

# MEDTECH MARVELS

Smart wards, “talking” beds, robots and more – these innovations do not just save and improve lives, but also help with long-term care



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Step into the Smart Ward on the second level of Alexandra Hospital and the first thing that catches the eye is the soft, almost natural, lighting. It is designed not only to help visitors find their way, but also to minimise eye strain in patients when they are wheeled out of the ward for surgery.

Its smart beds can also “talk” to nurses through alerts, real-time updates and round-the-clock monitoring of a patient’s vital signs.

Over at Mount Elizabeth Novena Hospital, a hulking 800kg robot assistant helps surgeons with complex microsurgery that almost halves the length of an operation, with less blood loss in the patient and faster healing times.

More Singapore hospitals and medical start-ups are rolling out state-of-the-art medtech designs that are saving lives as well as improving the quality of life for those who need long-term medical attention, such as asthma patients and wheelchair users.

Medtech design is a highly specialised discipline that not only looks at aesthetics, but also aspects of user experience, such as patient safety, cost-effectiveness and the efficiency of equipment and products.

According to Singapore’s Economic Development Board, the Asian medtech market is expected to grow at an annual rate of about 8 per cent and projected to overtake the European Union as the world’s second-largest market after the United States.

Singapore is well placed to help medtech companies tap the growing potential in Asia.

The republic has a vibrant ecosystem of top universities, research institutions and start-ups. There are more than 25 research and development (R&D) centres here, established by multinational medtech companies and a local pool of more than 200 medtech start-ups and small and medium-sized enterprises.

Singapore’s early adoption of 5G and 6G networks, and the shift to connected devices, also offers companies a strong base to build their businesses centred on big data and patient-centric care.

According to a Netherlands Enterprise Agency report commissioned by the Dutch Ministry of Foreign Affairs in March 2022, the Asia-Pacific medtech industry was valued at almost \$213 billion that year.

The report noted that despite the economic recession caused by the Covid-19 pandemic, the medtech industry in Singapore continued to grow.

Medtech in Singapore represents an important sector of the economy, sustaining more than 9,000 jobs.

Singapore is a leader in Asia’s medtech R&D. It accounted for \$105 billion of health technology funding, which makes up 24 per cent of the total investment across Asia (except China and India).

Many of these medtech innovations are already in use in hospitals and other health institutions here. Here are some game-changing designs.

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## Singapore General Hospital

### 3D SURGICAL MODELS AND GUIDES

Singapore’s oldest hospital has set its sights on the future with 3D-printed guides that improve the precision and accuracy of surgical operations.

The 3D Printing Centre at Singapore General Hospital (SGH), launched in October 2022, developed surgical models and guides with the help of vendors. These guides are used in complex head and neck, cardiac and reconstructive surgeries.

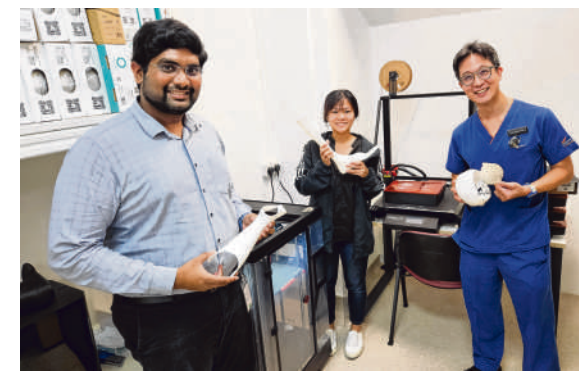
The 3D-printed surgical models allow doctors to rehearse surgical procedures and size implants before an operation.

For patients who require complex reconstructive surgery for

facial fractures, models of the facial bones are 3D-printed from CT scans, and surgical plates used for fracture repair are pre-shaped on the model before implantation. This avoids surgical complications and improves outcomes.

Since March, SGH has developed in-house 3D-printed sterilisable surgical guides that are customised to the patient through medical imaging. These allow doctors to locate surgical targets and perform complex bone reconstructions accurately. The guides are developed by a team of clinicians, engineers and imaging specialists for rapid deployment in clinical care.

Dr Mark Tan, clinical lead of the SGH 3D Printing Centre and consultant at the SGH Department of Diagnostic Radiology, says: “SGH has successfully performed bone tumour resection, hip preservation and ankle reconstruction surgery using these surgical guides, and is preparing for different types of surgery using these guides moving forward.”



(From far left) Centre manager Nisar Ahamed, engineer Chee Shu Ping and Dr Mark Tan at the 3D Printing Centre. PHOTOS: SINGAPORE GENERAL HOSPITAL

## Mount Elizabeth Hospital (Orchard Road and Novena)



### ROBOTIC KNEE SYSTEM

A recent medtech innovation at Mount Elizabeth Hospital in Orchard Road is the Robotic Knee System (above), a robot-assisted knee replacement surgery seen as a significant advancement in the field of orthopaedics.

By combining advanced imaging, precise surgical planning and robotic arm assistance, it enhances the accuracy and personalisation of knee replacement procedures.

Patients benefit from improved implant positioning, enhanced joint mechanics and faster recovery.

Dr Wang Lushun, senior consultant orthopaedic surgeon at Mount Elizabeth Hospital, says the high level of precision offered by the system improves knee joint mechanics. This in turn improves stability and offers a greater range of motion as well as other functional outcomes.

“Patients may experience a quicker return to daily activities and an improved quality of life,” he says.



## MOUNT ELIZABETH NOVENA HOSPITAL: DA VINCI XI SURGICAL ROBOT

Before 2005, urologist Dr Chin Chong Min recalls that open surgery on the prostate gland, also called a prostatectomy, in men would take four to six hours. A partial kidney surgery (nephrectomy) would last between three and four hours.

But when the 800kg Da Vinci Xi surgical robot – with its glossy white arms featuring eight joints each – was introduced to Mount Elizabeth Novena Hospital (MNH) nearly two decades ago, it almost halved surgery time for a majority of Dr Chin’s patients. “The robot helped with better precision and there was hardly any need for a blood transfusion as there was less bleeding, which resulted in a shorter hospital stay for patients,” says Dr Chin.

He finds the robot’s range of movements crucial in keyhole surgery, which is minimally invasive, unlike open surgery, which he says can be quite “bloody”.

The Da Vinci series of robotic assistants was developed in 2000 by Intuitive Surgical, a corporation in the US that manufactures robotic products designed to enhance minimally invasive surgery and improve clinical outcomes.

The company regularly releases new models and issues software upgrades to keep up with changes in surgical technology.

Dr Chin recently operated on Madam Judy Koh, a 75-year-old retiree who had a 3cm cancerous tumour at the back of her right kidney after an ultrasound screening in Sept 2020.

She was told by a previous urologist that her entire right kidney would have to be removed, as the tumour was too close to the main artery supplying the kidney.

“Madam Koh sought my advice for a second opinion, as she wanted to preserve as much of the kidney as possible, and delay the risk of dialysis,” recalls Dr Chin.

Madam Koh also had diabetes, hypertension, elevated cholesterol levels and early kidney impairment.

After studying her computed tomography scan, Dr Chin thought of using the robotic assistant to help him remove the tumour in a way that would spare most of the kidney.

He did so in 2020, in a process which took less than three hours.

Madam Koh, who was discharged on the second post-operative day, says she felt no pain after the surgery and was able to walk on the second day. “There are just some small incisions on the right side of my lower back,” she says. She lives with her husband, eldest son and two grandchildren in a terrace house in the Kembangan area. Her last CT scan at the end of 2022 showed no recurrence of the cancer, and her kidney is functioning well.

Dr Chin says that robotic assistants like the Da Vinci series “certainly make a good surgeon better”. Still, he hopes such machines will be less bulky in the future, as they take up a lot of space in an operating theatre.

Urologist Chin Chong Min with the Da Vinci Xi surgical robotic assistant. PHOTOS: SHINTARO TAY, MOUNT ELIZABETH HOSPITAL

## National University Health System



The Whizz provides users with visual feedback that reinforces the correct inhalation of asthma medication. ST PHOTO: ARIFFIN JAMAR

### NUHS CENTRE FOR INNOVATION IN HEALTHCARE

At the NUHS Centre for Innovation in Healthcare (CIH), which is housed on the hospital grounds, a different ecosystem is thriving. The centre is a one-stop hub for innovations that improve the quality of healthcare for patients.

CIH is run by Professor Lawrence Ho, its director, and Dr Rina Lim, who heads the centre.

Two of its market-ready innovations are The Whizz, which helps asthma patients, and the Spectra IMDx, an optical biopsy device which detects gastric cancer.

The Whizz (above), developed by local start-up Meracle, simplifies medication delivery and routine to help patients achieve good asthma control. It provides users with visual feedback that reinforces the correct inhalation of medication with each breath. This ensures medication is delivered to the lungs and not the back of the throat.

The Whizz was developed by researchers and doctors from the National University Hospital and National University of Singapore, and recently obtained approval from the Health Sciences Authority. The team is conducting clinical trials at NUH and aims to deploy the gadget in the next one to two years.

Singapore start-up Endofotonics developed Spectra IMDx, an artificial intelligence-enabled optical device that can provide doctors with real-time diagnosis of gastric cancer.

Doctors are able to differentiate between pre-cancer and non-cancer lesions during the endoscopy. The device complements traditional white light in a standard endoscopy and helps reduce unnecessary biopsies.

## Alexandra Hospital

### SMART WARD ECOSYSTEM

One of Singapore’s oldest hospitals has rolled out a game-changing idea in medical care that will provide solutions for a range of challenges, such as the acute shortage of nurses and hospital beds, and the city-state’s ageing population.

The concept in Alexandra Hospital (AH), which started the first phase of its Smart Ward operations for subsidised patients in October 2022, is simple.

Under a Smart Ward ecosystem, a single nurse can manage multiple wards through “virtual nursing”, reducing the number of bedside nurses required by about 30 per cent.

Virtual nursing is the first phase of a multiphase development plan to establish the “Alexandra Virtual Hospital” (AVH).

According to Dr Alexander Yip, clinical director of AH Healthcare Redesign, AVH will be Singapore’s first full-scale remote hospital combining digital health services, Internet of Medical Things (IoMT), digital therapeutics and care navigation technologies to provide continuous and coordinated care both inside and outside the physical hospital.

He says virtual nursing will improve staff retention and let retired nurses rejoin the workforce through advances in telemedicine.



Alexandra Hospital’s smart wards have naturally ventilated patient “pods” with modular walls, circadian lighting and sound insulation. ST PHOTOS: ARIFFIN JAMAR

## Singapore-based incubator transforms start-ups into global brands

One of the biggest medtech, healthtech and biotech accelerators in Singapore is MedTech Actuator, which was founded in 2018 by a group of entrepreneurs and health policy experts to help promising start-ups rise quickly to global prominence.

Dr Buzz Palmer, its co-founder and chief executive, says the MedTech Actuator has become one of the Asia-Pacific region’s premier medtech commercialisation initiatives, developing innovation ecosystems with support from more than a hundred global partners.

“The MedTech Actuator, through its many global programmes and initiatives, has supported more than 200 healthtech start-ups that have collectively raised over \$1 billion in capital and created more than 900 jobs,” he says.

Two Singapore-based start-ups under the accelerator programme are Rebee Health and Anto Medicare.

skeletal conditions or chronic pain, as well as those recovering from post-operative surgery. It works through physical rehabilitation sessions with limited to no supervision at the hospital or in a user’s home. The system is said to reduce the cost of physiotherapy and the number of in-person visits to the clinic or hospital by over 50 per cent.

The company’s flagship product is the Rebee 2.0 (above), which contains wearable sensors for tracking body movements to ensure the user is doing rehabilitation exercises correctly. Its accompanying app (above left) features a humanoid model that mirrors the patient in real time, guiding him or her safely through the rehabilitation movements using audio and visual cues.

Another element is the “therapist portal” that lets physiotherapists or clinicians access advanced data in-

sights in the form of easy-to-read graphs and charts, in order to make informed decisions about the user’s progress remotely.

The company is helmed by chief executive Lincoln Dacy, 42, and chief operations officer Jada Seet, 39, who met while studying for their master’s in innovation science at Singapore Management University.

It has six full-time engineers and clinical trainers in Singapore, and three full-time staff in India.

“Over the last two years, we have invested significantly in research and development and piloting Rebee across Singapore’s leading public hospitals and community care organisations,” says Mr Dacy.

“We have worked with senior citizens suffering from various conditions such as muscle deconditioning, frozen shoulders, knee osteoarthritis and neurological rehabilitation.”

Mr Dacy says Rebee Health is collaborating with the Agency for Science, Technology and Research to develop a wearable sensor that will improve Rebee Health’s appearance and features, so the platform can be launched in the wellness sector. “The wearable sensor, which is

able to track body movements, is worn like a smart watch and simply placed on the injured limb,” he says.

At Singapore-based digital start-up Anto Medicare, its founder Edison Bellarmin developed a remote monitoring tool called the Anto Smart Cushion (right) that helps prevent pressure injuries and falls for people in wheelchairs.

Pressure injuries are serious conditions that occur after prolonged periods of sitting.

Dr Bellarmin, 40, founded the company in 2020, and is also Anto Medicare’s chief executive. Dr Thomas Ooi, 44, joined as head of operations in the same year.

The product, which will be launched in a few months, is designed for both community care and home use.

Dr Bellarmin says it targets issues related to wheelchair use – such as wounds, pain, falls and wrong posture – through a smart sensor cushion with a built-in algorithm that detects poor sitting posture.

It works with a mobile app that alerts users and caregivers to potential pressure injury risks. This device is registered with the Health Sciences Authority, and is expected to retail at pharmacies and through local distributors.



PHOTOS: ANTO MEDICARE, XCLRB TECHNOLOGIES

Dr Bellarmin and Dr Ooi are working on a new version of the cushion which will have features such as automated repositioning with proprietary technologies. Dr Bellarmin says: “Currently, wheelchair users need a helper or caregiver to help reposition them at frequent intervals as well as monitor them. “Our new iteration will help reduce reliance on manpower, as well as rising medical costs for the wheelchair user. We will be rolling out the product with proprietary materials and patent-pending technologies to improve the quality of life of wheelchair users.”

“Virtual nursing will revolutionise the way we monitor, react to and care for our patients. By harnessing the ability to continuously monitor patients remotely, a single virtual nurse will be able to monitor multiple wards of patients,” says Dr Yip.

Smart glasses worn by nurses and doctors for tele-rounding (assessing a patient’s condition), tele-collaboration (discussing care with other clinicians) and teleconferencing.



The 41-year-old, who heads AH’s gastroenterology and hepatology division, coordinates the hospital’s digital technology transformation to provide better healthcare.

He adds that the virtual nurse does not replace the bedside nurse, but provides added support in the coordination of care and data-driven decision-making that does not require physical intervention, allowing care to be proactive rather than reactive.

Central to virtual nursing is the hospital’s IoMT ecosystem, which Dr Yip says is designed to “provide a central location for collecting, integrating and analysing health data from different medical devices and consumer

wearables”. Assisting him is clinical pharmacist Dr Koh Tsingyi, head of AH Healthcare Redesign, who says a major challenge in healthcare is data fragmentation, as patient data is often spread across different systems and devices, making it difficult to access and analyse.

“With the IoMT ecosystem, data will be stored on a single platform which will provide doctors with data that is complete, accurate and up to date to provide holistic care,” says the 39-year-old, who has more than 15 years’ experience in specialised fields such as solid organ transplantation, paediatrics and pharmacy administration.

Dr Yip says aggregating data from different sensors and devices allows the use of predictive analytics to generate real-time insights.

Paired with data visualisation,

such clinical intelligence – together with smart hospital systems – it will improve overall efficiency, reduce redundancy and improve coordination within the hospital.

A highlight of the new Smart Ward’s IoMT ecosystem is the connected smart bed.

AH is the only hospital in Singapore that uses smart beds as a gateway to connect other IoMT devices. Each bed is equipped with alarms that alert nurses electronically if a patient attempts to get out of bed.

Underneath the mattress of each smart bed is a contactless vital-sign sensor that continuously monitors a patient’s heart rate and respiratory rate. It can weigh patients without moving them, reducing their fall risk. Lights projected on the ward’s floor also indicate whether these fall-prevention measures are properly armed.

Various other devices and medical sensors are being deployed at AH. These include patches for nurses to monitor patients’ vital signs even after discharge, and an artificial-intelligence food scanner that records a patient’s nutritional intake and frees up nurses from having to document this data.

There are also smart glasses worn by nurses and doctors for tele-rounding (assessing a patient’s condition), tele-collaboration (discussing care with other clinicians) and teleconferencing.

These technologies and digital tools for care transformation are all housed within two of AH’s smart wards.

The focus of this innovation sandbox is not only on rapid implementation and transformation using technology, but also on the well-being of the patient and

medical provider. The two wards on Level 2 of the hospital cover about 1,200 sq m and have 39 beds.

There are 17 “pod” beds equipped with “switchable glass” which turns opaque when privacy is needed, as well as 17 open cubicle beds.

Circadian lighting throughout the wards mimics natural light and reduces eye strain, creating a conducive ambience for patients to start the healing process.

The pod design provides sound insulation, privacy and better infection control.

If more single rooms are needed, the pods can be converted into isolation rooms. Modular walls allow space for more beds, should the number of patients surge in an emergency.

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