Professor Carolyn McGregor: Using Big Data to save tiny lives

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Video:

Computer scientist Carolyn McGregor has developed a disruptive technology utilising big data, that is set to start a new era in personalised medicine. Her life-saving Artemis IT platform analyses patterns in data such as heartbeats and breathing in newborn babies and spots problems before they are apparent to medical staff. The approach has great potential to save lives and is now being applied beyond the neonatal intensive care ward to astronauts and tactical response units.

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In 1999, computer scientist Carolyn McGregor found herself in a neonatal ward in Sydney's Nepean Hospital, surrounded by newborn babies, each connected to a range of medical monitoring devices.

"I was watching all of these medical devices flash different numbers, alarms going off, and I was just looking at the sheer volume of the data and thinking there's just such a rich source of data here and wondering what was happening with all the data that was on the screen," she recalls.

McGregor, Canada Research Chair in Health Informatics based at the University of Ontario Institute of Technology, Oshawa, Canada discovered that measurements were being jotted down on paper charts every 30 or 60 minutes. "I thought, these numbers are changing every second or even faster. There's so much we could potentially do with all of that," she says.

That meeting was the spark for McGregor's work in the use of big data in neonatal health and she is now a leading international researcher in critical-care health informatics. Before moving to Canada in 2007, McGregor established, grew and led Health Informatics Research at the University of Western Sydney, where her internationally recognised research was supported by over $1 million in grant funding from sources such as

the Australian Research Council and the Telstra Broadband Fund. This was foundational research that led to her going on to establish her award winning Artemis Platform.

Typically a nurse in an intensive care ward watches a patient's breathing and heartbeat, essentially to make sure they're still alive and haven't gone into cardiac arrest or another life threatening situation. But as McGregor suspected, the data can tell doctors and nurses so much more than that, when harnessed and analysed properly.

Subtle changes in the pattens of breathing, heart rate and other indicators can all show changes in the patient's condition that might indicate something more serious, but are undetectable from traditional observation.

For instance, neonatal sepsis is the leading cause of death among new-born babies in both the developing and developed world.

"If you watch the behaviour of the heart, the heartbeat actually starts to become very regular or more regular if the body's coming under stress, like it does when you have an infection. So because we watch every beat of the heart, we can tell if we're starting to see a regular heart rate. Couple that with some other indicators and it gives doctors a better tool to help them to say this is probably infection," says McGregor.

The Artemis platform which McGregor and her research team have developed records more than 1,200 readings every second, helping doctors harness and manage all of the information that the medical devices produce, and providing a mechanism to analyse all that information in complex ways. It allows them to choose which indicators and conditions they want to monitor, and track those important subtle changes.

It is a lifesaving technology for the tiny patients where a few hours can make a major difference in recovery rates. "We can see these patterns sometimes 24 hours before the baby starts to really succumb and show signs of an aggressive infection," McGregor says. Neonatal infections can cause lifelong health care issues for sufferers, such as with their lungs.

Along with improving outcomes for individual patients, the technology has the potential to help health care systems save money. For instance, if a baby acquires an infection in the neonatal unit then the length of their stay is typically doubled – a two-month stay becomes a four-month stay. Identifying and treating these infections earlier has the potential to slash these times.

So far the Artemis platform is being used in partnering hospitals in Canada, China and the United States. It has developed to the point where it is scalable and will be rolled out to more hospitals in the near future.

McGregor says neonatal babies are arguably the most complex patient population, so solving a problem for them first, means it will be easier to solve for other populations. Indeed, McGregor's work has applications beyond neonatal critical care. Variations in the heartbeat, for instance, can indicate a viral or bacterial infection, the onset of depression, drowsiness, or post-traumatic stress disorder.

It also has application beyond the traditional healthcare sector. A conversation with former Canadian astronaut Dave Williams led to a joint project with the Canadian Space Agency and NASA on how the technology can be used to monitor the health of astronauts when they travel into space.

Astronauts share several similarities with neonatal babies, McGregor says. "Both have to do with adaption. There's a physical body change when a baby is born, and when it's born early the change happens before the body's ready. The lungs have to start to functioning to provide oxygen to the body and the heart changes its function when you're born. And when an astronaut goes into space, they have to deal with weightlessness, there is a risk from radiation and the impact of weightlessness on the body can cause problems. We need monitoring systems to help watch the body adapt," she says.

There are plans to use the system on NASA's planned journey to Mars in the next couple of decades, because there will be weeks at a time when the alignment of the moon and the planets cut the astronauts off from communication with Earth.

McGregor is also working with tactical response teams.When soldiers or police have to clear a building or rescue a hostage, their adrenalin can surge and their heart rate can accelerate to such an extent that they're at risk of passing out. A platform called Athena gathers and monitors the soldiers' physical indicators as they complete virtual reality training and provides analytics of how their body is behaving during the training activity. In this way they can understand how they are behaving in those scenarios which helps them learn how to control their physical reactions.

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McGregor grew up in the Hills district of Sydney's north-west and says she always had an affinity with maths and enjoyed logic puzzles, so her maths teacher suggested she study computing after finishing school.

She enrolled in computer science at the University of Technology, Sydney and at the same time worked at St George bank as a computer science cadet. Following her studies, she joined and ultimately led a project at St George to set up what was then called an executive information system and would now be referred to as big data. "It was the first of the new type of computing systems to analyse the way the business ran as opposed to the computing systems that we originally had which were systems to help the company run," she says.

After a stint at Woolworths using data to understand what customers were buying and how to group products in the store to induce them to spend more, McGregor enrolled at the University of Technology, Sydney to do her PhD in computer science, and then began to teach part time at the University of Western Sydney (now Western Sydney University)

It was then that Dr Mark Tracy, a neonatologist from the Nepean Hospital, approached the University of Western Sydney and said he'd like to work with the computing and maths departments because he had more data than he knew what to do with – a visit that set McGregor on her current path.

McGregor says the practical experience that many Australians gain during education by being required to spend time working in companies while they study, is invaluable and an opportunity that many other countries do not provide.

As McGregor completed her undergraduate degree, she was one of only five women in a class of around 100. Sometimes women in science and IT can have inferiority complexes she says. But a well-functioning innovative environment needs different perspectives and people of different backgrounds, genders and cultures, she says. "So for women I would say, acknowledge the skill set that you have and the abilities that you have. You have a fantastic potential to make a significant difference in the technology space."

Australian workers are highly regarded overseas, she says. "I think the Australian culture is to just get in, contribute, make a difference, get it done. We have a very good reputation as a highly skilled workforce to come into companies, whether you're bringing innovation or you're just bringing commitment," says McGregor.

While McGregor currently bases herself in Canada, she is is an honorary professorial fellow at the University of Wollongong, south of Sydney which enables her to supervise students in Australia and also to bring her research to Australia.

McGregor says she is inspired by the possibilities for further innovations in the use of big data for medical research.

“I really think we’re just at that tip of the iceberg of a whole new wave of doing research in the medical space,” she says. “

“This is the new face of health care. In partnership with genomics, for every individual using fitbits and other personalised devices, the way forward will be to manage your own health and wellness. We are building the platforms and tools to do this.”

Find out more about Australian women breaking new ground in science.
