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Implementation of Artificial Intelligence Applications in Australian Healthcare Organisations: Environmental Scan Findings

Anna B. JANSSEN[a,1], Shah KAVISHA[a], Alison JOHNSON[b], Anna MARINIC[b], Helena TEEDE[b,c] and Tim SHAW[a]
[a] *Faculty of Medicine and Health, The University of Sydney, Sydney, NSW, Australia*
[b] *Monash Partners Academic Health Science Centre, Melbourne, VIC, Australia*
[c] *Monash Centre for Health Research Implementation, School of Public Health, Monash University, Melbourne, VIC, Australia*

Abstract. Artificial Intelligence (AI) has great potential to improve healthcare, but implementation into routine practice remains a challenge. This study scoped the extent to which AI and Natural Language Processing (NLP) is being implemented into routine practice in Australian healthcare organisations. An environmental scan of publicly available data was undertaken to identify AI applications. Publicly available data consisted of news posts from Australian public healthcare organisations and conference proceedings from key research organisations. Two researchers reviewed and analysed posts related to AI applications to create a list of potential implementation case studies. The final list of AI applications was reviewed by a governance committee in order to identify any missing applications. One application was identified by the governance committee and subsequently added. The environmental scan identified eighteen AI applications, of which eleven met all eligibility criteria. Only one application included NLP. Twelve applications were included when the application identified by the governance committee was added to the list. Implementation of AI applications is spread across four broad categories of use: 1) Decision Support, 2) Monitoring Treatment Effectiveness, 3) Personalised Care and 4) Risk Prediction.

Keywords. digital health, artificial intelligence, health services, health systems

1. Introduction

Healthcare organisations are increasingly adopting digital technologies to support the delivery of health services and support health professionals and teams [1]. The digital technologies used in the health system, termed Digital Health, describe a breadth of tools, platforms and applications [2]. Information systems such as Electronic Medical Records (EMRs) and Electronic Health Records (EHRs) are foundational digital technologies in this sector and are designed for the purpose of optimising individual level clinical care [3]. EHRs, EMRs and other clinical information systems are designed to collect both

[1] Corresponding Author: Anna Janssen, Charles Perkins Centre, The University of Sydney, email: anna.janssen@sydney.edu.au.

structured and unstructured data. These data have the potential to generate insights which can transcend individuals to inform health organisation and system transformation, but typically clinical information systems do not have analytical functionality built in by default.

Increasingly, AI applications are being applied to clinical or healthcare delivery settings to question, enhance, and understand the rich data sets in health information systems [4]. AI describes intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans [4]. Thus far, considerable focus has been placed on developing and testing AI applications, but there is a gap in understanding on how to embed AI into real world practice [5]. Challenges related to implementation of AI applications in healthcare include the need for accuracy, consideration of diversity and complexity and ethical issues. Other problems include variations in performance of Machine Learning (ML) algorithms with differences in software and data training sets [6] and algorithm suitability for dynamic population settings and understanding how embedding technologies in local contexts can influence performance [5]. There is a recognised need to establish a strategic approach, standards, and frameworks to guide the implementation of AI in healthcare [7]. Likewise, evaluation is important to inform the sector on the quality and efficacy of AI applications before regulatory approval and adoption [8].

2. Methods

The objective of this environmental scan was to scope the extent to which AI applications are being implemented into routine practice in Australian healthcare organisations to harness clinical data, particularly data from clinical information systems such as EHRs, and scope the extent NLP is being incorporated to question clinical data. An environmental scan was conducted between Aug. and Sept. 2021.

Healthcare organisations and conference proceedings were included in the environmental scan if there was publicly available information about implementing an AI application in the last five years (since 2016) and were an eligible organisation. Eligible organisations for the environmental scan included healthcare providers such as hospitals, primary care providers, aged care groups across Australia and conferences from key digital health associations in Australia. Eligible AI applications are those that used AI or NLP to mine structured or unstructured clinical data. Unstructured data included data such as PDFs, imaging and clinical notes routinely collected by informatics systems such as EHR and EMR. Applications also had to be implemented into routine practice or designed with the intention of implementation into routine practice in the near future, to be eligible for inclusion.

A member of the research team reviewed each document related to AI on eligible organisations' websites. If deemed relevant, data was extracted into a excel spreadsheet. This data was analysed by two researchers to answer the aims of the project and create a list of healthcare organisations implementing AI and NLP applications. The list of organisations identified through the environmental scan underwent a two-step review process. The first step included a review by the Australian Health Research Alliance (AHRA) data committee. The second step included inviting representatives from state/territory government agencies responsible for Digital Health strategy to undertake additional review of the list to ensure that no major AI/NLP applications had been missed as part of the environmental scan.

3. Results

The review identified 18 articles that described the use of AI applications in Australian healthcare organisations. Once duplicates were removed 14 AI applications remained. An additional three AI applications were removed from the shortlist as secondary review by the researchers deemed them to not fully meet the inclusion criteria, leaving 11 AI applications on the list. Of these 11 AI applications only one overtly described the use of NLP to question electronic health data. The application was being used to analyse structured and unstructured clinical data to identify patients at risk of presenting to emergency departments with sepsis.

The list of 11 AI applications being implemented in Australian healthcare organisations was subsequently reviewed by a governance committee and one additional AI application, that met the criteria for inclusion in the environmental scan, was identified. The majority of applications were being implemented in New South Wales (n=6), followed by Queensland (n=3), Western Australia (n=1) and South Australia (n=1). Refer to Table 1 for an overview of AI applications being implemented in Australian healthcare organisations and their key characteristics.

Table 1. An overview of Artificial Intelligence applications being implemented in Australian healthcare organisations, their key characteristics and which of the four identified application categories they aligned with.

Description of Application	Data Used	Implementation Context	Application Categories
App enhances detection of sepsis in emergency department waiting rooms by using AI component to extract EMR data and aggregate it with historical information to develop a patient risk score.	Electronic Medical Record	Emergency Care	Decision Support
An app uses AI to measure, analyse and treat patient wounds and stores the data in the patient's EMR.	Photographs	Wound Care	Decision Support
An app uses AI to analyse images taken by patients who are using an aligner on their teeth and detects tooth movements as small as 0.1mm.	Imaging, Photographs	Oral Health	Monitoring Treatment Effectiveness
AI used to customise treatment for patients with heart disease. The tool uses existing patients' history to automatically send customised life-saving information and education directly to their email or smartphone.	Patient history data	Heart Disease	Personalised Care
Photograph and OCT (Optical Coherence Tomography) taken to detect early signs of eye problems along with a regular check-up with their endocrinologist and diabetes educator. The AI tool analyses these images to detect eye problems and other complications early.	Imaging, Photographs	Diabetes	Risk Prediction
The platform maps data to standard terminology which can form a basis for other integrated AI to monitor and detect safety problems.	Electronic Medical Record and others	Emergency Care	Risk Prediction
AI and NLP tool that uses a predictive algorithm to scan data logged in the integrated EMR to help clinicians with the early identification of sepsis in patients.	Electronic Medical Record	Emergency Care	Decision Support
AI applied to data from COVID-19 patients to identify treatments that are most effective for COVID-19 patients in intensive care.	Clinical Data	Intensive Care Units	Monitoring Treatment Effectiveness
Early Warning Tool (CEWT) gives nurses an early warning score for patients at the bedside on the monitor and transferred vital signs into the EMR using wireless transfer.	Electronic Medical Record	Paediatrics	Risk Prediction
Tool uses AI to identify and categorise polyps as benign or malignant in images collected through colonoscopies.	Imaging	Colorectal	Decision Support
Risk of medication related harm is predicted using an	Patient	Coordinatio	Risk

integrated algorithm, and outputs support coordination of post-discharge care between hospital and community-based care.	readmission and post-discharge	n of Care Post-discharge	Prediction
Continuous patient monitoring system for vulnerable patients using AI to detect early signs of clinical deterioration.	Electronic Medical Record and others	Deterioratin g patients	Risk Prediction

The AI applications being implemented in Australian healthcare organisations were being used to harness a diverse range of clinical data. The majority of applications (n=4) were using imaging or photographic data, followed by data from electronic medical records (n=3). The application using NLP was one of the several (n=3) using EMR data. The remaining applications (n=2) were applied to a combination of data sets including imaging, EMR, pathology data, and patient risk indicators.

The AI applications were being implemented across a diverse range of health conditions and departments. Of the 12 AI applications, the most common implementation settings were in Emergency Care (n=3). The remaining AI applications were implemented in intensive care (n=1) , paediatrics (n=1), colorectal care (n=1), heart disease (n=1), wound management (n=1), oral health(n=1) and diabetes (n=1), identifying deteriorating patients (n=1) and coordination of care post-discharge from hospital (n=1). There were four broad categories of AI applications identified in the environmental scan: (1) Decision Support (n=4), (2) Monitoring Treatment Effectiveness (n=2), (3) Personalised Care (n=1) and (4) Risk Prediction (n=5). The four Decision Support AI applications could be split into sub-categories of: Early Diagnosis (n=3) and Treatment Decisions (n=1).

4. Discussion

This manuscript describes the findings of an environmental scan of publicly available information on the implementation of AI applications in Australian healthcare organisations. Regarding the extent to which AI applications are being implemented in routine practice in Australian healthcare organisations, this study found twelve that met this criteria. Only 1 of the applications was using NLP to question clinical data. Of the twelve applications, most collected data wholly or partially from clinical information systems.

Findings from the environmental scan indicate that there is only a handful of healthcare organisations who have implemented AI applications into routine practice. This finding confirms previous observations in the literature around the world [9]. The scan further identified four broad categories where AI applications were being implemented in healthcare organisations. Of these, the most common reason AI was being implemented was to undertake Risk Prediction tasks for a range of different patient cohorts. Findings from the environmental scan indicated there was a notable gap in the use of AI applications in Australian healthcare organisations to improve efficiency of organisational processes. This is surprising as it has been noted in the literature that AI applications have potential to improve healthcare processes through enhancements to resource allocation and delivery of administrative tasks [10]. However, this gap may be partially explained due to the number of barriers to implementing the technology in including determining fit within organisations, algorithm suitability for local contexts [11] and the complexity of regulation of AI and Digital Health more broadly [5].

5. Conclusions

This manuscript reports findings of one of the first studies to map implementation of AI applications in Australian healthcare organisations. Findings indicate there are few reported instances of these organisations implementing AI applications into routine practice. Of these healthcare organisations, appear to be implementing NLP applications. The AI applications being implemented encompassed four categories 1) Decision Support, 2) Monitoring Treatment Effectiveness, 3) Personalised Care and 4) Risk Prediction (n=5). Future research would be beneficial exploring why AI applications are not more widely implemented in this context.

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