

Emerging Health Technology Advice

July 2019
V0.4



for Robotics in Healthcare

Introduction

The Emerging Health Technology (EHT) Team is part of the Ministry of Health Data and Digital Directorate, responsible for understanding and advising on the impacts of new technology across the health & disability system.

In general we seek to:

- outline where new technologies are being used in the health sector
- highlight what impacts the technology may have to current models of care
- set the scene for future conversations where the technology may be applied and present general considerations for health sector stakeholders.

This is the first step into discovering a technology. There are many other aspects to consider, whether clinical, funding or technical, however we're not trying to cover everything – **merely start the conversation**.

For Robotics in Healthcare

The focus for this document is robotic technology that is beginning to be implemented in healthcare settings around the world. There are plenty of cool things on the horizon, like nanobots, which are in the first stages of research. Whilst nanotechnology is advancing, real world applications in healthcare are yet to be fully investigated. We look forward to these becoming more than just a conceptual idea, with the development of evidence and solutions enabling progress into something that could benefit the New Zealand public in years to come.

Our intended audience is those who are interested in how emerging technologies will benefit their health services, or who maybe just want a bit more information on what it's all about.

This document provides a snapshot of what is happening both locally and internationally, and identifies some health policy questions. It is not intended to endorse a specific product or service.

What do we mean by **Emerging**?

We look at where the technology sits within [McKinsey's Three Horizons of Growth](#).

Is it an improvement to the current model – like improved road tyres, or will it be disruptive – like driverless cars?

In this case, robotics that assist pharmacists dispensing is an improvement on the current delivery model (Horizon One). Companion robots with some of the specific technology components like empathetic Artificial Intelligence (AI) sitting in the disruptive space (Horizon Three).

How does this relate to the **Technology**?

The Horizon One and Two technologies have been readily available for some time in other industries, however the need for more stringent scientific and economic validation means they are still quite new in terms of the healthcare system.

Where does this all sit in the New Zealand **Health** context?

There are researchers and private companies who are offering these technology services, however it is still in its infancy compared to what is available overseas. Access to the latest technology and research is often self-funded and expensive.



Robotics – what is it?

How does this relate to healthcare?

Robotics in the health sense can be divided into three main functions, those that:

- assist an individual - eg patients & workforce
- aid the overall system - eg pharmacies & hospitals
- support digitally

New Zealand's healthcare system is labour intensive. The healthcare and social assistance sector is New Zealand's largest employer, with the combined District Health Boards (DHBs) having over [72,000 employees](#).

Robots can help improve operational efficiencies by taking over low value administrative or repetitive clinical tasks – such as monitoring patient's vitals and logging the patient data into an Electronic Health Record (EHR).

Where can robots be used within the health system?

Surgical robots – allows surgical operations to be carried out with greater precision than an unaided human surgeon, and/or allows remote surgery where a human surgeon is not physically present with the patient.

Telepresence robots – allow off-site medical professionals to move, look around, communicate and participate from remote locations.

Disinfection robot – has the capacity to disinfect a whole room in minutes, generally by using pulsed ultraviolet light. Beneficial for preventing hospital acquired infections (such as MRSA).

Companion robot – also known as 'carebots' have the capability to engage emotionally with patients, keeping them company and alerting if there is a problem with their health. Some have a combination of touch sensors, cameras and microphones. Embedded displays can remind users about medication adherence.

Pharmacy automation – robotic systems to dispense pharmaceuticals either in a retail or hospital pharmacy setting (eg sterile IV admixtures).

Supply-chain robots – automated storage and retrieval for goods – from medical instruments to laundry, meals to blood samples.

Assistive robots – used as tools for rehabilitation, training, therapy or mobility – such as exoskeletons, assisting the lifting of patients, prosthetics and orthotics.

Patient simulation robots – clinical training with a realistic robotic patient that can simulate human physiological responses. Can be used in a multitude of different high-risk or rare medical procedures and patient cases within a team-based learning environment.

Robotic Process Automation (RPA) – software robots that are configured to carry out business processes previously done by people. The software acts as a virtual worker, programmed to carry out operational procedures eg financial transactions or health records. Main benefit being cost and time savings.

So, what is a robot?

A machine, especially one programmable by a computer – capable of carrying out a complex series of actions automatically. They can be guided by an external control device or the control may be embedded within.

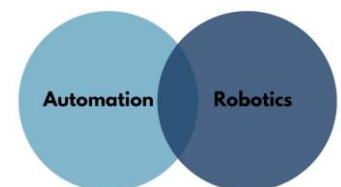
[Wikipedia](#)

Robotics is the branch of technology that deals in the design, construction, operation and application of robots, as well as the computer systems for their control, sensory feedback, and the information processing.

Automation vs Robotics

“Automation” and “Robotics” are sometimes used interchangeably, however there are minor differences between the two.

- Automation is the process of using technology to complete human tasks
- Robotics is the process of developing robots to carry out a particular function



Not all types of automation use robots – and not all robots are designed for process automation.



Where is robotics being used in New Zealand?



The da Vinci robot is a specialised surgical device used for complex and delicate surgeries, predominantly urological and gynaecological procedures.

Robotic assisted surgery was first performed in 2007 at Grace Hospital, Tauranga, where surgeon Peter Gilling performed a robotic assisted prostatectomy for a patient with prostate cancer. There are three da Vinci robots currently operating private hospitals in New Zealand, Grace Hospital in Tauranga, and Southern Cross Hospitals in Auckland and Christchurch.



Completely operated by a surgeon through a magnified 3D vision system, the robot technology translates the surgeon's hand movements into smaller and precise movements. A movement of five centimetres by the surgeon's hand at the control console can translate to a movement of one centimetre by the miniature instruments inside the body. That enables very precise and gradual movement in delicate areas involving high concentrations of nerves and blood vessels, minimising the risk of complications.



The system can't be programmed or make decisions on its own, so patients can be assured their procedure is still performed entirely by their surgeon.

Medical specialists have the appropriate accreditation to operate using the robotic systems.

Healthcare Holdings Limited is using RPA for processing all ACC invoicing and receipting for Auckland's Mercy Radiology. 'Matilda', the virtual worker spends two hours a day doing a task that previously took two people around three to five hours a day. The Matilda software moves data very quickly and accurately, which has led to a 10 per cent reduction in error rates for these processes. As a virtual worker, the software also does not need a desk or any space or equipment. There is also a cash flow benefit as the software submits daily to ACC, whereas previously this was done weekly.

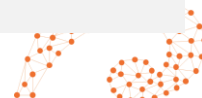


Mercy Radiology and Clinics partnered with RPA specialists Virtual Blue and developed the Matilda software in six weeks using Blue Prism technology.

Automating essential repetitive tasks and processes staff currently do day in, day out, allows the people who previously did these tasks to have their roles expanded as they now have time to perform more value-added activities.

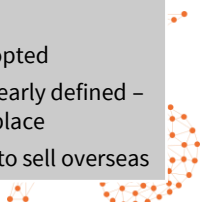


The use of RPA will allow the organisation to continue to grow without having to increase headcount to manage these essential but repetitive processes. RPA means investing in a virtual workforce as part of overall workforce strategy to support continued growth.



Considerations for health sector stakeholders

Stakeholder	Opportunities	Risks
NZ Public/ Patients	<ul style="list-style-type: none"> Healthcare is easier and faster for people to access Robotic services can be in places healthcare workforce can't – eg rural setting controlled by a remote clinician Patients will experience a smoother journey through the healthcare system by automation of processes The service can be easily tailored to the person – eg personalisation of care plan for companion robot More services can be delivered for the same spend 24/7 access to services that are always reliable 	<ul style="list-style-type: none"> Access to technology may not be publicly funded, out of private financial reach for some individuals Aversion to/distrust in new technology – not enough information out there to feel comfortable in its adoption Robots for the sake of robots aren't the answer, needs to be useful to the patient A public perception of “robots stealing jobs” Engagement feels impersonal, and lacking ‘human touch’
Healthcare Workforce	<ul style="list-style-type: none"> Ability to offer new technology and services to patients Allows automation of physical tasks so workforce can focus more on a patient's care/wellbeing Repetitive tasks are reduced leaving more time for patient care and other more rewarding tasks Increases accuracy of service delivery - removes a substantial amount of human error 	<ul style="list-style-type: none"> Retraining time and costs for adopting new technology Parts of current role can be made redundant New capability may be mismatched to current skillset Shift in workforce focus to higher cost services Loss of tactile and sensory dexterity in the workforce Detailed understanding of business process/workflow can be lost Invisibility of the new process masks risk and opportunity
DHBs/ Hospitals	<ul style="list-style-type: none"> Ability for tasks to be completed 24/7 – robots do not tire Potential to lower overall operating cost or improved productivity over time More joined up and efficient workflow Better and more consistent outcomes for patients A more engaged workforce – better retention 	<ul style="list-style-type: none"> Up front investment needed to cover cost of implementation Planning for maintenance, upgrades, security patching etc Workforce needs to adopt new skill set for new technology to become mainstream Continuous improvement of the robot and automation is important to gain most of the benefits Ensuring or developing appropriate evidence including economic benefits for new technology is required
Ministry of Health	<ul style="list-style-type: none"> Adoption of new technology can improve overall productivity of the health system Better health outcomes for specific population groups in an earlier timeframe Increased value for money (allocative efficiency) in service delivery Health dollar stretching further – lower cost eventually as technology adopted Equity of access improves 	<ul style="list-style-type: none"> Security of health information and technology devices Potential for inconsistency and inequity of adoption over regions (AKA postcode lottery) Need for review of regulation and procurement of devices & services – Medsafe/Pharmac
Research/ NZ Inc	<ul style="list-style-type: none"> Opportunity to access population for research, scaling up of commercialisation to access bigger markets Ability to leverage strength in adjacent industries eg MPI 	<ul style="list-style-type: none"> First adopters hard to find Research outcomes not necessarily adopted Commercialisation pathways are not clearly defined – disconnect between pilots and marketplace Not making the most of our reputation to sell overseas



Considerations for health sector stakeholders – A deeper dive

Public/Patients

As technology in healthcare evolves, patients are accessing faster and better diagnoses, more effective treatments, and have more opportunities enabled by technologies to live healthier lives.

Companion robots have been piloted in research studies within New Zealand, and have shown benefits in emotional well-being, medical adherence and rehabilitation.

Robotic exo-skeletons such as those developed by New Zealand's [Rex Bionics](#) are bringing newfound mobility to users worldwide, providing physiotherapy to and improving physical and psychological well-being of people with mobility impairment.

Robotic Process Automation, whilst not overly visible to the public, has streamlined a person's access to the health sector. It is being used for appointment booking and calculating scores for prioritising elective surgeries.

New Zealand's geography gives an opportunity to explore the use of robotics in other ways, and for patients in rural settings to access care remotely in a timelier fashion. An example of this may be being seen by a telepresence robot in a local hub, controlled via a clinician in a centralised location. The robot also has the ability to connect to other robots which can take blood samples, or perform suturing.

As robots become more visible within the health sector, the patient experience needs to be a focal point. Robots are not synonymous with an empathetic output – so the patient needs to be given a choice on their level of engagement, and the chance to opt-out as they wish.

Some will embrace it, others will not. Choice is key to ensuring we maintain and build social license.



Healthcare Workforce

The New Zealand Digital Skills Forum recently published the [Digital Skills for a Digital Nation](#) report which highlighted the growing gap between the number of projected new jobs in data and digital industries and the number of new graduates trained. There is an explosion of new jobs created across the whole technology domain, and current training rates are not at pace with this acceleration.

Demand for healthcare services continues to [rise rapidly](#), but there are constraints on finances, and a shortage of skilled professionals in some areas and health-related occupations.

Using robotic technologies to assist and carry out repetitive routines and duties allows staff to focus on issues that require human decision making skills and empathy.

Healthcare is personal, so we must not lose sight of the human element. Any adoption of new technology will mean redefining the various roles of healthcare professionals, and ensuring that the necessary new skills are understood and taught in workforce training.

There will be nervousness about the adoption of robotics due to apprehension it will be mismatched to the worker's current skillset. A portion of a current role may be made redundant – ultimately causing a shift in workforce focus. Those who are late-career at time of implementation may find it harder to adapt to this change.

A role of educator and confidant to patients and their families continues to grow in importance, to discuss treatment options, reassure quality of care will be sustained or improved, and to explain the risks and benefits of including robotics in their care plan.



Considerations for health sector stakeholders – A deeper dive

Hospitals

In a hospital, the well-being of patients has top priority. However to ensure this, medical, sterile and food supplies must be provided quickly and efficiently to where they are needed.

Behind the scenes, our hospitals are some of the largest procurers of catering and laundry services in New Zealand. The logistics required to ensure a hospital runs smoothly – from the pharmacy to the kitchen – requires a substantial workforce that needs to be optimally managed.

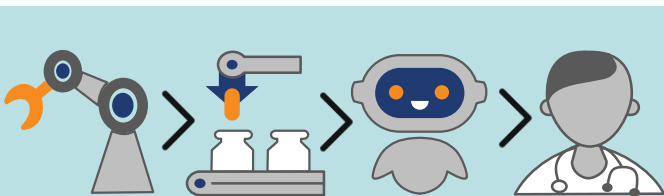
Supply-chain robots are being adopted internationally as a mechanism for moving items such as laundry and food around a hospital. These autonomous vehicle robots have the ability to run 24/7, returning themselves to base for recharging before undertaking the next task.

Supply-chain robots have also been integral in the dispensing of medications, supporting hospital pharmacists in stock inventory management, dispensing and delivery of medications to wards, and the sterile preparation of IV bags.

Surgical robots such as Da Vinci allow for more precise surgical procedures, often with shorter recovery periods for patients. These machines are able to be synchronised with the beating of a heart or the breathing of a patient, automatically removing a cognitive load from the surgeon.

Assistive robots aid in moving patients in and out of beds, help with their rehabilitation, and help patients self-manage their recovery once they are discharged.

RPA allows streamlining of hospital appointment booking systems, and the automation of current manual financial account processing.



Imagine this in a New Zealand hospital - pharmacists connecting the pharmaceutical stock management robot to the dispensing robot to the supply-chain robot, which then autonomously delivers to the ward for healthcare professionals to administer to the patient!

DHBs

Outside of the hospital, DHBs also have a responsibility for the primary and community care capacity of their local population catchment.

Implementation of any new medical technology is an ongoing process, one that should be phased and optimised over time. Investment models will need to ensure the implementation of a robotic technology can demonstrate a measurable economic benefit to both the community and the health system.

An appropriate evidence base prior to adopting robotic solutions is essential to support investment priorities and ensure patient safety, including understanding the device support model – requirements for maintenance, upgrades, and device security patching. A DHB with the latest robot but not the IT infrastructure to support it will delay benefits and harm perception of value. Investment in end-to-end business process is necessary to make the transition as effective as possible.

Approximately [12.1% of New Zealand's working population](#) is in the healthcare and social assistance sector, with the combined District Health Boards (DHBs) having over [72,000 employees](#). Time freed up by automation of lower-value, repetitive tasks enables the ability to up-skill in higher-value areas which leads to a more engaged workforce and better staff retention.

Researchers/NZ Inc

New Zealand's diverse population demographic and compact geographical size offers universities, researchers and tech companies a flexible and available test-bed for the development of robots. There is significant opportunity for robotic researchers in adjacent agency industries such as Ministry for Primary Industries (MPI) to develop alternative use-cases within health.

Once a product has been piloted, companies have the opportunity to scale up commercialisation in an attempt to access the bigger international markets. However, local first adopters can be hard to find – DHBs may be risk-averse to testing a new technology that hasn't yet been on-boarded in other regions.

Commercialisation pathways into the New Zealand health sector are not clearly defined – a clear disconnect between a successful pilot and finally breaking into the marketplace. Agencies such as Callaghan Institute and MBIE offer seed funding but don't necessarily factor in the ongoing operational costs and additional establishment – sustainable business model.

Considerations for health sector stakeholders – A deeper dive

Ministry of Health

As the Ministry is a steward for the New Zealand health and disability system, there will be overarching frameworks that adoption of new technologies will need to adhere to.

One of these, the [Health Information Security Framework](#) is designed to support health and disability sector organisations and practitioners holding personally identifiable health information to improve and manage the security of that information. The healthcare provider must treat personal health information with proper care and respect and to keep it secure.

Both [Medsafe](#) and [PHARMAC](#) need to consider any need for review of regulation and procurement for the relevant medtech devices and services while supporting and acknowledging that technology could unlock significant benefits to the health system and economy.

The Ministry's [five strategic themes](#) reflect the balance that everyone working the system has to strike between what is best for people's health and wellbeing, at individual and population levels, and what is affordable and possible.

The Ministry will encourage the adoption of new technology that will have a long term benefit improving the overall productivity of the health system, which in turn will allow increased value for money in service delivery. The Ministry wants to be seen as making healthcare more accessible and affordable, without putting it out of financial reach of New Zealanders or geographically disadvantaged the population by 'postcode lottery'.

Data & Digital is working on an Innovation framework as a part of the Ministry's Digital Health Strategic framework. It is the Ministry's approach to accelerate the development of new medical technologies, to incubate them and gather the evidence to make the technology more commercially viable for scaling.

Technologies such as robotics need to be considered and factored into future hospital (re)developments. Trialling new technology during the earlier phases provides opportunity to assess suitability of the technology to new models of care and adapt insights from this to inform the remainder of the development.



The broader world of robotics

The New Zealand Productivity Commission, in partnership with Australia, produced in 2019 a joint research report for [Growing the digital economy in Australia and New Zealand](#). The robotic aspect of this report focusses on the agriculture, horticulture and forestry industries.

“Difficulties attracting labour and rising costs in agriculture and horticulture, and high accident rates in forestry, are driving interest in robotics”

New Zealand’s [Robotics Plus](#), an agricultural robotics company is currently developing robotics and automation products for highly variable tasks and agricultural environments. Capabilities currently being developed by Robotics Plus include:

- A robotic apple packing cell, which can pack up to 120 apples per minute, 24 hours a day
- Multipurpose orchard robots, which can automatically harvest crops such as kiwifruit

MPI have [announced a seven-year collaboration](#) between themselves and a consortium of forestry owners and forestry machinery manufacturers, who have their sights on developing a new in-forest harvesting and log sorting system specific to New Zealand’s forests, using automation and robotics – a first for New Zealand.

[Callaghan Innovation](#) – New Zealand’s Innovation Agency – offer the opportunity for New Zealand companies to [trial a collaborative robot](#) to validate digital manufacturing as an R&D tool. Callaghan are committed to helping manufacturers embrace the digital revolution that is changing the face of manufacturing and industry (often referred to as ‘Industry 4.0’ or the ‘Industrial Internet of Things’).

Many of our Universities have dedicated robotics facilities. The University of [Auckland’s Centre for Automation and Robotic Engineering Science \(CARES\)](#) is an interdisciplinary research hub with a mission to create inspiring and innovative robotic technologies that improve societal wellbeing.

The [New Zealand AI Forum](#) is an NGO that brings together New Zealand’s artificial intelligence community, working together to harness the power of AI technologies to enable a prosperous, inclusive and thriving future for New Zealand. Their report on [AI: Shaping a Future New Zealand](#) highlights the relationship between AI and robotics, both local and internationally.

The World Health Organisation (WHO) makes reference to robotics in the context of [Assistive technologies for people with dementia: ethical considerations](#) and [Patient safety in robotic surgery](#). The latter being a project funded by the European Commission to explore whether robotic surgery carried out in accordance with safety criteria can improve the level of patient safety currently achievable by traditional surgery.

Internationally, both government and NGOs are beginning to take a proactive view of how robotics will benefit their economy and social services. Below are some examples of such strategies and roadmaps:

- [A Robotics Roadmap for Australia](#) – 2018 – developed by the government funded Australian Centre for Robotic Vision, based at Queensland University of Technology
- [Robotics 2020 – Multi-Annual Roadmap for Robotics in Europe](#) – 2017 – released by SPARC – The Partnership for Robotics in Europe
- [A Roadmap for US Robotics – From Internet to Robotics](#) – 2016 edition – sponsored by National Science Foundation, University of California San Diego, Oregon State University, Georgia Institute of Technology
- [Robotics in Social Care](#) – 2018 – The Parliamentary Office of Science and Technology, Houses of Parliament – UK
- [New Robot Strategy](#) – 2015 – The Headquarters for Japan’s Economic Revitalization – Ministry of Economy, Trade and Industry
- [Human Assistant Robotics in Japan](#) – 2016 – EU-Japan Centre for Industrial Cooperation
- [Statement on Artificial Intelligence, Robotics and ‘Autonomous’ Systems](#) – 2018 – European Group on Ethics in Science and New Technologies – European Commission



Case Study – Companion robot for COPD patients

(an [excerpt](#) from University of Auckland School of Medicine)

In 2017 University of Auckland School of Medicine piloted a randomised controlled trial using robots to help people at home with [Chronic Obstructive Pulmonary Disease \(COPD\)](#). The study found that the robots helped patients take their medication, carry out exercises, and keep them company.

The pilot study aimed to investigate the effectiveness of a robot delivering telehealth care to increase adherence and home rehabilitation, improve quality of life, and reduce hospital readmission compared to a standard care control group.

In all, 25 people received an iRobi robot in their homes for four months in addition to standard care, while 29 received standard care alone. All participants had COPD. Other inclusion criteria included patients had to be relatively isolated and get out of the house less than four times per week, be living alone or with a spouse who was also largely housebound, geographic rural location, and aged between 16 and 90 years.

The iRobi robots were programmed to measure heart rate, breathlessness, and quality of life on a weekly basis. They reminded patients when to take medication and inhalers and recorded patient adherence several times a day; reminded patients to do their rehabilitation exercises, and displayed videos of a patient performing these at least twice weekly; provided education about COPD via video modules and pop-up messages; allowed participants to use an “I am feeling unwell” function on demand; and showed trends over time of health status and adherence on the screen to the patient.

The robot was also integrated with Wi-Fi linked Smartinhalers to monitor inhaler use. The data was sent to a secure web server that managed all robot and patient data and logged all activities, with alerts if the measurements were out of range or patients were not adherent. Specialist physiotherapists monitored the patients’ health data.

The study found that while there was no significant difference in the number of respiratory related hospitalisations between groups, the group with robots were significantly more consistent in taking their long-acting inhalers than the control group. The participants with robots also significantly increased their rehabilitation exercise frequency compared to the control group, though there were no significant differences in quality of life.



Of the 25 patients who had the robot, 19 had favourable attitudes. They said the robot helped remind them to take their medication, they enjoyed doing the exercises with it, and their friends and family were interested in the robot, particularly young children who enjoyed visiting to see the participant as well as the robot.

They commented that the robot raised awareness for the family about when they should be taking medication and about their illness. Most people said they enjoyed having the robot because they felt it had a personality and was good company. As a consequence, many participants had given their robot a name over the time they had it.

However six people did not enjoy having the robot, three of whom returned it before the 4 month period was complete. They said they did not find the robot useful because they were very good at managing their medication and exercise on their own. The other three said they were unnerved by having the robot in their home.

Hospital admissions for Chronic Obstructive Pulmonary Disease (COPD) are expensive, with the average cost per admission in New Zealand around NZ\$4800. While the robots did not significantly reduce patients’ hospital admission rates, there was a trend for costs to be lower for those patients who had robots.

The study, *Using robots at home to support patients with COPD: A pilot randomised controlled trial*, was published in the [Journal of Medical Internet Research](#).

The study, funded by a Health Innovation partnership grant from the Health Research Council of New Zealand and the National Health Committee, followed previous trials in Gore and Auckland where healthcare bots helped elderly patients, checking their blood pressure and heart rate, and monitoring for falls.

Case Study – Hospital Pharmacy Robots

Pharmaceutical robots are not new in the UK's National Health System (NHS). Automated dispensing systems have helped support hospital pharmacists since their first introduction at St Thomas's Hospital in London in 2000.

The organisational benefits of automated dispensing systems were published in 2000 in the Department of Health's [Pharmacy in the Future: Implementing the NHS Plan](#). It advocated the use of modern technology to remove some of the repetitive tasks involved in dispensing to increase the accuracy of dispensing and to free up hospital pharmacists' time to focus on clinical care.

This was further enforced by the Audit Commission's 2001 report [A Spoonful of Sugar – medicines management in NHS hospitals](#) which highlighted the importance of both original pack dispensing and the use of pharmacy automation to reduce risks and release pharmacy staff to perform patient-centred services.

Each Automated Dispensary System (ADS) has different technical specifications, but many are able to safely store controlled drugs and refrigerated items, meaning the machines can be used for almost any medication. This is one reason why many busy hospital pharmacies have taken advantage of the technology.

The three main types of ADS are pharmacy-based, ward-based, and automated unit-dose dispensing.

In practice, a robot dispenses prescriptions faster and more accurately than humans and enables pharmacies to directly free up staff to have a more patient focused role.

This also means decreased waiting times for inpatient prescriptions resulting in a quicker turnaround in bed availability for new inpatients.

In 2001 early adopter Wirral Hospital's NHS Trust, as published in the [Pharmaceutical Journal](#), reported a 50 per cent reduction of dispensing errors in the four months after implementing a pharmacy robot.

[King's College Hospital NHS Trust](#) released a report in 2006, two years after the implementation of their pharmacy ADS. The system was used 13 hours a day and on an ad-hoc basis by the on-call pharmacist.

The implementation of the ADS had a positive impact on the way that pharmacy services were delivered at the hospital, with all benefits detailed in the original business case realised.

- Agency expenditure was reduced by £128k
- Dispensing errors reduced by 65%
- Dispensing times for patients were reduced – Outpatient avg of 15 min, TTAs avg of 27 min
- Releasing staff to support direct patient care was achieved
- Improve the reliability of service with 99.7% uptime
- Reduced stock holding by £534k as a one off saving
- Expired drug expenditure was reduced by £50k

As published in [Achieving Excellence in Pharmaceutical Care: A Strategy for Scotland](#), NHS Greater Glasgow and Clyde, the largest hospital pharmacy robotic installation in the world exists within a Pharmacy Distribution Centre and distributes nine million packs of medicines to 4000 destination points from the eastern boundary of Glasgow to Argyll in the west Highlands.

Semi-automated medicines cabinets are beginning to be used in hospital wards and departments, often targeted in areas such as Acute Receiving Units and theatre wards. Benefits seen from this include releasing time for nurses to care for people and quicker access to medicines. Typically wards can store 20% less medication through the use of these cabinets. The cabinets also provide automatic ordering of required medication and allow keyless but secure access to stored medication through fingerprint identification which also enables greater accountability and tracing of medication.

IV compounding robots are not yet commonplace within the NHS, however some Trusts like [Charing Cross Hospital](#) and Imperial College Healthcare NHS Trust in London have invested in the technology. Compounding robots are seen to be quicker, safer and more accurate especially when preparing hazardous sterile IVs like cytotoxic preparations for cancer patients. The robot arm is designed to withdraw dose of cytotoxic drugs from single or multiple vials, and transfer these doses into a variety of final containers.

Benefits in the investment of this type of technology has seen a reduction of the waste of expensive drugs and vials, and in terms of labour, the equipment can be operated by non-specialist technicians. The technology also protects the users from the physical hazards of manually compounding the preparations.

Robots in healthcare – a snapshot

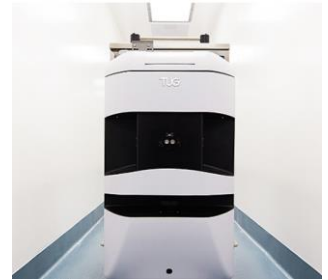
Supply-chain robots

A [group of hospitals](#) in San Francisco have brought in a fleet of 25 'TUG' autonomous vehicle robots to transport carts and compartments around the hospital, hauling food, linens, specimens and medications around the facility. This allows employees to devote time to something more important, helping and interacting with patients.

It uses a built-in map and LIDAR to navigate hospital halls alongside its 27 infrared and ultrasonic sensors to avoid collisions, and communicates with elevators, fire alarms, and automatic doors via Wi-Fi. When not at work, the robots return on their own to individual charging stations to stock up on energy before the next run.

For secure shipments like medications and specimens, hospital staff open and close the TUGs' secure compartment via fingerprint identification.

The 25 TUGs will average more than 1300 trips per day, which translates to about 315 hours of travel over 770km.



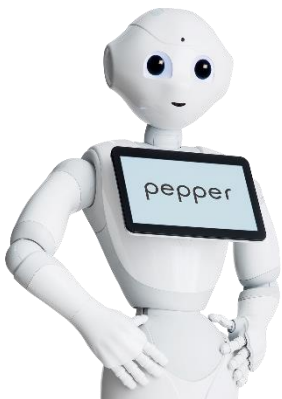
Companion robots

Robots are an integral part of [Tokyo's Shintomi nursing home](#), where residents have access to 20 different models of care robots – from Paro the harp seal, a furry companion robot which delivers emotional responses and reacts to sound, touch and movement – to Pepper the humanoid which leads the afternoon exercise programme. Senior care facilities across Japan are testing out robots that deliver an assortment of social and physical health care.

The Japanese government has been funding development for elder care robots to help fill a projected shortfall of 380,000 specialised workers by 2025. The government hopes nursing homes like Shintomi can serve as a model for harnessing the country's robotics expertise to help cope with a swelling elderly population and dwindling workforce.

A [research study](#) by the Japan Agency for Medical Research and Development announced results that, with robot care, senior's autonomy, sociability, mood and communication improved along with a better quality of life over all.

The intent is not for robots to replace human caregivers, but to assist - saving time and improving the working environment.



Assistive robotics

New Zealand company [TASKA Prosthetics](#) had produced the world's first waterproof multi-articulating myoelectric prosthetic hand.

Myoelectric prosthetic devices are designed to mimic human anatomy and function. The user controls the prosthesis using sensors placed on the muscles in the remaining part of their limb. The sensor technology in the device reads the movement, and once it is calibrated to the wearer it becomes a functioning replacement hand. The hand is also Bluetooth enabled, with iOS and Android apps available to customise the availability of the grip patterns at any time. The rechargeable battery lasts 10 hours. The hand has a tiny motor, gearbox and clutch for each finger and two for its thumb. Currently priced at around NZ\$35,000, the majority of devices are purchased through insurance schemes.

[Callaghan Innovation](#) and the New Zealand Artificial Limb Centre supported TASKA on the commercialisation of their robotic hand.



What about the future?

Autonomous vehicles – driverless cars or drones to transport patients to appointments, or fly medical supplies between hospitals

Nanobots – capable of healthcare at a cellular level including delivering drugs to specific locations inside the body

AI diagnostics – training AI to analyse massive sets of medical data to approximate conclusions without direct human input



Additional Reading

Robotics

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