The Australian e-Health Research Centre: enabling the health care information and communication technology revolution

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ABSTRACT

- The CSIRO (Commonwealth Scientific and Industrial Research Organisation) and the Queensland Government have jointly established the Australian e-Health Research Centre (AEHRC) with the aim of developing innovative information and communication technologies (ICT) for a sustainable health care system.
- The AEHRC, as part of the CSIRO ICT Centre, has access to new technologies in information processing, wireless and networking technologies, and autonomous systems.
- The AEHRC's 50 researchers, software engineers and PhD students, in partnership with the CSIRO and clinicians, are developing and applying new technologies for improving patients' experience, building a more rewarding workplace for the health workforce, and improving the efficiency of delivering health care.
- The capabilities of the AEHRC fall into four broad areas:
  - smart methods for using medical data;
  - advanced medical imaging technologies;
  - new models for clinical and health care interventions; and
  - tools for medical skills development.
- Since its founding in 2004, new technology from the AEHRC has been adopted within Queensland (eg, a mobile phone-based cardiac rehabilitation program), around Australia (eg, medical imaging technologies) and internationally (eg, our clinical terminology tools).

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In the *MJA*, Van Der Weyden[1] called for Australians to "rediscover our courage and commitment and move health care into the new millennium" by developing a robust health information technology infrastructure. There is already activity on several fronts to achieve this aim. The National E-Health Transition Authority (http://www.nehta.gov.au/) is putting in place the building blocks of an e-health infrastructure: individual patient and provider identifiers, a set of terminology standards, and standards for a shared, electronic health record. However, implementing and realising the benefits of this infrastructure will require innovation.

The CSIRO (Commonwealth Scientific and Industrial Research Organisation), as part of Australia's National Innovation System, has a wealth of experience in developing and applying technologies in a range of sectors. Over the past 30 years, the CSIRO has developed technologies for use in the medical sciences, from early work on the use of ultrasound in medicine[2] through to the innovative use of videoconferencing between emergency departments.[3] All these developments have been forerunners of commercial and widely used technologies.

In 2004, the CSIRO Information and Communication Technology (ICT) Centre, together with the Queensland Government, established the E-Health Research Centre, now the Australian e-Health Research Centre (AEHRC). The AEHRC is an unincorporated joint venture between the CSIRO and the government, through Queensland Health and the Department of Employment, Economic Development and Innovation. The AEHRC gives CSIRO scientists the opportunity to work with clinicians and health service executives in the development and piloting of new health technologies, with the aim of improving patients' experience, building a more rewarding workplace for the health workforce, and improving the efficiency of delivering health care.

The AEHRC consists of 50 researchers, software engineers and PhD students working in two main areas: information systems and biomedical imaging. Since 2004, the AEHRC has achieved critical mass research capabilities, which are now being used across a range of projects in the health system around Australia and internationally.

Research capabilities and projects

As part of the CSIRO ICT Centre, the AEHRC has access to new technologies in information processing, wireless and networking technologies, and autonomous systems. As well, the AEHRC contributes substantially to the program of the CSIRO's Preventative Health Flagship, one of the National Research Flagships, and collaborates with scientists from across the CSIRO.

The capabilities of the AEHRC fall into four broad areas: smart methods for using medical data; advanced medical imaging technologies; clinical and health care interventions; and tools for medical skills development. We outline here the range of e-health projects undertaken by the AEHRC, and introduce the articles in this Supplement.

Smart methods for using medical data

Information is the currency of health, from patient data captured at the point of care, through to secondary data use for reporting and research and, finally, the development of clinical guidelines. The Health Data Integration (HDI) project, the first major project undertaken at the AEHRC, aimed to provide a data linking and transfer tool designed for the health environment.[4] The HDI project, through the CSIRO Preventative Health Flagship, partnered with key clinicians to use linked data to examine the effectiveness of the faecal occult blood test for detecting bowel cancer,[5] now a major screening program in Australia.

The HDI project spawned many new research projects to capture and analyse health and medical data. Crilly et al (*see page S34*), taking data from three health information systems, compared the relative accuracy of manual data linkage and automated data linkage using the HDI software. The linked data are being used to investigate health service delivery outcomes.

Because multiple data dictionaries are used to capture data, the Snapper toolkit[6] has been developed to allow all data items to be described with concepts from the Systematized Nomenclature of

Medicine – Clinical Terms (SNOMED CT), a systematically organised computer-processable collection of medical terminology. While initially developed to enable secondary data use of existing data collections, the Snapper technology also has the potential to improve primary data capture and clinical decision support (*see* Hansen et al, *page S8*). One part of the platform has also been adopted internationally for further development of SNOMED CT.[7]

Another project concerns the extraction of information from medical narratives. Initially, this involved extracting synoptic statements from pathology reports for the purpose of inferring a stage for patients with lung cancer when reported staging data were incomplete.[8] This was done in partnership with the Queensland Cancer Control Analysis Team. Current research is examining how clinical terminologies, such as SNOMED CT, can improve this process and allow generalisation to other cancer types and, in the future, to other types of medical narratives, such as clinical notes or radiology reports, which could then be used in clinical decision-support algorithms.[9]

Data analysis is also a key area of research at the AEHRC. Current research includes analysis of physiological data from increasingly complex anaesthetic machines,[10] and statistical analysis of administrative and clinical data.[11]

Advanced medical imaging technologies

With the increasing use of medical imaging for diagnosing and treating patients, new algorithms are needed to extract the maximum amount of information from the captured images, and to automate standard image segmentation tasks. The MILXview platform (http://www.csiro.au/science/MILX.html) provides algorithms for the processing of medical images; these can be reused, depending on the image capture mechanism and the tissue being imaged.

Working with the CSIRO's Preventative Health Flagship, AEHRC researchers have used the MILXview platform to analyse 200 brain images for cortical thickness and uptake of amyloid-β plaque. The images are from the Australian Imaging, Biomarkers and Lifestyle (AIBL) study of ageing.[12-14] The aim is to correlate the images with the diagnosed cognitive state of the patients over a 3-year period to develop an atlas of the brain that will allow earlier diagnosis of Alzheimer's disease (*see* Ellis et al, *page S20*). This research has also given the AEHRC experience in dealing with clinical trials data and an opportunity to use tools developed for health and medical data in a new area. McBride et al (*see page S12*) also used data from the AIBL study of ageing to create a normative dataset and developed the Cognitive Performance Calculator, a web tool that uses the normative dataset to distinguish cognitive decline from normal age-related cognitive change.

The MILXview platform is also being used to improve radiotherapy treatment planning for prostate cancer[15] and cancers of the brain. On *page S24*, Greer et al describe an alternative treatment planning method for prostate cancer.

Clinical and health care interventions

New models of care are needed for a sustainable health care system. While videoconferencing technologies are being increasingly used, the novel use of wireless technologies, mobile phones and the internet allows a more flexible approach to cardiac rehabilitation programs. Through a randomised clinical trial (the Care Assessment Platform trial) in the Metro North Health Service District (Qld), the AEHRC and Queensland Health aim to show that cardiac rehabilitation programs offered remotely with the aid of ICT provide the same clinical outcomes as rehabilitation programs run in hospitals or community centres,[16] and are a cost-effective alternative to these currently underused programs. Increased uptake of, and adherence to, ICT-enabled cardiac rehabilitation programs would mean that expensive hospital readmissions may eventually be reduced (*see* Varnfield et al, *page S15*).

Statistical analysis of data can also provide information for health services to use for planning purposes. In conjunction with the Gold Coast Hospital (Qld), a Patient Admission Prediction Tool has been developed that allows hospitals to predict patient load and plan accordingly.[17] Based on an analysis of emergency department data, Boyle et al, on *page S28*, describe approaches to predicting and tracking influenza epidemics.

Tools for medical skills development

Workforce issues continue to be a challenge for a sustainable health care system. Increasingly, simulation technologies will be used for training, and perhaps accreditation, of clinical staff (*see* de Visser et al, *page S38*). Using the AEHRC's capability in medical imaging, an advanced colonoscopy simulator has been developed in conjunction with École Polytechnique Fédérale de Lausanne, Switzerland.[18]

While it is often clinical skills that receive the most attention, interpersonal communication problems within the health workplace can lead to adverse patient outcomes.[19] A novel research project at the AEHRC is examining interpersonal communication in multidisciplinary care meetings. Together with Griffith University (Qld) and Queensland Health, team meetings are being recorded, and interpersonal communication coded (*see* Harden and Locke, *page S42*), with the aim of better understanding what makes a successful health care team.[20]

Project results

Already, the projects delivered by the AEHRC for building a sustainable health care system show the value of the CSIRO's place within the National Innovation System.

Improving patients' experience

Initial feedback from the Care Assessment Platform trial indicates that undertaking cardiac rehabilitation in the community using ICT is well accepted by patients, with more patients adhering to the home-based rehabilitation program compared with conventional rehabilitation.

While all projects aim to improve patients' experience, two in particular — reducing waiting times at emergency departments through better resource planning,[17] and improving radiotherapy treatment for prostate[15] and brain cancer — fulfil this aim.

Building a more rewarding workplace for the health workforce

Providing advanced training in performing difficult colonoscopies gives confidence to clinicians, and can lead to a safer, more rewarding workplace. While this is a concrete example of improving the workplace, successful organisations also have a culture of supporting innovative ideas for improving the safety and quality of health care. The AEHRC aims to provide research support and technology for the many new ideas put forward by clinicians and executives. An example of this is the Patient Admission Prediction

Tool, which originated as an idea from the staff of the emergency department at the Gold Coast Hospital.

Improving the efficiency of delivering health care

Efficiencies in health care models will often have multiple benefits. While the major benefit of a mobile phone-based cardiac rehabilitation program might be the ability to offer it to more people for a similar price, doubling the number of patients who complete rehabilitation to 30% could save $50 million in hospital readmission costs. The AEHRC is now also working to build tele-ophthalmology services for people in remote areas of Western Australia.

The report of the National Health and Hospitals Reform Commission recommended "a transforming e-health agenda to drive improved quality, safety and efficiency of health care".[21] As an ICT centre, most of the projects undertaken at the AEHRC deal with getting information to where it is needed, when it is needed. In supporting one of the key building blocks of the national e-health infrastructure, it is hoped that the Snapper platform,[6] in particular, will play a key role in this transition.

Conclusion

Over the first 5 years of its operation, the AEHRC, in partnership with clinicians and health service executives, has become a centre for innovation and development. Over the next 5 years, many of the projects and technologies described will mature and be adopted. However, with access to the scientific expertise of the CSIRO, and through partnerships with health service providers and academia, the centre will play an increasingly important role in the development of a robust health ICT infrastructure for the Australian health system. The use of ICT can improve the efficiency of health services and make the clinical environment a more rewarding place to work. However, improving the journey for patients is the key aim.

Competing interests

None identified.

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