New Zealand: Partnering for Science and Business Innovation

NZ-Japan Bilateral Workshop in Technologies for Elderly Care
March 2017
New Zealand Science and Innovation System

Dr Seishi Gomibuchi, Senior Advisor- International Science Partnerships
The Government support for the S&I system

**THE GOVERNMENT (MINISTERS OF THE CROWN)**

**POLICY AGENCIES**
- Ministry of Education
- Other government ministries (e.g. Primary Industries and Environment)

**PUBLIC RESEARCH INVESTMENT**
- Tertiary Education Commission
  - Royal Society of NZ (incl. Marsden Council)
  - Health Research Council

**DELIVERY ORGANISATIONS**
- Centres of Research Excellence
- Tertiary Education Institutes
- Crown Research Institutes
- Independent Research Organisations
- Businesses
- Incubators
- Regional Business Partners
- NZ Trade & Enterprise

**Callaghan Innovation**
Catalyst Fund

The Catalyst Fund supports activities that initiate, develop and foster collaborations leveraging international science and innovation for New Zealand’s benefit.

- **Catalyst: Strategic** funds strategic research and large-scale international collaborations
- **Catalyst: Seeding** supports small and medium-sized new international partnerships
- **Catalyst: Leaders** supports targeted international fellowships for exceptional individuals
- **Catalyst: Influence** supports New Zealand’s involvement in international fora
The Investment Attraction Taskforce is designed to deliver the strategy and support a step-change in New Zealand’s investment attraction efforts, to unlock barriers and enable the seamless facilitation of investment opportunities.
Attracting Multinational R&D Investment to New Zealand

• **Aim to attract 10 multinationals by 2020**

• **Objectives:**
  • Build a more internationally connected science system
  • Contribute to lifting BERD
  • Enhance R&D investment ecosystem
  • Build NZ’s reputation as an R&D location
  • Enhance our reputation as a great place to do business
Our global rankings – a great starting point

1st for Entrepreneurship

1st for corporate ethics and accountability

2nd best country in the world to do business with

1st for trust-worthiness and confidence

1st in world for investor protection and monetary freedom

3rd in world for economic freedom and opportunity

1st highest investment level in digital network

2nd easiest place in the world to do business

4th most attractive investment destination in the world
The flip-side...

Small

Remote

Great science

Ideal test-bed

Nimble and responsive government

Privacy

Disease-free agricultural environment
NZ MedTech Research and Partnering Ecosystem

Dr Diana Siew
MedTech Sector Specialist
Consortium for Medical Device Technologies, CMDT

- National industry-research network
- Accelerate innovation – medtech one stop portal
- Simplifies cross-organisational collaborations
- International connections

www.cmdt.org.nz
Centre of Research Excellence (CoRE)

- MedTech CoRE – solving health needs with new technologies and creating commercial opportunities
- Brain Research NZ – understanding the aging brain to develop interventions and treatments for neurodegenerative disease
- Te Punaha Matatini – data analytics

National Science Challenge (NSC)

- Science for Technological Innovation
- Ageing Well – providing better health and wellbeing for older Nzers
- Healthier Lives – prevention and treatment of chronic conditions
NZ MedTech Industry - Overview

- Emerging & vibrant $1.4B sector
- 160 companies – 90% start-ups to $10M revenue

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostics &amp; Therapeutics</td>
<td>Sleep Apnea, Fisher &amp; Paykel Healthcare; Bladder cancer screening, Pacific Edge Biotechnologies</td>
</tr>
<tr>
<td>Interventional Technologies</td>
<td>Anaesthesia monitoring, Custos; Devices for interventional radiology, Adept Medical</td>
</tr>
<tr>
<td>Assistive &amp; Rehabilitation</td>
<td>Robotic mobility devices, REX Bionics; Stroke Rehabilitation, AbleX Healthcare</td>
</tr>
<tr>
<td>Technologies</td>
<td></td>
</tr>
<tr>
<td>Telehealth &amp; Health Informatics</td>
<td>Electronic patient records, Orion Health; Remote communication, Poppin; Behaviour modification, SHI Global</td>
</tr>
<tr>
<td>Regenerative Med Technologies</td>
<td>Tissue Scaffolds, Aroa; Orthopaedic implants, Enztec</td>
</tr>
</tbody>
</table>
Standing Trial Populations (STPs)

NZ as a Test Bed

• Institute of Healthy Aging STP - Waikato DHB
  (An.Yu@waikatodhb.health.nz)

• Rehabilitation Innovation Centre – AUT, BAIL
  (nada.signal@aut.ac.nz)

• Rural Health STP - Callaghan Innovation Maori Health & Social Services Cluster

• DesignLabs – AUT and VUW

www.standingtrialpopulations.nz
We are growing older

Global Age Watch Index 2015
The role and potential of medical technologies for care of an ageing population

Professor Matthew Parsons

Clinical Chair in Gerontology
Waikato District Health Board in partnership with The University of Auckland
Exploring the market

Identifying the technology gap

The case for technology
Rectangularisation of ageing structures
We are getting older...

...by 20 minutes a day...
<table>
<thead>
<tr>
<th>Age-group</th>
<th>2001</th>
<th>2011</th>
<th>Change 2001-11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (000s)</td>
<td>%</td>
<td>N (000s)</td>
</tr>
<tr>
<td>0-4</td>
<td>281</td>
<td>7</td>
<td>258</td>
</tr>
<tr>
<td>5-14</td>
<td>597</td>
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<td>489</td>
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<td>314</td>
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<td>75+</td>
<td>210</td>
<td>5</td>
<td>263</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3,884</td>
<td>99</td>
<td>4,249</td>
</tr>
</tbody>
</table>
Population structural changes (2000)

Population

Age group
- 65–74
- 75–84
- 85+

DHB region
- Canterbury
- Waitemata
- Auckland
- Waikato
- Counties-Manukau
- Bay of Plenty
- Capital and Coast
- Taranaki
- Hutt Valley
- Nelson Marlborough
- Hawke’s Bay
- South Canterbury
- Northland
- Tairawhiti
- Northland
- Whanganui
- Taranaki
- Southland
- Lakes
- Whanganui
- South Canterbury
- Waikatia
- Tararwa
- West Coast

0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000
50,000
55,000
60,000
Population structural changes (2021)
Change drivers

<table>
<thead>
<tr>
<th>Age-group</th>
<th>2001</th>
<th>2011</th>
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Number of Potential Workers Per Elderly Person in Eight Countries, 1960-2020

Source: United Nations Demographic Indicators 2000-2001 draft data, 2003 revisions, medium estimates

Consumer
...and consumer expectations
Older people are staying at home

“people should be able to continue living in their own place of residence in their later years”

O.E.C.D. 1994
The Cost of a Long Life

Average Life Expectancy

Per Capita Spending

Life Expectancy

Per Capita Spending (International Dollars)
Number Of Potential Workers Per Elderly Person In Eight Countries, 1960–2020

Ratio of persons ages 15–64 to persons age 65 and older

12

10  NZ

8

6

4

2


Japan

New Zealand

Canada

Australia

United Kingdom

France

Germany

United States

• more costs
• more discerning
• less workers
• more complex conditions

“It sort of makes you stop and think, doesn’t it.”
Exploring the market

Identifying the technology gap

The case for technology
What is important to older people
### Social care outcomes for older people
*(Netton et al, 2002)*

<table>
<thead>
<tr>
<th>Old domains</th>
<th>New domains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Looking After the Home</td>
<td>Food &amp; Nutrition</td>
</tr>
<tr>
<td>Food</td>
<td>Personal Safety</td>
</tr>
<tr>
<td>Personal Self-Care</td>
<td>Social Participation &amp; Involvement</td>
</tr>
<tr>
<td>Physical Safety</td>
<td></td>
</tr>
<tr>
<td>Company</td>
<td></td>
</tr>
<tr>
<td>Daytime Activities</td>
<td></td>
</tr>
<tr>
<td>Money Management</td>
<td></td>
</tr>
<tr>
<td>Autonomy &amp; Choice</td>
<td>Control over Daily Life</td>
</tr>
</tbody>
</table>

**Total: 8 Domains**

<table>
<thead>
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<th>New domains</th>
</tr>
</thead>
<tbody>
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<td>Food &amp; Nutrition</td>
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</tr>
<tr>
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</tr>
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</table>

**Total: 5 Domains**
Alignment of older person goals with ICF

- Independence
- Self-care
- Support and relationships
- Community, civic and social life
- General tasks and demands
- Domestic life
- Interpersonal relationships
- Neuromuscular and joint functions
- Sensory functions and pain
- Learning and applying knowledge
- Mental functions
- Cardiovascular and respiratory...
- Skin functions
- Major life areas
- Products and technology
- Digestive, metabolic and endocrine...

IN-TOUCH, 2010, n=5,500
In a US institution (Langer, 1983)

One group received speeches from manager around staff being responsible for their lives

71% deteriorated functionally within 3 weeks

another received speeches from manager around individual responsibility. Encouraged to make decisions and given responsibility for something outside

93% showed improvement in self care, became happier and more active.
...therefore...
Losing control
Losing independence
Losing autonomy
What is important to the health sector
- Improving well-being
- Improving independence
- Increasing hospital capacity, curtailing growth (ED + Beds)
- Maintaining Aged Residential Care beds
- Maintaining Home Care spend
## Risk of entry to residential care

<table>
<thead>
<tr>
<th>Possible Indicators</th>
<th>Hazard Ratio</th>
<th>Lower CI</th>
<th>Upper CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence of inadequate meals</td>
<td>2.18</td>
<td>1.15</td>
<td>4.13</td>
<td>0.0166</td>
</tr>
<tr>
<td>Prevalence of dehydration</td>
<td>1.74</td>
<td>1.04</td>
<td>2.92</td>
<td>0.0347</td>
</tr>
<tr>
<td>Prevalence of social isolation</td>
<td>1.86</td>
<td>1.11</td>
<td>3.11</td>
<td>0.0190</td>
</tr>
<tr>
<td>Prevalence of delirium</td>
<td>3.65</td>
<td>2.16</td>
<td>6.18</td>
<td>0.0000</td>
</tr>
<tr>
<td>Prevalence of negative mood</td>
<td>2.17</td>
<td>1.29</td>
<td>3.65</td>
<td>0.0034</td>
</tr>
<tr>
<td>Status of family care using CRA</td>
<td>1.07</td>
<td>1.03</td>
<td>1.11</td>
<td>0.0006</td>
</tr>
<tr>
<td>Prevalence of ADL/rehab potential with no therapies</td>
<td>0.38</td>
<td>0.20</td>
<td>0.71</td>
<td>0.0027</td>
</tr>
<tr>
<td>Failure to improve/incidence of decline in ADL</td>
<td>11.07</td>
<td>2.57</td>
<td>47.74</td>
<td>0.0013</td>
</tr>
</tbody>
</table>
Areas of interest...

- Being in control...but also
- Carer stress
- Social isolation and negative mood
- Identifying decline
Opportunities

> Supporting carers...distance vs. live in, alleviating stress
> Social isolation and negative mood...spiral of decline, methods of communication
> Identifying decline...monitoring, identifying insidious decline
> Maintaining control...devices to support independence
Exploring the market

Identifying the technology gap

The case for technology
Old age is not an illness, it is a continuation of life with decreasing capacities for adaptation.
The humble toilet seat...

...simple inexpensive aid or something more sinister...
The position of technology

Well older people - prevention
Frailty - Reversing decline
End of life

Threshold for standing

Strength

Age
another consideration
**Number of chronic conditions**

<table>
<thead>
<tr>
<th>Indicator self-reported</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50-64 years</td>
</tr>
<tr>
<td>0</td>
<td>29.4</td>
</tr>
<tr>
<td>1 to 3</td>
<td>63.6</td>
</tr>
<tr>
<td>4 +</td>
<td>7.0</td>
</tr>
</tbody>
</table>

*Multiple specialties, multiple records*
Co-development in design, testing and implementation

- Involvement of consumers and users in the conception of the device
- Identification of the problem
  - i.e. Home Care workers visit clients x2 a day if someone is unable to administer their own eye drops and there is no one around
  - TED stockings need visits if a client is not able to put them on themselves
Making the case
The Triple AIM

- The Triple Aim is a framework developed by the Institute for Healthcare Improvement that describes an approach to optimising health system performance.
- New designs must be developed to simultaneously pursue three dimensions...’The Triple Aim’
The Triple Aim

1. Improving the patient experience of care (including quality and satisfaction);
2. Improving the health of populations; and
3. Reducing the per capita cost of health care.
Does the technology align?
Conclusion

- Rapid changes imminent – a reflection of changing demographics
- Technology has a clear role
- Successful technology needs to align with the real issues
THANK YOU...
The University of Auckland

オークランド大学について

> **Top 100** research universities in the world & NZ’s leading research university
  世界トップ100入り＆ニュージーランド屈指の研究大学

> **Largest university in NZ** 国内最大規模の大学
  > 40,000 students, 10,000 post graduates & 4,900 staff
  学部生4万人、修士・博士課程1万人、教職員4900人
  > 6,000 international students from 80 countries
  世界80カ国から6000人の留学生
  > Eight faculties and five campuses - about 60 Research Units, Centres and Institutes
  8学部、5キャンパス、約60の研究部門、センター、機関
UniServices – Who are we?

- Dedicated to **connecting** the University’s capabilities to business & investors, Government, the community

- UniServices is a **wholly-owned** company of the University of Auckland

- We provide you with **exclusive** access to the University of Auckland capabilities and IP

- We work alongside academic staff to **identify, protect and develop** big ideas with you, our business partner
CARES – Aims
CAREの目的

Centre for Automation and Robotic Engineering Science
オートメーション・ロボティック工学センター

Creating innovative and inspiring robotic technologies that improve societal well-being
より良い社会を目指して、革新的で豊かな発想のロボティック・テクノロジーを創造する

1. Healthcare assistive technologies  医療支援テクノロジー
2. Robots in Agriculture  農業用ロボット
3. Human-Robot Interaction  人間とロボットのコミュニケーション
4. Technology transfer  技術移転
5. Robotic Device technologies  ロボットデバイス技術
6. Software Systems for Robots  ロボット用ソフトウェアシステム
CARES – Multidisciplinary Team
学際的なチーム構成

- Engineering 工学
  - Bruce MacDonald (robotics ロボティクス)
  - Ho Seok Ahn (robotics ロボティクス)
  - Catherine Watson (robot voice ロボット音声)
- Medicine & Psychology 医学・心理学
  - Ngaire Kerse (gerontology 老年学)
  - Kathy Peri (nursing 介護)
  - Elizabeth Broadbent (health psychology 健康心理学)
- Science Health IT 科学、保健、IT
- Postgraduates 修士・博士課程の学生
- Business ビジネス
- Partners in Robotics, Healthcare
  ロボティクス、ヘルスケア分野のパートナー
Healthbot™
Rationale and Origin
ヘルスボット™開発の背景

- Addressing the growing need for older care and costs, as recognised by:

  高齢者の介護ニーズの高まりとコスト負担増に対応する。この課題を認識しているのは、
  - Developed-world Governments
    先進国の各国政府
  - Asian Development Bank and other aid agencies
    アジア開発銀行などの国際援助機関
  - WHO
    世界保健機関

We created Healthbot™: a healthcare robotic platform
このような課題認識のもと、ヘルスケアロボットのプラットフォームとして「ヘルスボット™」が誕生した。
Healthbot™

Features  ヘルスボット™の特徴

- Develop a healthcare robotic platform ヘルスケアロボットのプラットフォーム開発:
  - Robot hardware platform ロボットのハードウェアのプラットフォーム
    - Touch Screen / Camera / Sensors タッチスクリーン / カメラ / センサー
  - Middleware ミドルウェア
    - Interoperability 相互運用
    - Speech / Dialogue スピーチ / 会話
    - Vision / Gestures / Emotions 視覚 / ジェスチャー / 感情
    - Clinical guidelines / protocol 臨床ガイドライン / プロトコール
  - Robotic devices ロボティックデバイス
    - Wired, wireless and wearable devices 有線、無線、ウェアラブルデバイス

- Applications 用途
  - COPD, Dementia, medication reminder, vital signs monitoring
    慢性閉塞性肺疾患、認知症、服薬リマインダー、バイタルサインのモニタリング
### Healthbot™ Key Trials 主な実証調査

<table>
<thead>
<tr>
<th>#</th>
<th>Time-frame 時期</th>
<th>Main goal 成果</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2008</td>
<td>User requirements study 利用者のニーズ調査</td>
</tr>
<tr>
<td>2</td>
<td>2009</td>
<td>Acceptability study 利用者のロボット受容調査</td>
</tr>
<tr>
<td>3</td>
<td>2010-11</td>
<td>Feasibility study 実用可能性調査</td>
</tr>
<tr>
<td>4</td>
<td>2011-12</td>
<td>Risks/Benefits and deployment study リスク/ベネフィット分析、開発調査</td>
</tr>
<tr>
<td>5</td>
<td>2014</td>
<td>Pilot study 4 robots in people’s homes ロボット4台を一般家庭に導入・実証</td>
</tr>
<tr>
<td>6</td>
<td>2014</td>
<td>Robot screens patients before seeing family doctor or nurse 医師・看護師に面会する前にロボットが患者をスクリーニング</td>
</tr>
<tr>
<td>7</td>
<td>2015-16</td>
<td>Robots in people's homes to help manage respiratory problems 家庭に導入されたロボットが呼吸疾患の管理を支援</td>
</tr>
</tbody>
</table>
Healthbot™ ヘルスボット™
Eco-system エコシステム

**Patient 患者**

**Robot ロボット**

**Web Server (robogen) ウェブサーバ (ロボジェン)**

**Pharmacist/Nurse 薬剤師・看護師**

**Doctor 医師**

Medication packaging & delivery 薬の調剤と配送

Prescribed medication data 処方箋データ

Medication Scheduling & Data Reports:
Answers, vital signs, meds taken
服薬スケジュールの設定 & データレポート:
患者の応答、バイタルサイン、服薬歴

Questions Summary:
Answers
Vital signs
Meds taken
患者の応答、バイタルサイン、服薬歴を照会
Healthbot™ in Action

Videos: http://robotics.auckland.ac.nz
Healthbot™ Environments 使用環境

- Paro パロ
- Cafero
- Private places 日常生活
- Public & Private places 日常生活&公共の場
- Guide ガイド
- Public places 公共の場
- Friend 友人として
- iRobiQ
2008

Goal: User requirements study
目的：利用者のニーズ把握

Questionnaires, focus groups for staff, residents, relatives
介護施設の職員、利用者とその家族に対するアンケートを実施

Results 結果

• Identification of key tasks for a cognitive-support robot
  コグニティブ支援ロボットの主なタスクを特定

CARES – Study 2
実証調査2

2009
Goal: Acceptability study
目的：利用者のロボット受容調査

Residents meet and interact with a robot for a brief session
老人ホームの入居者がロボットと短時間対面し、コミュニケーションをはかった。

Results 結果
• Robot acceptable to older people
  お年寄りはロボット受け入れ可能

2010-11
Goal: Feasibility study
目的: 実用可能性調査

Robot deployed in older care facility for 4 months
老人ホームでロボット1台を4ヶ月間使用

Results 結果
• It is feasible to deploy a robot in different places in a retirement village to interact with residents and staff
老人ホームの施設各所にロボットを導入し、入居者や職員と交流することは可能。

2011-12
Goal: Risks/Benefits and deployment study
目的：リスク/ベネフィット分析と開発調査
25 robots deployed in a retirement village for four months
老人ホームで25台のロボットを4ヶ月間使用

Results 結果
- Feasible deployment (proof of principle). Robots stimulate activity.
  No negative results. Some positive results: robots needs a proper operational role.
  ロボットは導入可能（原則を証明）。ロボットは高齢者の活動を活発化。悪影響は見られなかった。ポジティブな結果として、ロボットは施設運営上、適切な役割が必要であることが分かった。

CARES – Study 5
実証調査5

2014

Goal: Pilot study 4 robots in people’s homes
目的：患者家庭に4台のロボットを導入し実証調査

Cognitive aid for high risk patients
ハイリスク患者に対するコグニティブサポートを行う

Results 結果
• Robots may reduce hospitalizations, phone calls and visits to doctor.
患者家庭へのロボット導入により、入院や医師との電話・面会回数を低減できる可能性がある。

2014
Goal: Robot screens patients before seeing family doctor or nurse
目的: 医師・看護師に面会する前にロボットが患者をスクリーニング

Robots measure vital signs
ロボットがバイタルサインを測定

Results 結果
• Robots reduce doctor and nurse time. Cost savings pay for robot < 1 year (ROI)
  ロボットは、医師・看護師の時間を節約。このコスト削減効果により、ロボットへの投資は1年で回収可能。

CARES – Study 7
実証調査7

2015-16

Goal: Robots in people's homes (4 months) to help manage respiratory problems (COPD)
目的：患者家庭でロボットを4ヶ月間使用し、呼吸器疾患(COPD)の管理を支援する。

Randomised controlled trial 30+30
ランダム比較試験(30+30)

Robot integrated with wireless inhaler monitor and specialised COPD-aid software
ロボットには、無線呼吸モニターおよびCOPD患者支援用の専門ソフトウェアを内蔵。

Results 結果

• Robots reduce length of hospitalisations and improve patient adherence to medication schedule. ロボットは入院期間を短縮し、患者の服薬遵守率を改善。

Scientific papers in preparation.
Other projects

- Dementia care robot design (Ewha’s Women’s University, Seoul + partners. 4 year project)

- Delivery robot evaluation (Yujin Robot, Seoul)

- Big data for older care robots (Yujin Robot, Seoul)
Healthbot™
Value Delivery (1)
ヘルスボット™が創出する価値

Workforce supplementation 医療従事者の活動補助：

1. Patient condition logging and alerts 患者の状態を記録、アラート
2. Vital signs バイタルサイン
3. Repetitive care-processes 反復的なケアプロセス
4. Medical reminders 服薬リマインダ
5. Medication delivery 医薬品のデリバリ
6. Remote consultation リモート医療相談
7. Customisation / setup – variable to suit the patient/situation カスタマイズ可能 / セットアップ – 患者さんの状況に沿って調整可能。
8. Additional services via third-party software/devices e.g. Life Time Health Diary
   外部ソフトウェア、デバイスを利用してすることでサービス内容の追加が可能。
   例: タイムヘルス・ダイアリー
Highly rated intangible value 目に見えない優れた価値:

9. Companionship and trust - valued by family and the elder
   人に寄り添い、安心感を与える - お年寄りとそのご家族が重視
10. Communicative connections - including elder-friendly Skype etc
    コミュニケーションを活性化 - お年寄りにも使いやすいSkype機能等
11. Entertainment - on robot or to remote display/TV
    エンターテイメント機能 - ロボットに搭載、またはディスプレイ・TVで表示

Intervention 連携:
12. Cognitive fitness 脳体操
13. Other third party service conduit 外部サービスとの連携が可能
**Conclusion まとめ**

- Expert multidisciplinary healthcare robotics team  
  CARESヘルスケア・ロボティクスチームは、分野を横断する学際的な専門家が集う。

- Experienced – many international collaborations  
  経験 – 国際共同研究の実績多数

- New Zealand is a good testbed for older care technology  
  ニュージーランドは、高齢者介護テクノロジーの実証調査の場として適している

- Older people and robots can work together  
  高齢者とロボットは協力が可能

- Cost benefits are possible; need more evaluation  
  コストを上回るベネフィットが可能。さらなる評価を行う。

*There is much untapped potential for technology to help older people by empowering them to be independently living, healthy and happy. However it is crucial to evaluate and develop the technology in real environments.*

お年よりが自立した生活を健康的に幸せに送るために、テクノロジーができる事は大いにある。そのためには、テクノロジーを実際の生活の場で評価し、開発していくことが重要である。
Thanks
ご清聴ありがとうございました

> Please contact us for further information
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International Business Development Manager, Science & Engineering
p.medrano@auckland.ac.nz

http://robotics.auckland.ac.nz
User-centered Rehabilitation Technology Development

Richard Little
Rex Bionics & Exsurgo Rehab

3rd March 2017
User-centered Design – Playing to your Audience/Market

• You have to give your customers what they want/need.
• They might not know they need it until you provide your solution.
• Not every one of your customers will like all of your products but they are still your customers.
• Customers vote with their dollars.
• You’re only as good as your last interaction with the customer.
• Your customers have a choice.
Why User-centered Design

- Investment - US$150M+
- USP – Can climb stairs

- Problem?
  A skilled engineer observed a man in a wheelchair struggling to get up a step outside a mall.

- Solution
  Design a wheelchair that can climb stairs.

- However
  With this wheelchair to go upstairs the user needs to lean back and manually tip the wheelchair backwards, the problem is people who use electric wheelchairs typically don’t have the upper body strength to do that otherwise they wouldn’t use an electric wheelchair.

The company went out of business!!!
User-centered Design

Use Cases
- Who?
- Where?
- When?
- What?

Requirements
- User
- Product
- Market
- Regulatory

Evaluation
- User
- Engineering
- Clinical
- Regulatory

Product Development

Cautions...

- “If I had asked the people what they wanted, they would have told me **faster horses.**” Henry Ford (probably not)

- Being a user doesn’t necessarily make you an expert and not everyone's experience is the same.

- Continually evaluate your story even when you are in the market – things change.

- The development project will have different customers and their needs will be different e.g. investors, regulatory bodies as well as users.
And Don’t Forget

Customers come in many forms....
• End Users
• Family & Friends
• Health Funders
• Health Care Providers
• Clinicians

Healthcare Products have complex relationships...
• Researchers...........Prove it works
• Regulatory Bodies...Approve it
• KOLs......................Promote it
• Funders..................Pay For it
Making it Work

In Auckland we have the Rehabilitation & Innovation Centre, a collaboration between:

- Industry
- Government
- Research Institutions
- & Community

What does that mean for industry?

- Access to clinicians
- Access to patients
- Use data in real time to feed into development
- Reduced development timeframes
- Clinical validation for regulatory bodies
- Better products!!!
In the Clinic with Patients

• We learn about our customers' needs by trying to understand their experiences, by listening to them and sharing their journey/experience/product interactions as much as we can.

• Design your products to meet the customers' needs.

• Let customers test and validate your designs in real clinical use, use the learnings.

The use of the REX Robotic Exercise System, not for walking but for pain management and rehabilitation in the neck and shoulders of a 35-year-old male with a Spinal Cord Injury.

A single case report

The patient had a complete T5 SCI from a traumatic motor vehicle accident 1 year prior. He was referred for robotic assisted rehabilitation. Initial assessment indicated significant left-sided shoulder pain with neck pain as well.

A single case report

The patient had a complete T5 SCI from a traumatic motor vehicle accident 1 year prior. He was referred for robotic assisted rehabilitation. Initial assessment indicated significant left-sided shoulder pain with neck pain as well.

Methods

The patient was placed in a seated position for 1 hour, followed by 1 hour of seated robotic assisted rehabilitation. Pain was assessed on a visual analog scale (VAS) before and after the intervention. The patient reported a decrease in pain from 7/10 to 2/10.

Results

Significant improvements were recorded in the participant's quality of life and a reduction in pain. The pain was significantly reduced from 7/10 to 2/10.

Discussion

The participant reported a significant improvement in pain reduction, and an overall increase in quality of life. The intervention was well tolerated and did not cause any adverse effects.

Conclusion

Standing while completing upper body rehabilitation and strengthening in a stand-alone robotic exercise device can significantly enhance neck and shoulder pain management and improve quality of life. Highlighting that robotic exercise devices can offer a range of rehabilitation opportunities as well as gait training.
User-centered Design - The Results

“Miracle!
I woke this morning with no discomfort in [my] hip. I didn’t realise the low grade pain until it wasn’t there. The session yesterday worked wonders.

Thank you so much”
Questions
accelerating neuro recovery: stroke, dementia, cerebral palsy

www.im-able.com/
Callaghan Innovation
The problem: stroke

- The most prevalent cardiovascular disease
- The greatest YLL (years of life lost)
- The greatest cause of disability amongst adults
- In the next 40 years stroke incidence will double
- Upper limb impairment = loss of independence
- Conventional upper limb rehabilitation is insufficient
The collaborations

Callaghan Innovation (Industrial Research Ltd)
CDHB:  Burwood Spinal Unit
          Brain Injury Rehabilitation Service
          The Princess Margaret Hospital
University of Otago

Victoria University of Wellington
Auckland University of Technology
Laura Fergusson Trust
ABI Rehabilitation

University of Melbourne
initial research: computer gaming by stroke survivors

What stroke survivors want

- Social interaction
- Feedback
- Intellectual stimulation
- Easy to understand/Relate to game
- Tolerance for disabilities
- Physical benefit

What gamers want

- Social interaction
- Feedback
- Concentration
- Challenge
- Player skills
- Clear goals
- Immersion
- Control

King et. al. 2010 Dis and Rehab

Sweetser et. al. 2005 ACM computers in entertainment
The solution: a gamified rehabilitation system

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No movement is observed.</td>
</tr>
<tr>
<td>1</td>
<td>Only a trace or flicker of movement is seen or felt in the muscle or fasciculations are observed in the muscle.</td>
</tr>
<tr>
<td>2</td>
<td>Muscle can move only if the resistance of gravity is removed.</td>
</tr>
<tr>
<td>3</td>
<td>Muscle strength is further reduced such that the joint can be moved only against gravity with the examiner's resistance completely removed.</td>
</tr>
<tr>
<td>4</td>
<td>Muscle strength is reduced but muscle contraction can still move joint against resistance.</td>
</tr>
<tr>
<td>5</td>
<td>Muscle contracts normally against full resistance.</td>
</tr>
</tbody>
</table>

Games

Devices
Control devices and therapy games
Clinical efficacy proven
FDA cleared
CE marked
1500+ patient interventions


10. de Ruiter N et al. 2010 A Variable Resistance Virtual Exercise Platform for Physiotherapy Rehabilitation Intelligent Systems technologies and Applications 8, 261-275
$n = 92$; individuals and groups of 5

Typically in OP phase, deliberately wide inclusion criteria to reflect clinical practice, no control group

Administered by 1 OT and 1 therapy assistant

ableX and ableM devices, plus ReJoyce. Protocol had no fixed prescription.

18 hours of extra rehab per patient over 6 weeks

*J Rehabil Med* 2016; 48: 522-528

A transformative solution

ableX gamifies intensive UL rehabilitation to stimulate neuroplasticity.

Promising evidence from practising clinical environments.

Opportunity to improve expected and longer term outcomes vs standard of care.

This solution continues to evolve as a result of progressive clinical use.
Used in multiple healthcare settings:

Stroke, Dementia, Cerebral Palsy, Autism, Traumatic brain injury, Spinal injury, Depression...
Acute care; rehabilitation units; residential care; home; community professionals...
Used in multiple healthcare settings

First use
(7 years post-stroke)
Minimal function

T+1 month
Lower tone, individual finger control
Gaming for dementia: a current PhD project
Japan-NZ Bilateral Workshop in Technologies for Elderly Care
March 2017

Research at the ABI and the MedTech CoRE related to aging and medical robotics

Peter Hunter and Thor Besier
Hip protector adherence and the Internet of Things (IoT)

Hip protectors prevent fractures...but only if they are worn

– In aged residential care they work
– In the community setting they don't

• The difference is adherence: in aged care they are worn because of the influence of staff
• We can accurately measure adherence using temperature and acceleration data* – Can we use the IoT to close the loop in order to monitor and encourage adherence?
• Clinical trials planned for 2018

Robo-bed

- Soft transducer technology (integrated length actuator and force sensor)
- Configured into arrays of transducers that can dynamically support patients and move patients on and off the bed

Skin (and other soft tissue) mechanics

- Dynamic dexterous 3D parallel robot to provide controlled rapid deformations and measure mechanical properties of skin in vivo
- Super-resolution image registration algorithms to measure subtle differences in (multi-dimensional) images of patients
- Diagnose skin pathologies and monitor wound healing

Pelvic floor health

- Development of devices to assess pelvic floor health and provide feedback on training to improve levator ani muscle fitness (FemFit)
- Finite element models of pelvic floor mechanics to assess tissue injuries
Human Joint Sensing and Actuation in Preventive Ergonomics and Rehabilitation Therapy and Monitoring in an Ageing Society

Dr Thor Besier, Associate Professor
Auckland Bioengineering Institute & Department of Engineering Science
University of Auckland
The first generation of highly integrated sensing and actuation technology for human exoskeletons

Challenge to be solved

- to assess activity in heavy physical work in an ageing working population
- to assist at work with light weight, smart, powered exoskeletons
- to assess rehabilitation success and assist in daily activities e.g. stroke recovery
- to monitor activity for homecare needs
Components of a neuromusculoskeletal controller

Musculoskeletal Model Generation

- Musculoskeletal model
- Parametric mesh of bones and muscles
- Model fit to CT dataset (n=300)

Wearable sensors

- Inertial sensors
- Stretch sensors
- Electromyography (EMG)

Kinematic Modelling

- OpenSim model
- "Autolev" representation of model dynamics

Neuromusculoskeletal Controller

- EMG-synergy model
- Joint angles
- Muscle and joint forces and torques

Exoskeleton

- Robotic torque actuator

Bone and muscle geometry

Accelerations, strains, angular velocities

Muscle activity
Musculoskeletal Model Generation

**Goal:** To develop a statistical shape model of the upper limb to rapidly generate anatomical models of bone and muscle geometry for musculoskeletal modelling.
The Musculoskeletal Atlas Project: An anatomical and functional atlas of the musculoskeletal system
Parametric meshes of the upper limb fit to 1000 CT scans from the Victorian Institute of Forensic Medicine (VIFM)
Wearable Sensors

**Goal:** To integrate inertial, stretch, and EMG sensors into a comfortable arm sleeve to measure arm motion and muscle activity.
Kinematic Modelling

**Goal:** To develop a computational model of the upper extremity to estimate kinematics of the upper arm in real-time
Neuromusculoskeletal Controller

Goal: To develop an EMG-synergy-driven model of the upper limb to predict muscle forces and joint torques in real-time.
The Rehabilitation Innovation Centre (RIC) is a partnership between industry and research, supported by Callaghan Innovation and spearheaded by AUT University.

Vision

By working collaboratively with industry and end-users the Rehabilitation Innovation Centre will be a world leader in the evaluation and development of rehabilitation technologies that can positively impact the lives of people experiencing disability.
## Directors
- Dr Denise Taylor, Professor of Rehabilitation
- Dr Nada Signal, Senior Research Fellow
- Dr Nicola Kayes, Associate Professor of Rehabilitation

## Researchers
- Dr Imran Niazi, Post Doc Fellow
- Gemma Alder, Research Officer
- Dr Mark Boocock, Professor of Ergonomics and Biomechanics
- Nicola Saywell, Lecturer in Physiotherapy
- Sharon Olsen, Research Officer
- Bronwyn Harmen, Lecturer
- Ruth McLaren, Research Officer

## Students
- Nitika Kumari, PhD Physiotherapy, Usman Rashid, PhD BioEngineering
- Kate Charlesworth, Masters Occupational Therapy
- Fawad Zaidi PhD, Game Design, Keith Chan, PhD Electrical Engineering
Rehabilitation Technology Development
**Development: ArmBoost**

ArmBoost uses accelerometry (movement) data to provide information about the amount, type and symmetry of arm and hand activity following stroke.

- Increased dose of rehabilitation
- Patient engagement
- Family engagement
- Measuring outcomes of importance
Neuromodulation

Muscle

Brain Signal

A

Development: ExciteBCI

Neural plasticity

Recovery

Muscle

B

Neuromodulation
Development: iVR²

iVR²- an immersive Virtual Reality Vestibular Rehabilitation system designed for patients with vestibular disorders to provide graded exposure to increasingly complex visual imagery.
Rehabilitation Technology Evaluation
Focus

- Expert advice and review of clinician training methods and materials.
- Exploration of REX® potential as a rehabilitation device in various neurological populations.
- Expert review of relevant clinical evidence and research.
- Identification of key challenges to implementing REX® in clinical practice
Research Aim

- Describe;
  - Motion of User and REX®
  - Muscle activation patterns
  - Pressure distribution
during REX® locomotor tasks.

- In comparison to unsupported
  locomotor tasks in healthy people.

- In people with SCI and people
  with stroke.
• Promote the future development of REX®.
• Address questions commonly asked by clinicians when evaluating the suitability of REX® for their patients.
• Support clinical reasoning by clinicians during REX® use.
Research Aim:
The feasibility, safety and acceptability of the REX robotic exoskeleton for ambulation and upper body exercise in people with SCI

Research Method:
A prospective, international, cohort study in people SCI (n=56).
• Feasibility; successful transfer, device control, the timed up and go test (TUG) and completion of upper body exercise.
• Safety; adverse events reporting.
• Acceptability; User questionnaire.
• Explored patient reported outcomes.
“This study highlights that, distinct from other robotic exoskeletons, REX® is suitable for people with high level lesions and enables a range of rehabilitative activities to be undertaken.”
Planning underway for a multicentre international clinical trial investigating the efficacy of REX® Rehabilitation in people with moderate to severe stroke.
By working collaboratively with rehabilitation technology developers, industry and end-users the Rehabilitation Innovation Centre will be a world leader in the evaluation and development of rehabilitation technologies that can positively impact the lives of people experiencing disability.

Summary

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About Bupa

Bupa is a leading global health and care company with unique breadth, scale, influence and expertise. Our aim is to improve and engage millions of people in their health and wellbeing across the globe.

We serve 32 million customers in more than 190 countries, and employ almost 84,000 people world-wide. We deliver a broad range of services to fund and provide healthcare.
Bupa around the world

We have over 32 million customers

We employ almost 84,000 people

In over 190 countries

Principally in the UK, Australia, Spain, Poland, New Zealand and Chile, as well as Saudi Arabia, Hong Kong, India, Thailand, USA and Latin America.
Who we are

Our status as a private company, limited by guarantee, means we have no shareholders and are not driven by short-term profit.

This means we behave commercially and focus on our customers, whilst taking a long-term view and reinvesting our profit to provide more and better healthcare, fulfilling our purpose: *longer, healthier and happier lives.*
Australia and New Zealand

**BUSINESS UNITS**

- Bupa Australia Health Insurance
- Bupa Aged Care Australia
- Bupa Care Services New Zealand
- Bupa Health Services Australia

**HEALTH INSURANCE**

Bupa Australia is the largest privately owned health insurance provider in the country with 4.7m customers.

**CARE SERVICES**

Bupa Aged Care in Australia and New Zealand is the largest privately-owned aged care provider in the region.

We offer 125+ care homes, 36 retirement villages and 7 rehabilitation sites. We also provide telecare services via a personal alarm network.

**GP CLINICS**

In October 2014 Bupa offered GP services for the first time at a flagship clinic in Sydney. There are plans to open five more.

**BUPA MEDICAL VISA SERVICE**

We are a delivery partner for the Australian government, and will carry out around 250,000 visa medical assessments each year.
HEALTH & CARE

Bupa Aged Care New Zealand is the largest privately-owned aged care provider.

We offer 62 care homes, 36 retirement villages and 7 rehabilitation sites. We also provide personal alarms.

4,000+ employees

5,000+ residents

9,000+ medical alarm customers

25 dental clinics
Current Technology

Traditional Medical Alarms
Personal Emergency Response System (PERS)

- Base unit plugged into the phone line or built in SIM
- Programmed to communicate with Bupa’s central monitoring station when the pendant worn by the client is pushed
- Using two way voice, the monitoring station communicates via the speaker in the alarm to establish help required
- When the alarm is activated, the monitoring station knows who the person is and where they live from details provided at the time of installation.

So what is mPERS?

- A MOBILE Personal Alarm
- Limitation of traditional alarms is the client can only call for help when in radius of their base unit e.g. garden or letterbox
- Our clients are more independent and demanding the freedom to call for help ‘beyond the gate’
Bupa Watch - Wearable Alarm Project

What does it DO?

- A wearable device (Samsung Gear 3G) that can be activated to request help to be sent to wherever the wearer is at that point in time (nationally)
- Standalone device - separate mobile not required
- Wearer’s location supplied to Bupa’s central monitoring station
- Two way voice communication through the watch with Bupa’s monitoring station

- Facilitates interaction with wearers support network - e.g. informal or formal carers and nominated contacts via Jupl’s Friends & Family text and app services

The Players

Bupa has a financial investment in Jupl and BCNZ has an existing supply agreement.

The latest product that Jupl is developing is in partnership with Samsung to provide an mPERS solution.

Bupa’s Advantage

The solution is not yet available in-market and Bupa have the following advantages prior to full market launch:

- Undertake live customer trials
- Conduct presale activities with consumers (B2B & B2C)
- Onboard potential resellers
Future Possibilities

- **Geofencing** - alerting carer should the wearer leave or arrive at a designated boundary

- **Fall Detection** - self activation should the watch detect the wearer has had a fall

- **Health & Care Partner** - once devices are with customers, layering of additional Health & Care applications (including Telehealth) as ‘add on’ subscribed services is possible
Thank you
The private photo album that connects generations
Our sweet spot

Grandparents
● 30% of population

Parents with kids at home
● 30% of population

Kids 4 - 14 years old
● 15% of population

Expat families
● 20% of population
What makes kin2kin different for families?
Our emotional, unique and simple solution

Grandparents
● Organised photos and direct relationships

Parents with kids at home
● Quickly connect family via photos they share

Kids 4 -14 years old
● Safely included

Expat families
● No time zone challenges
The kin2kin private network for modern families

- 30% of grandparents are separated
- 55% of kids live in non-traditional households
- Average first internet use is now 3 years old
We have solutions for these highly engaged and private networks through:

- Senior Care
- Youth Organisations
- Family Organisations
- Gifting
- Photo Printing
Solutions for aged care organisations
Connecting highly engaged family support networks to:

- Care Homes
- Retirement Homes
- Dementia Organisations
- Health Insurance
- Medical Alarms
- Health Apps

We are seeking international strategic partners
Families living with Dementia

- The proven benefits of memory books
- The power of love and support networks
- The positive results from organised photos with faces, names and relationships
- Alzheimer’s impacts 1/3 of all families
Organisations supporting those living with Dementia

Communication with full family network possible
Care homes working with Dementia

Caregivers assist residents in connecting with family.
Care home and retirement home services easily paid for by family

Families can meet both the emotional and financial needs of seniors
Self-directed care organisations

Win-win relationship via connecting Seniors and promoting services
Extension to medical alerts

kin2kin can amplify the reach of brands and services
Similar extension to medical apps

Not all family are primary caregivers. kin2kin can extend the reach.
Finally, branded kin2kin for life insurance companies...

Maintain a meaningful and segmented conversation with customers
...and international senior care organisations
We are keen to talk to new international partners in senior care
Appendix:

1. kin2kin website: www.kin2kin.com

2. kin2kin explainer video: https://vimeo.com/kin2kin/whatmakeskin2kindifferent

3. kin2kin reviewed on TVNZ Breakfast Show: https://vimeo.com/167217745