Horizon Scanning Series

The Effective and Ethical Development of Artificial Intelligence: An Opportunity to Improve Our Wellbeing

Case Study on AI's Application in Health and Aged Care (With a Specific New Zealand Focus)

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Case study on AI's application in health and aged care (with a specific New Zealand focus).

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3-5 pages, with references.

1. What work is currently happening in this space in New Zealand?

A number of researchers around the world are studying interactive software applications on computers, tablets, smart phones, and robots, as potential assistive technology to help people who need assistance to remain living independently, as they must manage chronic health conditions. As the population ages, the need to help chronic diseases sufferers is increasing, while the available human workforce is shrinking, and technology may be one way to close the gap. These technologies have evolved from providing reminders to supporting healthcare as cognitive aids for monitoring health status via objective and subjective assessments, assistance (such as managing medication), entertainment, providing therapies such as physical and breathing exercises, classifying activity patterns, detecting possible falls, and helping with social support for loneliness. Over the last 10 year field trials were carried out in New Zealand to determine the acceptability, feasibility, and effectiveness of robots as cognitive aids to deliver this support. The work is a collaboration between South Korean researchers and companies, as the South Korean government is investing in personal service robots, and New Zealand researchers who are creating the software for the robot to undertake healthcare functions. The results show that robot assistance is acceptable to older people and staff in older care, that it is feasible to deploy such robots in people's homes and in older care facilities, and that there can be positive cost-benefits [1-32]. Studies of a companion pet robot show that robots can have psychological and physiological benefits for older people [33-38].

Other activities in New Zealand include technology such as robots and exoskeletons to manage rehabilitation for stroke sufferers, and development of effective direct brain-computer communication to help people control prosthetics and communicate with technology that can help them. Several researchers are studying the feasibility of using data gathered from wearable devices such as accelerometers, to estimate people's activity patterns, to indicate conditions such as dementia, to detect events such as falls, and potentially predict falls risk. A NZ wide project funded by the National Science Challenge "Science for Technological Innovation" is addressed personalised management of chronic

conditions in people's homes, for example using personalised models of a patient's type 2 diabetes (https://www.sftichallenge.govt.nz/research/portfolios/portfolio-3-medical-technology-home-and-community). There is a variety of advanced technology research and development in NZ for healthcare, including the Auckland Bioengineering Institute's focus on physiological modelling of all aspects of the human body, the ;NZ MedTech CoRE, and CMDT (cmdt.org.nz). Some work involves AI and over time more AI methods may be included in the complex modelling and analysis of human health. The Precision Driven Health partnership funded by the NZ government (http://www.precisiondrivenhealth.com/) also includes the potential to use AI methods for health management.

A recent study indicates that healthcare robots may help people with Chronic Obstructive Pulmonary Disease (COPD), a severe chronic respiratory condition, possibly reducing the length of hospital stays and improving adherence to medication for those who need help with it [39]. While medication and rehabilitation can help COPD sufferers, generally adherence to these treatments is low. Technologies that can improve adherence and provide monitoring may reduce hospitalisations, improve quality of life, and reduce healthcare costs. A small personal service robot, iRobi, was programmed to provide medication management, spirometer readings and blood oxygen monitoring, monitoring of activity, and symptoms, and be linked to Smart inhaler devices. The data from the robot and smart inhalers was monitored and if the early signs of an exacerbation were detected, appropriate advice was provided to patients. The hypotheses were that the robot would reduce hospital admissions and bed-care days compared to a control group, and improve mental health, quality of life, and adherence. This was a feasibility study with a novel technology and results were expected to provide initial data to inform a larger study. The project aimed to address a gap in knowledge about whether a robot in the homes of patients could help improve COPD management. Previous research has indicated that adherence to COPD medication is low, particularly for those who suffer depression and anxiety related to their illness. These psychological factors have been linked to a higher risk of hospital admission and to a greater expense to the healthcare system. Previous research has found that telemonitoring can reduce hospital admissions and improve quality of life. Robotic solutions as a mode of delivering healthcare interventions have been trialled with older people and found to be acceptable. People can build personal relationships with robots, and can regard them as a companion, decreasing anxiety and loneliness. The implementation of a robot in the home may therefore, not only provide healthcare support but help improve psychological well-being, especially for those who live alone or in a more geographically isolated community. Patients in the robot group spent fewer days in hospital over the study period. Although there were no significant differences between groups in COPD quality of life, medication adherence, loneliness and depression, those in the robot group had a trend towards better outcomes. Some patients who had the robot had significantly better adherence than the control group. Most patients had favourable attitudes towards the robot. This pilot study suggests that the robots can reduce days of hospitalisation, increase adherence and improve functioning, symptoms, loneliness, and self-efficacy. This may reduce healthcare costs, reduce strain on services, and improve patient quality of life. This was the largest randomised controlled trial in the world to test whether robots in people's homes in the community can reduce hospitalisations and improve health and adherence.

Recent, ongoing work is adding more reasoning, and more human-like interaction, to the functions of this kind of software, and comparing the effectiveness of the software on robots

versus tablets. This work includes the design of robots to help people with mild dementia, and the design of social human-robot interaction capability. This includes developing a robot receptionist who can work with or without a human receptionist. The robot receptionist is being given an artificial emotion system so that it can “show” empathy and sympathy. Chatbot technology and speech recognition can now be feasibly included in such a robot assistant. However further research is needed in order to provide the depth of understanding and reasoning required to provide personalised and adaptive help to patients, which is a step beyond the current fixed dialog of the healthcare robots studied so far.
Similar technology is being developed for text chatbots, and for avatars by NZ companies such as Soul Machines and FaceMe.

2. What are the issues for New Zealand around AI in health and aged care?

The study in [39] found a number of issues that should be addressed for scaled up deployment of robotics to help people with chronic conditions such as COPD in their homes:

1. Internet connectivity is not sufficiently reliable in some areas while healthcare assistive devices need effective network connection for communicating with cloud services, enabling remote monitoring and supervision of the robot functions and patient status. Solutions should include both improved internet infrastructure and also software on the robot or device that is able to manage intermittent network disruption.
2. The implementation of technology for use by patients in their homes, should be very reliable and robust to error conditions, unusual inputs and interactions. This is a challenge for new technology as the software requires considerable time and effort to become mature.
3. Current personal service robots are not yet fully developed. The most suitable physical form and functions are not yet fully optimized. Recent developments such as the Jibo robot that emerged from the MIT media lab, and the Kuri robot from Bosch, have suffered severe commercial setbacks; the market and technology for such robots is yet to be fully realised.
4. Software integration of devices in people’s homes is underrated as a significant issue. The robot functions must be integrated in to the human healthcare workflows, so that carers are able to fully realize the benefits and efficiencies that are available. In addition the software must be integrated with healthcare IT systems so that the robot can be fully aware of the patient’s clinical context, and so that the robot is able to upload and download the patient’s information to and from doctors’ and nurses patient management systems, including the NZ e-prescription service, and the NZ drug database.
5. Hardware integration with medical monitoring devices is an limitation at present. Vital signs measurement devices do not have a standard hardware nor software protocol. They are largely used as individual devices and results recorded manually. Electronic connectivity will be essential if technology is to be widely used in people’s homes in the future. For the devices to be inexpensive and widely used, standards for connection will be essential (as in the PC market for USB devices, for example).
6. Assistive devices used for healthcare in people’s homes will need technical support 24/7, and will likely require 24/7 clinical support from something like the NZ

healthline. Probably the technical support knowledge and the clinical support knowledge will be needed via one call line as patients will not be able to clearly distinguish the two needs.

7. For full acceptance by patients, robots and other technology must be non-stigmatising, easy to use, and perceived as useful to the patient.
8. Current robotic technology mobility is via wheels and currently robots are not able to navigate older buildings with narrow corridors, outside steps or non-level ground.
9. Software for reminding people to take medication, or making recommendations about health, will need to be certified somehow; a technology development stream should address this requirement early on, for example using validated model development for these functions, and generating software from the model (the generator will need to be validated also).
10. Privacy must of course be maintained, which requires new analyses of the privacy risks introduced by robots and other automated networked connected devices to ensure data is secure and the risk of device hacking is minimised.
11. New ethics issues should be studied, that maintain the dignity of patients and staff in a world where robots, AI and devices are intimately connected to people's personal health status.
12. Family members and older people will require more training in technology in order to well use the new technologies.
13. New funding and cost effectiveness models are needed, in order to introduce AI technologies in to healthcare systems that are currently stretched for funding, and lack funding pathways for new technologies.

3. Are there any distinct opportunities for New Zealand?

New Zealand's distinct opportunities include the following points:

- The healthcare system has just one level (the DHBs), and compared to other countries is relatively straightforward and consistently governed. There are also a number of significant private healthcare providers, some of which are innovative and have the resources for substantial deployment of technology through PHOs, pharmacies, and doctors' practices.
- NZ Health IT is world leading and a number of small and medium sized companies have substantial ability to carry innovations to both the NZ and international market places (eg Orion Health); coordinated by the NZ Health IT Cluster.
- NZ is a very suitable testbed for health technology, as it is a small, isolated country, with a broad range of ethnicities and cultures. It is a suitable place for large internationals to evaluate AI technology in health.
- NZ has a strong focus on health innovation, such as the three national science challenges focused on health, and in addition the national science challenge focused on high value nutrition.

4. What does the Horizon hold in this area?

The healthcare system has few choices in addressing the growing economic burden of chronic disease as the population ages and the incidence of such conditions grows. While there is much discussion in the media about robots and AI empowering people to remain

living happily and healthily despite carrying chronic conditions, there is little commercialised. The technology must take some significant steps in terms of its depth of knowledge and ability to reason about people's health needs before it will motivate companies to create products that do more than surface interactions. Considerable research is needed. NZ is well places as an innovative country with a willingness to work across disciplines to create such technologies. However NZ lacks the large scale of multinationals that may be needed to introduce this technology across the world, and may need to partner with such companies to provide a suitably scaled solution. NZ may find niches in providing parts of the software needed for such innovations, in diagnosis, monitoring support, reduce depression, loneliness, relieving caregiver burden.

Rest homes already using the robotic seal pet Paro, however this device is expensive and we expect to see much cheaper similar devices in the future. The future also has potential for home support robots doing practical tasks, giving companionship, and helping with cognitive tasks so that people can stay at home for longer.

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