr>
<td>1.9 External services</td>
<td>Met</td>
</tr>
</tbody>
</table>

Fig. 2  a– An example of findings for Outcome 1.8 Information Systems in the original accreditation report in PDF format. b– An example of the processed txt format of the content presented in Figure 2a

**1.8 Information systems**

*This expected outcome requires that "effective information management systems are in place".*

**Team's findings**

The home does not meet this expected outcome

Management could not demonstrate that effective information management systems are in place. There are inconsistencies in the home’s clinical information systems in relation to duplication of assessments, incomplete assessments, and inaccurate care plans used to guide staff in resident care. Clinical incidents are not always reported. Incidents that are reported are collated, however the information is not analysed to identify trends or opportunities for improvements for individual residents or the home’s processes. The home has only implemented three audits to date in 2013. Gaps identified through these audits have not all been actioned.
Data Analysis

Both qualitative and quantitative data analyses were conducted in this study. Pearson’s Chi-square test was used to identify differences between the four groups of the RAC homes – those that used EHR systems or used paper records in meeting or not meeting aged care accreditation standards. The level of significance was set at p = 0.05.

Qualitative content analysis was conducted to identify and classify the indicators for not meeting accreditation Outcome 1.8 Information Systems. This enabled us to identify the statements that described the reasons for failing to meet this outcome. We compared these statements with the contributions of EHR to residential aged care suggested by the previous studies.

Results

Thirteen RAC homes were found to not meet one or more accreditation standards. These RAC homes and the relevant accreditation outcomes that at least one RAC home did not meet are listed in Table 2.

<table>
<thead>
<tr>
<th>Homes</th>
<th>Matching times</th>
<th>Details of matching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring Valley</td>
<td>1</td>
<td>...uality improvement plan 2012 Contractor database Electronic care planning, assessment and documentation program Emergen...</td>
</tr>
<tr>
<td>Sunset Village</td>
<td>2</td>
<td>...tion calendar, attendance and evaluation records Electronic care planning system Emergency evacuation plans and...</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>... evaluation, care plans are now completed on the electronic care planning system. Clinical staff are satisfied the ...</td>
</tr>
</tbody>
</table>

Risk Indicators for Failure to Meet Outcome 1.8 Information Systems

Six risk indicators were identified in the reports for the nine RAC homes using paper records that failed to meet the information system outcome (Table 3). Staff in six homes did not have access to accurate and appropriate information (R1). Monitoring mechanisms were not effective in identifying deficiencies in information systems in four homes (R2). Two homes did not always report clinical incidents (R3). There were insufficient records of residents’ clinical changes in two homes (R4). One home failed to produce accurate care plans (R5) and one home’s communication processes were not effective (R6). These deficiencies led the agency to conclude that these RAC homes did not have effective information systems.

Discussion

This study aimed at identifying the contribution of EHR to managing risks for information system accreditation in RAC homes. We found that EHR systems had already been adopted by 37.4% of 2754 RAC homes. Thirteen RAC homes did not meet all expected outcomes in the Australian standards. Of these, nine out of 12 that used paper-based records failed the outcome for information systems. Through analysis of the records for these nine homes, we identified six risk indicators in information systems, which were used by the accreditation agency to decide that the information system accreditation outcome had not been met. This provided insight about the areas of information system management to which RAC homes may need to pay attention and continuously improve.

The study findings indicate that the overall contribution of EHR to meeting aged care accreditation standards in Australia was very small. Only 9 (0.3%) RAC homes failed the information system outcome. This may cause stagnation in the adoption of EHR by the rest 62.6% of RAC homes that were still using paper records by the end of 2013. The further adoption of EHR in Australian RAC sector needs to be continuously followed. However, none of the RAC homes that used EHR for information management failed to meet that
outcome. Also, the proportion of RAC homes using EHR that met all accreditation standards was significantly higher than that of homes with paper records.

The aged care accreditation system in Australia is established to ensure an RAC service meets the minimum safety standard mandated by the Aged Care Act. It is not a quality ranking system, such as a star ranking system for e-Bay, which is available to the general public, thus providing the pressure and incentive for the aged care service providers to improve services. This explains why only 0.3% of RAC homes in this study failed the standard. Therefore, there is a lack of policy incentive for RAC homes in Australia to further improve quality once the minimum safety standard audited by the aged care accreditation system is met. This may cause inertia in the whole sector and stagnation in innovation, which needs to be further confirmed and studied.

Nevertheless the strength of this study is that it had the advantage of a nationwide overview of the performance of Australian RAC homes in information management and the possible contribution of EHR to this process. We believe it

Table 2

<table>
<thead>
<tr>
<th>RAC Home</th>
<th>Expected Accreditation Outcomes</th>
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<tbody>
<tr>
<td>R1</td>
<td>F F F F F F F F F F F F F F</td>
</tr>
<tr>
<td>R2</td>
<td>F F F F F F F F F F F F F F</td>
</tr>
<tr>
<td>R3</td>
<td>F F F F F F F F F F F F F F</td>
</tr>
<tr>
<td>R4</td>
<td>F F F F F F F F F F F F F F</td>
</tr>
<tr>
<td>R5</td>
<td>F F F F F F F F F F F F F F</td>
</tr>
<tr>
<td>R6</td>
<td>F F F F F F F F F F F F F F</td>
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Fig. 3 An outline of the RAC homes that used EHR or paper records, met or did not meet the accreditation outcomes, and whether they met or did not meet the accreditation Outcome 1.8 Information Systems

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Table 3

<table>
<thead>
<tr>
<th>Homes</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
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<tbody>
<tr>
<td>H1</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H2</td>
<td>F</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>H3</td>
<td>F</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4</td>
<td>F</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H5</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H6</td>
<td></td>
<td></td>
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<tr>
<td>H7</td>
<td>F</td>
<td>F</td>
<td></td>
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<tr>
<td>H8</td>
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<td></td>
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<tr>
<td>H9</td>
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</tr>
<tr>
<td>Total</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
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F = Fail information system accreditation outcome. R1: No access to accurate and appropriate information. R2: Monitoring mechanisms were not effective in identifying deficiencies in information systems. R3: Not reporting clinical incidents. R4: Insufficient recording of residents’ clinical changes. R5: Not providing accurate care plans. R6: Communication processes were not effective
provides some indication of the benefits from EHR in RAC, consistent with those found in previous studies using other methods [7, 8, 20–22].

An inevitable limitation is that what we have reported is an association between EHR and accreditation, rather than decisive evidence that use of EHR is a reason for RAC homes to perform better in accreditation. Also, the sample size for detailed analysis of risk factors for failing to meet accreditation standards is small. Another limitation of the study is it does not provide information on practice details of the sort obtained from observational studies with small numbers of homes.

Conclusion

This study identified six risk indicators for an RAC home to fail the information system accreditation standard in Australia. While a small number of RAC homes that used paper records failed accreditation standard on information systems, those that used EHR fully complied.

References

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