Enhancing Care with Robotics

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Increasing Demand

- Increasing Complexity of Care
  - Ageing Population
  - Improve outcomes (including reduction of unnecessary variation)
  - Bending the Cost Curve
Our citizen population reached a turning point in 2012, as our first cohort of Baby Boomers turned 65. From 2020 onwards, the number of working-age citizens will decline, as older Singaporeans retiring outnumber younger ones starting work.

A SUSTAINABLE POPULATION FOR A DYNAMIC SINGAPORE

POPULATION WHITE PAPER

JANUARY 2013
The future of healthcare in Singapore will be patient-centric, combining the best in facilities and technology and integrating different levels of care from hospital to home,

Prime Minister Lee Hsien Loong

5 Feb 2016
The Potential of Robotics

• Increasingly sophisticated cognitive capabilities
  o More adaptive and able to learn without explicit programming
  o Able to function in semi-structured environments
  o Able to support human-machine interactions including short duration social interactions

• Increasing technology convergence
  o Robotics, analytics and medical device technologies

• Increasing device connectivity
  o With Internet of Things, robots and devices can communicate transactional data with each other, effect coordinated actions and share processed information with humans

• METI and MHLW engaged stakeholders to categorize the 4 Priority Areas of development for service robotics

• Establish safety standards (ISO 13482) and set up safety assessment center

• METI & NEDO (New Energy & Industrial Technology Development Organisation) launched Public Private Partnership to seed:
  - 30 companies
  - 50 projects
  - 2013: USD 24m
  - 2014: USD 35m
Launch of CHART by President on 23 Jul 2015

- Improving productivity by enabling staff across various care settings to perform their respective clinical and operational roles more efficiently.

- Optimising healthcare work force with automation augmenting/substituting some of the more labour-intensive jobs.

- Improving health and clinical outcomes with solutions that help care teams extend human capabilities.

- Supporting ‘right siting’ of care by facilitating independent living and care in the community with assistive technology.
Rehabilitation

Work In Progress

- Analytics to enable customisation of therapy and prediction of progress of recovery.
- Provide in-therapy feedback on performance
- Brain-computer interface to enable control of simple machines
A typical stroke inpatient requires therapy sessions 2 times daily (30mins each) for an average LOS of 6 days.

1. Introduction of Assistive Technology

- 2 Therapists
- 1.5 Therapists
- Rehab robot

2. Patient receives standardized rehabilitation treatment

- Stroke inpatient
- Stroke inpatient

25% reduction in therapist manpower
Extending Care from Hospital to Home

Tele Rehabilitation Device system allows patients to continue rehabilitation exercises in the comfort of their own homes after hospital discharge.

Therapist can conduct a real-time video conferencing session with patient to monitor and ensure exercises are done as prescribed.
Tele-Rehabilitation for Stroke Patient

Visits hospital ~11 times a year for rehab appointments

~220 mins of rehab therapy in hospital a year

Introduction of Tele-rehab solution

Attends rehab appointments every alternate visit, requiring on 6 visits a year

Estimated reduction to 120mins of rehab therapy in hospital

~ $150/year

~ $25/year

Family needs to monitor patient’s compliance to rehab exercises

Family takes 5.5 days^ of family care leave a year

Remote monitoring improves compliance and potential re-admissions

~ $800/year

~ $150/year

~ $25/year

Stroke patient

Family takes 5.5 days^ of family care leave a year

Reduction to 3 days^ of family care leave a year

^estimated on 0.5 day of FCL for each rehab appointment
Standardising Processes

Closed Loop Medication Management System

CGH's robot machines are filled with various drugs. The robot machines dispense patients' medicines into sachets with QR code. Before serving medication, the nurse scans the QR code on the medicine sachets to ensure the right drugs in the right dosages for the patient.

The nurse then scans the patient's wristband to ensure the right medicine is given to the right patient.
ASRS overcomes space constraints and reduces time taken for retrieving and packing

7) 2nd tote is delivered to staff from holding bay

6) After completing 1st tote, it is returned by the arm for storage

5) Concurrent to #4, arm retrieves 2nd tote based on Rx. 2nd tote is queued at holding bay until staff completes 1st tote

1) Floor-to-ceiling height ASRS containing totes that stores one drug SKU per tote

2) Triggered by Rx, the arm retrieves 1st tote and delivers to staff

3) Drug label is printed only when tote reaches staff

4) Staff packs and labels SKU with a guided image

Overstretching or twisting the back when retrieving items from shelves may result in musculoskeletal injuries

Current Process

<table>
<thead>
<tr>
<th>Patient check-in</th>
<th>Keying</th>
<th>Labeling</th>
<th>Retrieve + Pack Drug 1</th>
<th>Retrieve + Pack Drug 2</th>
<th>Retrieve + Pack Drug 3</th>
<th>Med Check</th>
<th>Dispense</th>
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Avg. Time per Rx = 405s

Future Process (w proposed OPAS solution)

<table>
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<tr>
<th>Keying + confirmation</th>
<th>Patient check-in</th>
<th>Label + Pack Drug 1</th>
<th>Label + Pack Drug 2</th>
<th>Label + Pack Drug 3</th>
<th>Assembly</th>
<th>Dispense</th>
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Avg. Time per Rx = 119s

70% reduction in retrieving & packing time!
Moving Patients

Motorised Trolleys
- intelligent and secure powered unit for beds. This allows hospitals to push beds with less staff. It could also allow older staff to be able to push these beds.

Patient Hoist
- Reduce injury and manpower
Future Developments?

Upper body exoskeletons

- Powered wearable exoskeleton that supports staff who need to bear heavier loads in lifting patients (or materials)
Moving Material

Items requiring delivery in CGH

Scheduled
- AGV
  - Scheduled deliveries

Ad-hoc
- Pneumatic Tube
  - Ad-hoc delivery requests
- Porters (by hand)
  - Ad-hoc requests for fragile, bulky infectious items

~25 FTE
Moving Material

Hospi
Robotic transporter delivers medication, specimen, case notes, etc. Navigates around easily

Automated Trolley Mover
Ergonomically friendly mover allowing 2 trolleys of 200kg each to be pushed lightly and easily

Hybrid Assistive Limb
Powered wearable exoskeleton. Suit detects bio-electrical signals from brain to muscles. Suit then uses power units to assist in intended motion
Autonomous cleaning machines

**Objective:** Reduce reliance on housekeeping staff by automating cleaning requirements through self-navigating cleaning machines

- **I-Mop**
  - Battery operated portable unit dries floor faster, avoiding potential fall

- **Auto Scrubber Cleanfix**
  - Self navigated technology, scrub, vacuum and dry

- **2 in 1 Burnisher**
  - Combining Vacuum or mop with burnisher
Enabling Care in the Community

PARO

- Five sensors: tactile, light, audition, temperature and posture
- Trigger positive psychological response – improve socialisation and reduce loneliness

Assisted bath machine
First Self-Help Kiosk in the Community for Health Tracking

Features:

1. Physiologic Measurements
   Blood Pressure, Heart Rate, Temperature, Height, Weight, Body Mass Index

2. Lifestyle Questionnaire
   Smoking, exercise, diet, social interaction

Self Enabling and Empowering Kiosk (Project SEEK)

A project by
Funded by
In partnership with

Co-created with over 50 elderly residents and patients
Lessons Learnt
Generating New Insights

National Assistive and Rehabilitation Technologies
Student Innovation Challenge
30th March 2016
Robust Evaluation

- Improvement in care outcomes
- Productivity gains
- Lifecycle costs (CAPEX and OPEX)
- Training and change management plans
  - Involvement of internal and external stakeholders
- Scalability across institutions and settings
- Technology readiness
Robotic surgery evaluation: 10 years too late

During 2003–13, the number of radical prostatectomies done with the robot-assisted laparoscopic technique increased from about 1.8% to 85% in the USA despite the lack of high level evidence comparing robotic surgery to the standard, cheaper, open technique. In this issue of The Lancet John Yaxley and colleagues report the early outcomes of the first randomised trial comparing these two techniques and find no difference in quality of life outcomes at 12 weeks. The final results are awaited with interest. The authors of the Article, and the patients randomised, should be congratulated on a huge achievement in undertaking this long awaited trial. A randomised comparison was thought, by many, to be impossible due to “inherent biases both from a patient and clinician perspective” as Erik Mayer and Ara Darzi explain in their accompanying Comment.

The results of this trial should give a renewed understanding of the importance of uncertainty. Patients look to doctors for advice and expect an evidence-based assessment of the probability of different outcomes—of cure or complications—on which to make informed and personal decisions. In medicine, the discomfort of uncertainty, desire to constantly improve, failure to recognise personal biases, and susceptibility to aggressive marketing can lead to innovation being embraced without rigorous evaluation. By doing so, we risk the use of inferior techniques or not providing evidence of benefit and limiting widespread adoption.

In the near future big data, personalised medicine, wearable technology, machine learning, and medical apps all have the potential to play a part to help the health sector reap the potential rewards of the digital revolution. But without health-care workers leading the assessment of these technologies, demanding evidence on behalf of their patients, additional expenditure risks failing to be translated to real gains. Robust scepticism towards innovation and the ability to admit uncertainty will ultimately drive improvements in health. ■ The Lancet

Innovation Ecosystem

**Research**
- RIs
- IHLs
- Polys

**End User**
- Hospitals
- Homes
- Community

**Technology**
- Singapore Company A
- Overseas Company B

**Incubator for Healthcare Technology and Robotics**

**Solution Development Process**

**Ideation and Prototyping**
- Design Thinking
- Clinical insights, engineering expertise

**Development and Validation**
- Availability of open development platforms and APIs
- HL7 expertise
- Establishment of clinical protocols to meet standards & regulations

**Rollout and Adoption**
- IP management/tech transfer
- Integration with market

**Capabilities**
- Clinical protocols and training development
- Market Development

**Space**
- Simulation Facility
- Living Lab @ Hospital

**Administration**
- Grant admin
Innovation Ecosystem

Smart Logistics

AGV Fleet 1
Autonomous Transporter Fleet 1
AGV Fleet 2
Autonomous Transporter Fleet 2
AGV Fleet 3

Smart Logistics Fleet Management
Scheduling
Optimization
Routing

Infrastructure
Fire system
Lifts
Doors

Dispatching & allocating Robotic Agents to Patients

Analytics

Smart Ward Process Flow Management

Ward 3
Ward 2
Ward 1
Sensor enabled Devices
Assistive Robotics
Robot Nurse Assistant
IOT for care staff

Ward 4
Ward 5
Technology
Supplementing, Complementing, Augmenting Care
Delivering Care That Matters