

Health Technology Update

CADTH

A newsletter on new and emerging health care technologies in Canada

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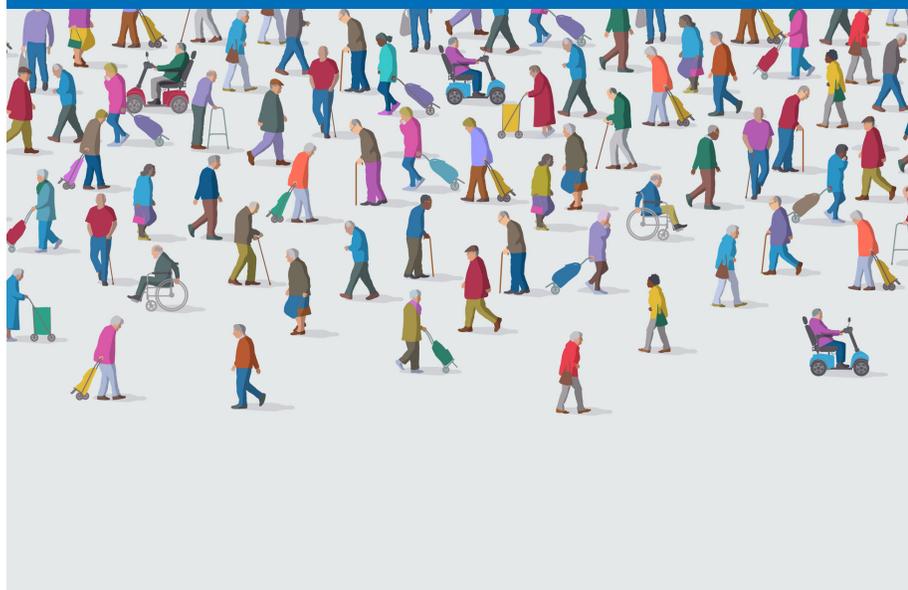


Photo: iStock/Group of elderly

Aging in Place

This issue of *Health Technology Update* features brief summaries of information on a range of technologies that aim to support older adults and facilitate aging in place – from ingestible sensors for medication monitoring to a virtual reality-inspired exercise bike. These technologies were identified through the CADTH Horizon Scanning Service as topics of potential interest to health care decision-makers in Canada.

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FEEDBACK

Have you heard of a new health technology you think will have an impact on health care in Canada?

Please let us know!

Email: HorizonScanning@cadth.ca.

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Issue 24: Aging in Place

Aging in place has been defined as “the ability to live in one’s own home and community safely, independently, and comfortably, regardless of age, income, or ability level.”¹ By 2056, it is estimated that one-third of Canadians will be aged 65 and older.² With 92.1% of those who are 65 and older currently residing in private dwellings,³ there is a growing demand for policies, programs, and technological initiatives to help older adults remain in their communities.

There have been a number of studies regarding health interventions to reduce adverse outcomes in older adults who are living in the community, ranging from strength training to telemonitoring.⁴ These health promotion and disease prevention strategies contribute to the likelihood of a healthier and more productive life in older age.⁵

In this issue of *Health Technology Update*, we present readers with articles on five emerging technologies that facilitate aging in place:

- BikeAround, a virtual reality-inspired exercise bike designed to promote physical activity, memory skills, and social engagement for older adults with cognitive impairments in community settings
- Emerald, a device that employs wireless signals and artificial intelligence (AI) to track the activity of people in their homes as an unobtrusive means of home health monitoring
- Notal Vision’s patient-operated optical coherence tomography device created to monitor age-related macular degeneration at home
- Cala ONE, a wrist-worn device that delivers non-invasive peripheral nerve stimulation to control the symptoms of essential tremor
- ABILIFY MYCITE, an oral medication that includes a digital ingestible sensor, skin patch, and a smartphone app that can track medication adherence.

Author: Diksha Kumar

See references on page 14.



Photo: iStock/ipopba

How It Works

A defining characteristic of ET is uncontrollable shaking of the hands and forearms, which may also extend to a person's voice and other parts of the body, such as the head, neck, face, and legs.^{2,3} Depending on the severity of ET, people who are affected by this disorder can face significant physical impairment and psychological burden.^{1,2,4} Medication remains the first-line therapy for ET but has limited effectiveness, with about 25% to 55% of individuals not finding adequate relief from the medications they are prescribed.⁴ Other ET treatment and management options that may be considered include surgery, peripheral nerve stimulation, and devices designed to assist individuals with ET in undertaking their daily activities.

A new device in the spectrum of care for ET is the Cala ONE, which delivers non-invasive peripheral nerve stimulation to provide temporary relief from ET-related hand tremors.⁵ The device resembles a smartwatch and is worn on the patient's wrist, where it stimulates the median and radial nerves through the skin with controlled electrical pulses.^{5,6} Past studies have demonstrated that this type of peripheral nerve stimulation can decrease hand tremor,⁶ although the exact mechanism of action is not fully understood. To begin the therapy, the Cala ONE's integrated sensors measure the individual's tremor frequency and a physician uses this data to program the device to dispense the appropriate level of nerve stimulation.^{5,6} The therapy is provided to the hand that is most affected

New Device for Managing the Effects of Essential Tremor

Essential tremor (ET) is a common movement disorder.¹⁻³ The condition can significantly impact the daily lives of affected individuals by making it difficult to perform regular activities such as eating, brushing teeth, and showering. A novel device is aiming to provide relief from the negative effects for patients with ET.

by tremor or to the dominant hand if both sides are similarly affected.⁶ The device can be worn all day and it delivers the therapeutic stimulation whenever the individual needs it.⁷

Who Might Benefit?

Estimates of the prevalence of ET range from 0.4% to 3.9% of the general adult population.⁸ While the condition can occur at any age, the population aged 65 years and older tends to be particularly affected, with a prevalence rate estimated at around 5%.² The Cala ONE can potentially be used by all adults living with ET.⁵

Availability in Canada

The Cala ONE is currently not available in Canada and it is not known if the manufacturer plans to enter the Canadian market. The device was approved by the US FDA in 2018.⁷

What Does It Cost?

No cost information for the Cala ONE was found in the publicly available literature.

Current Practice

As noted, medications like the beta-blocker propranol and the anticonvulsant primidone are the first-line treatment options for ET.^{2,3} Surgical interventions include deep brain stimulation and lesional surgery.^{2,3} Deep brain stimulation is reportedly the most commonly used surgical procedure for treating tremor.^{3,8} Lesional surgery, which involves making targeted lesions in the brain to block tremor-inducing neural pathways, is commonly performed using stereotactic radiosurgery and, more recently, magnetic resonance-guided focused ultrasound (MRgFUS).^{2,8}

What is the Evidence?

One randomized study evaluating the effectiveness and safety of the Cala ONE was published in 2019.⁶ The study included 77 participants, with 40 assigned to receive the treatment, and was funded by the manufacturer.⁶ Results showed Cala ONE to be safe and effective for the temporary relief of hand tremor and the FDA relied on the findings of this trial to grant its approval of the device.⁵

Safety

The aforementioned study on the Cala ONE reported that minor adverse events, such as skin irritation and stinging pain in the wrist, occurred in 3% of the participants but resolved within 24 hours.⁶

Issues to Consider

In addition to limited effectiveness, intolerable adverse effects are one factor that can restrict the use of medication in the treatment of ET.^{3,6} Similarly, the invasive aspect of surgical options like deep brain stimulation and lesional surgery may limit the appeal of these interventions for people with ET.⁹ Non-invasive peripheral nerve stimulation may present an alternative for managing ET when there are issues and concerns regarding medical therapy or surgery. However, the effectiveness and safety of the Cala ONE compared with medical therapy or surgery have not been evaluated to date.

Related Developments

Beyond peripheral nerve stimulation, other approaches are being leveraged to improve the life of individuals affected by ET. One such approach is neurosurgery

with MRgFUS, which was recently approved as a surgical option for the treatment of ET after being studied for several years in Canada and elsewhere.¹⁰ The procedure is performed with ultrasound waves that travel through the skull, avoiding the need for an incision or open surgery to access the targeted brain site.^{11,12} This non-invasive feature of MRgFUS is appealing for patients and clinicians.¹² Another approach consists of wearable assistive devices designed to

stabilize the hand and allow the individual to perform regular activities such as eating and writing, largely unhindered by the impact of tremor. Examples of this type of device are the GyroGlove¹³ and the Steadi-One,¹⁴ which are currently in the developmental phase.

to have a better sense of how helpful this device would be for individuals struggling with the limitations that ET imposes on their lives.

Author: Bert Dolcine

See references on page 14.

Looking Ahead

Peripheral nerve stimulation with the Cala ONE may provide a non-invasive option to control ET, but more evidence is needed



Photo: iStock/Doctor with Digital Tablet.

Ingestible Sensors for Monitoring Medication Adherence: Abilify MyCite and Proteus Discover

Medication nonadherence can have a negative effect on patients' health outcomes and overall health care costs.¹ ABILIFY MYCITE is an oral medication that includes a digital ingestible sensor that can track medication adherence using the Proteus Discover technology for patients with schizophrenia or bipolar I disorder.^{2,3}

How It Works

Using the Proteus Discover technology, the ingestible sensor in ABILIFY MYCITE communicates with an external patch applied to the skin.³ The sensor sends the information to the patch that the aripiprazole medication has been ingested to the patch, which communicates with the patient's smartphone and with their health care provider to better track the patient's medication adherence.³

Who Might Benefit?

ABILIFY MYCITE is approved in the US to be used for people with schizophrenia or bipolar I disorder.⁴ It is anticipated that ingestible sensors will be used in hepatitis C, heart failure, hypertension, diabetes, depression, and tuberculosis, or other conditions where adherence is critical.⁵⁻⁹ However, because it can potentially be used for any oral medications with the need for therapeutic drug monitoring, its use could expand.¹⁰

Availability in Canada

ABILIFY MYCITE and the Proteus Discover technology are not currently available in Canada. In the US, the Proteus Discover sensor was first approved in 2012 for analyzing event-associated heart rate, activity, and body position; it received an expanded indication in 2015 for medication adherence.^{11,12} ABILIFY MYCITE was approved by the FDA in November of 2017.⁴

What Does It Cost?

In the US, ABILIFY MYCITE costs US\$1,650 for 30 tablets, seven patches, the smartphone app, and access to the Web-based portal, whereas the generic Abilify, aripiprazole, costs US\$166.80 for 30 days of a 10 mg-per-day regimen.¹³ The Canadian costs are unknown.

Current Practice

Currently in Canada, medication adherence is tracked by methods such

as directly observed therapy, laboratory monitoring tests, electronic pill caps, pharmacy pill counts and refill frequency, and patient self-report.¹

What is the Evidence?

One systematic review published in 2019 was identified regarding ABILIFY MYCITE for monitoring medication adherence for patients with mental health conditions and monitoring evidence dissemination in the scientific literature and in the media.¹⁴ The authors of the systematic review identified three non-comparative, uncontrolled cohort studies.¹⁴ In the systematic review, 14 papers and 70 news stories were identified that cited the trials.¹⁴ The three cohort studies reported on the detection of ingestion events and the number of days with patch wear or good sensor detection data, but did not report efficacy outcomes such as remission or quality of life. Eleven out of 14 papers and 52 out of the 70 news stories reported an impression of benefit that is unsupported

by the evidence.¹⁴ The authors concluded that the FDA approval was granted on limited data and the technology could potentially form a new type of “digital” evergreening, whereby manufacturers gain exclusive market access by adding a digital component to a product that has a generic alternative.¹⁴

Two open-label, single-arm, non-randomized clinical trials were identified that were also included in the systematic review.^{15,16} The first non-randomized study included 49 patients at four US sites with bipolar I disorder, schizophrenia, and major depressive disorder, which was not part of the FDA-approved indications but investigated in the study.¹⁵ The authors reported that the mean ingestion adherence was 88.6% and that patch-wear adherence was 80.1%.¹⁵ The second study included 67 patients with schizophrenia at six US sites.¹⁶ The authors reported that 82.1% of the patients could use the wearable sensor, the mean wearable sensor use time was 70.7% of the duration of the trial, and that 78% of patients were satisfied with the digital medicine system.¹⁶ Five observational studies, two economic analyses, and two review articles were included in the ECRI Institute Product Brief on the Proteus ingestible

sensor for measuring medication adherence.¹⁶ The authors suggested that there was insufficient evidence to make conclusions about the effect of the Proteus system on patient adherence or its comparative effectiveness versus alternative patient medication adherence interventions.¹⁷

Safety

In the two clinical trials, the most common medication-associated adverse events were upper respiratory tract infection and headache, which were consistent with that of aripiprazole-only Abilify; the most common device-associated adverse events were patch-application site skin reactions such as itchiness, rash, and redness.^{15,16}

Issues to Consider

Some of the main ethical concerns regarding ingestible sensors are privacy, confidentiality, and patient autonomy.³ The collection of patient data and the storage of data generates concerns about data security breaches.³ There can also be a tension between patient autonomy and public health concerns, as those with certain mental health conditions or infectious diseases may be mandated by law or indirectly pressured by health care workers to receive the ingestible sensors as treatment.³

Related Developments

Ingestible sensors are being explored in other disease areas including hepatitis C, heart failure, hypertension, diabetes, and tuberculosis.⁵⁻⁹ Clinical trials are being conducted in ingestible sensors combined with oral hepatitis C treatments.^{6,9} Studies were also conducted to monitor medication adherence for patients taking tuberculosis treatments combined with the ingestible sensors.⁵

Looking Ahead

There is significant interest in ingestible sensors for medication adherence monitoring.¹ The introduction of ABILIFY MYCITE into clinical practice may offer more insight into the application of ingestible sensors as monitoring tools.

As ABILIFY MYCITE and the Proteus Discover technology are currently unavailable in Canada, the impact on health care human resources and financial resources for medication adherence monitoring in the Canadian health care system is unclear.

Author: Ke Xin Li

See references on page 14.

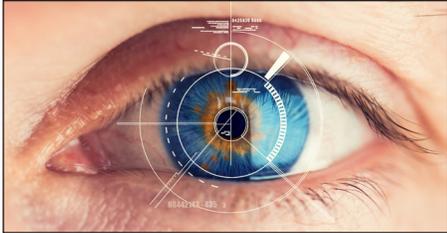


Photo: iStock/Secutiry Retina Scanner

How It Works

Optical coherence tomography (OCT) is an imaging method used by eye care professionals to see the anatomy of the retina.¹ These images are traditionally obtained during scheduled office visits and are used to assess and diagnose a variety of eye diseases, including AMD.¹ The Notal home-based OCT system has been designed to allow patients with wet AMD to image their eyes and monitor their ophthalmic pressure in real time from their home between scheduled visits with eye care professionals.¹ The system includes a patient-operated device easily used by people with visual impairment and older adults with potential physical or technological limitations.¹ The Notal home-based OCT system uses a proprietary artificial intelligence-based algorithm to analyze the patient's at-home OCT images and detect any retinal fluid changes in the central 10 degree visual field.¹ The results of the OCT testing are available, online, to the patients' eye doctors 24 hours a day, seven days a week. When a change is identified in a patient's testing pattern, the Notal Vision Independent Diagnostic Testing Facility will notify the patient's eye doctors and signal them to set up a follow-up appointment with the patient.¹

Who Might Benefit?

AMD is a degenerative eye disease.² By the age of 40, 1.5% of Canadians will experience AMD and this proportion can rise to 25% of the population by the age of 75 years.² Ninety per cent of new cases of legal blindness in Canada are caused

New Device Allows Imaging of the Eye at Home

Notal Vision has created a new patient-operated device to monitor age-related macular degeneration (AMD) at home. The device allows patients and health care providers to closely monitor the disease without the need for frequent office visits.

by AMD.³ There are two types of AMD: dry (or non-exudative) and wet (exudative). Nine out of 10 people with AMD will experience the dry form.² Dry AMD is typically slow to progress and causes less vision impairment. One out of ten people will experience the more advanced wet AMD, which can lead to serious vision impairment within weeks or months of the diagnosis.² It can result in the loss of the central field of vision, which can impact activities of daily living and quality of life. These impacts may include functional decline; dependency on others; injury and accidents; social isolation; increased morbidity; and increased burden on family, caregivers, and the public health system.² People with AMD in one eye have more than a 50% risk of developing AMD in the other eye within five years of diagnosis.²

The Notal home-based OCT system is intended to be used by patients with wet AMD.⁴ Given the speed with which vision loss can occur, more frequent monitoring of the condition might help patients seek out follow-up with their eye doctor as soon as changes occur instead of waiting until their next regularly scheduled follow-up appointment.¹ Earlier changes to the treatment plan may result in better visual outcomes for the patient.

Availability in Canada

The Notal home-based OCT system is not currently licensed for use by Health Canada.⁵ The manufacturer received breakthrough therapy designation for the product from the FDA in December of 2018.⁶ No similar devices were identified that are currently available in Canada.

What Does It Cost?

No information regarding the price of the Notal home-based OCT system was identified for the Canadian or the US markets.

Current Practice

For patients with AMD, it is important to closely monitor the condition of their eyes for any changes in retinal fluid.² These changes are a sign of the progression of AMD and are detected using OCT. Early detection of these changes allows for early intervention and can result in better patient outcomes by preventing further progression of the disease.²

There is currently no available cure for wet AMD; however, early detection and intervention have been shown to be effective in delaying vision loss associated with the condition.² Current treatment options include thermal laser, photodynamic therapy with verteporfin, and intravitreal injections with an anti-vascular endothelial growth factor (anti-VEGF) such as ranibizumab, bevacizumab, or aflibercept.² Current practice guidelines indicate that anti-VEGF therapy must be accompanied with frequent ongoing monitoring, including the use of OCT, and treatment for the remainder of a patient's life in order to remain effective.² Early detection of recurrence is important to optimize treatment and prevent further deterioration or vision loss.² This need for ongoing monitoring can become a burden on patients and their families.

There is currently no available cure for wet AMD; however, early detection and intervention have been shown to be effective in delaying vision loss.

What is the Evidence?

One retrospective observational study was identified that compared the accuracy of automated detection of intravitreal fluid by the Notal home-based OCT with the accuracy of evaluation by three retinal specialists using 155 anonymized previously obtained OCT scans.⁷ The results of the study showed high concordance in the image evaluation by the National Optometric Association and the retina specialists.⁷ No other published clinical studies were identified.

The first US-based clinical trial of the Notal home-based OCT device was initiated in October of 2018, in Baltimore, Maryland.⁴ The study is ongoing and results are not yet available.

No data were identified suggesting there would be any safety issues to be considered in the implementation of this technology.

Issues to Consider

Given the age of many of the patients who would use the Notal OCT system, ensuring they feel comfortable using the technology could be an issue to consider. Patients

may feel more comfortable seeing a doctor in person rather than relying on a machine they use at home to identify issues automatically and alert their care provider to changes in their condition. Some research has found that some older adults feel more comfortable with human contact over technology when it comes to health care.⁸

Related Developments

A research group in Switzerland published a feasibility study looking at an investigational spectral-domain OCT prototype meant to be used for patient-delivered retinal home monitoring.⁹

A variety of other home monitoring options exist for patients with AMD, such as the Notal ForeseeHome system¹⁰ and app-based method for monitoring vision changes,^{11,12} but they are meant to identify changes in the field of vision and signal the change from dry to wet AMD rather than monitor for changes in the retinal fluid of patients diagnosed with wet AMD.

Beyond its use for patients with wet AMD, the manufacturer of the Notal OCT system has indicated that it could be used by

patients experiencing any exudative eye condition, including myopic choroidal retinopathy and post-surgical macular edema in high-risk patients.¹

Looking Ahead

The manufacturer is aiming to market the at-home Notal OCT system to the US in 2020, but there is no indication when this technology might be available for use in Canada.⁴ Results from the ongoing clinical trials will help to inform the best use of this technology in the future. Given the advancing age of the Canadian population, and the prevalence of AMD as people age, finding ways to streamline and minimize the burden and associated costs of monitoring these patients will be important to the Canadian health care system.

Author: Michelle Clark

See references on page 14.

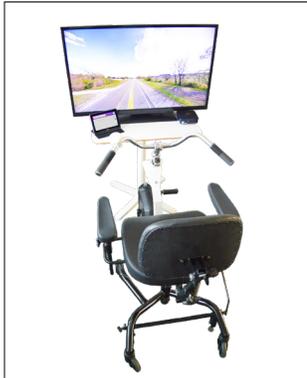


Photo: BikeAround Screen 3-D image.
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from Camanio Care Inc.

BikeAround: Combining Stationary Bikes and Google Street View to Promote Reminiscence and Physical Activity in Long-Term Care

First developed in Halmstad, Sweden,¹ BikeAround is a virtual reality-inspired technology designed to promote physical activity, memory skills, and social engagement for older adults with cognitive impairments in community settings.^{2,3} By combining a stationary exercise bike with Google Street View data, BikeAround users can revisit their childhood neighbourhoods, favourite vacation spots, or any other personal place of significance from the comfort of the indoors.^{2,3}

How It Works

BikeAround consists of an interactive exercise bike, a computer, and either a flat screen or dome with a projector that displays images using Google Street View.⁴ Users select any address around the world using the BikeAround software, which is then displayed on the screen surrounding the bike to create an immersive virtual reality experience. Users then ride through the virtual path by using the BikeAround bike with pedal sensors and rotating handle bars to navigate. A family member, friend, or a staff attendant may provide support to the user by typing the destination into the computer and by engaging in conversation about the locations being toured to further prompt memory recall and communication.² The makers of BikeAround encourage support persons and long-term care staff providing assistance during sessions to consult the resident's background information in advance, or with family members, to identify one or two addresses for starting destinations.¹ Support persons are trained in prompting conversation and using the technology, as well as ensuring participant safety during a session. BikeAround sessions typically last about 20 to 30 minutes, with a 10-to-15 minute post-session discussion. But these can last longer if desired by the participant.⁴

There are two types of BikeAround: Screen, with a flat-screen monitor, and the jDome.³ The jDome screen gives a panoramic view of the streets and allows users to feel immersed in their selected locations. Both screens are suitable; however, the jDome provides a more immersive experience that may trigger memory activation and reminiscence.⁴ It is hypothesized that the greater physical activity and social interaction of this technology could lead to a decrease in depressive symptoms and provide better sleep for residents.²

Both the manufacturer website and the BikeAround YouTube channel have instructional videos and clips on how to set up and use the technology.

Who Might Benefit?

This functional assistive technology is intended for older adults experiencing physical disabilities, memory problems, or cognitive disabilities such as dementia or Alzheimer disease, as well as those entering long-term care facilities for any other reason.^{2,3} In 2016, there were more than 5.9 million people 65 years and older in Canada⁵ and that number is expected to reach in excess of 9.8 million by 2031.⁶ Dementia is one of the major causes of disability and dependency among older people worldwide, and affects more than 500,000 Canadians.^{7,8} More than 75,000 Canadians are living in long-term care, with 90% of current long-term care residents

having some form of cognitive impairment and more than 86% having some physical limitations that require extensive daily activities such as getting out of bed, eating, or toileting.⁹ There is a need to reduce the progression of cognitive and physical deterioration within these communities while also improving quality of life.² Users with mobility limitations who cannot pedal on the bike can still benefit from the cognitive and reminiscent therapy benefits of BikeAround by having the trained individual use the mouse on the laptop to navigate the virtual path for them; this allows the user to see the images from Google Street View to spark conversation, which is one of the objectives of the technology.

Availability in Canada

BikeAround has been commercially available and distributed in Canada since 2018 and the current distributor is the Fermanis Group.⁴ There are currently five BikeAround units available at various long-term care and retirement residences across the country including Edmonton (Canterbury Foundation), Toronto (Fairview Lodge), Halifax (Ocean View), and two in Ottawa (both at The Glebe Centre)^{4,10,11} (Emily Wudie Jonsson, Camanio Care Inc., Woodbury, NY: personal communication, 2019 Jun 6). BikeAround is widely used across Europe and is increasingly available in certain parts of the US.²

What Does It Cost?

There are two types of BikeAround products. The first is the BikeAround Screen for US\$7,500.¹² The second is the BikeAround jDome for US\$13,600.¹² Annual payments for maintenance and upgrades are approximately US\$1,320.¹⁰ (Susan Zorz, The Glebe Centre Long-Term Care, Ottawa, ON personal communication, 2019 May 30).

Current Practice

Currently, there is no cure or standard form of treatment for cognitive impairment such as dementia.⁷ Multiple new therapies are being researched to prevent and slow the progression of disease development.⁷ There are currently several drug and non-drug treatments, such as cholinesterase inhibitors, and music and pet therapy, all of which may help with some symptoms. However, further research is needed.^{13,14} For now, dementia treatment is focused

This descriptive study, which included 37 people and 147 BikeAround sessions, provided feedback on features within the device such as the ability to increase resistance and having rotating handle bars. Moreover, participants and staff reported benefits such as reduced aggressive tendencies and feelings of agitation and social isolation. Additional benefits were that the BikeAround device increased physical activity and improved language abilities, memory recall, and quality of life.⁴

A three-month pilot of BikeAround took place at an Oshawa retirement residence with participants of varying levels of cognitive impairment.⁴ Residents who participated in the BikeAround pilot, as well as the observing staff, reported elevated mood, better memory recall, and reduced anxiety and aggressive behaviours in people with Alzheimer disease-associated aggression.⁴

enhance the best light quality on the screen. For the BikeAround Screen, light does not necessarily interfere with the TV screen. Potential safety considerations include the prevention of eye strain, dizziness, or emotional distress. It is thus important that a trained staff or another individual, such as a family member, is present during a session to identify potential risks and establish proper safety controls prior to engaging in a session.

Related Developments

Examples of other related virtual reality technologies for people with dementia include Rendever, ImmersiCare, Sea Hero Quest, and LookBack.¹⁵ Each technology has a reminiscence therapy component; however, only BikeAround integrates physical activity.³

For now, dementia treatment is focused on offering support for symptoms and improving quality of life for those living with the disease and for their families.

on offering support for symptoms and improving quality of life for those living with the disease and for their families.⁷ Importance is placed on physical activity, cognition, and well-being, as well as detecting and treating challenging behaviour, psychological symptoms, and physical illness.⁷

Pilot Program Results

Two non-randomized pilot studies conducted by Camanio Care Inc. and the Fermanis Group were identified. Camanio Care conducted an eight-month pilot at a rehabilitation centre aimed at getting feedback to improve BikeAround and evaluate its challenges and benefits.⁴

Thus far, there is limited evidence available regarding the effectiveness of BikeAround in improving cognitive and physical limitations in older adults. High-quality studies are required to accurately assess its benefits.

Issues to Consider

BikeAround jDome requires a large amount of space. For participants and staff to have enough space to utilize the technology, the product requires using a 12 x 12 foot space for BikeAround jDome; however, the BikeAround Screen only requires 2 x 3 feet (Susan Zorz: personal communication, 2019 May). The BikeAround jDome should be placed in a dark room or corner to

Looking Ahead

Further research is needed to clinically assess the benefits of this technology on cognitive function, memory improvement, and quality of life in older adults with cognitive and physical disabilities in long-term care. Currently, a randomized trial is being conducted at The Glebe Centre in collaboration with the University of Ottawa about the potential benefits of BikeAround on balance and mobility (Susan Zorz: personal communication, 2019 May).

Author: Deba Hafizi

See references on page 15.



Image courtesy of Emerald Innovations Inc.

How It Works

As we go about our daily lives, we are surrounded by invisible radio frequency (RF) signals.³ These RF signals pass through solid non-metal objects, like walls, but are also partially reflected when they come into contact with items in the environment, like people.³ Using a concept similar to radar or sonar imaging and software to make sense of the RF signals it transmits and receives, Emerald (Emerald Innovations Inc., Cambridge, Massachusetts)⁴ can detect movement and differentiate individuals in a room or behind walls.³ The device consists of a small, wall-mounted box containing multiple antennae for transmitting and receiving RF signals.³ The RF signals Emerald emits are of low strength so as to reduce power needs and to not present a danger to people.³ To “see” through walls, Emerald’s software accomplishes two tasks:

- It distinguishes between stationary objects, such as walls or chairs, and moving objects, such as people.
- It tracks the moving objects it detects.³

Because RF signals reflected by stationary objects are the same when measured at different times, Emerald’s RF signals can “see” the difference between such reflections and those of a moving object, which change, even minutely, over time when an object or person moves.³

A Wireless, Artificial Intelligence System for Monitoring Health in the Home

As Canada’s population ages, strategies that allow older adults to live at home longer and that support their caregivers have been identified as priorities by decision-makers.¹ Smart home technologies – technologies that gather, analyze, and communicate data about residents’ activities or health status – may help support independent living and alleviate the need for trips to the hospital.² A new smart home technology that uses wireless signals and artificial intelligence (AI) to track the activity and vital signs of people in their homes is currently being developed as an unobtrusive means of home health monitoring.

Tracking moving objects is somewhat more complicated, but it works by taking multiple measurements of the reflected RF signals over time, similar to how radar or sonar works.³ Ongoing advances in Emerald’s software employ AI that allows the device to track multiple moving objects; measure breathing, heart rate, and sleep; and learn about patterns of human activity in a house.⁵⁻¹³

Who Might Benefit?

By 2030, it is estimated that approximately 9.5 million Canadians (23%) will be aged 65 or older.¹ Not only is the proportion of seniors in the population growing, but Canadians are also living longer, with life expectancy anticipated to grow by about two additional years by 2036.¹ However, an estimated 90% of older Canadians are living with one or more chronic conditions (e.g., heart disease, diabetes, dementia), placing an increased burden on the health care system and caregivers.¹

To support healthy aging and aging in place, policy-makers have identified several needs including building age-friendly communities, developing programs to support caregivers, and creating innovative care models.¹ Smart home technologies like Emerald could play a role in supporting the growing number of older Canadians by acting as an unobtrusive source of information about the health status and

activities of older adults. This information may, in turn, allow clinicians to understand and monitor a patient’s condition and disease progression. Currently, Emerald is not available commercially and “is intended for Phase 1 [clinical trials], Phase 2 clinical trials, clinical research, health management, and chronic disease monitoring” (Dina Katabi, CEO, Emerald Innovations Inc., Cambridge, MA: personal communication, 2019 Jul 25).

Availability in Canada

Emerald is not currently licensed for use by Health Canada (Dina Katabi: personal communication, 2019 Jul). In the US, according to the manufacturer, the system is being used in partnership with physicians, clinical researchers, and pharmaceutical companies (Dina Katabi: personal communication, 2019 Jul).

What Does It Cost?

The cost of Emerald is not available.

What Do We Know?

At this time, the evidence for using Emerald for home health monitoring is focused largely on proof-of-concept or validation compared to standard assessments in research and real-world settings. Ten studies were identified that used the Emerald technology for health-relevant research.⁵⁻¹⁴ Eight of the studies were reported as papers in conference proceedings^{5,6,8-13} and one as a poster

abstract.⁷ One pilot study was reported as a full peer-reviewed publication.¹⁴ Many of the publications using the technology on which Emerald is based do not name Emerald explicitly. Rather, they focus on specific applications (e.g., gait or respiration) and report about the corresponding algorithm (e.g., WiGait, Vital-Radio) underlying the Emerald technology.

The identified studies evaluated Emerald's ability to monitor gait assessment and falls detection,^{6,9} breathing,^{8,12} heart rate,^{12,13} sleep,^{10,11} and behaviour monitoring (e.g., patient-caregiver interactions, pacing).^{5,7} Notable results or advancements in the technology reported include the ability to identify and monitor multiple people simultaneously,^{5,8} validation compared to standard assessments of gait⁹ and sleep,^{10,11} and correlation to standard assessments of Parkinson disease.¹⁴

Safety

No studies on the safety of Emerald were identified.

Issues to Consider

Integrating technologies like Emerald into the lives of older adults is not without challenges for patients, caregivers, and health care providers, and care will be needed to appropriately implement them.¹⁵⁻
²⁴ For example, in a series of surveys and interviews in the UK, researchers explored

the idea of smart cities and smart health with older adults and found that even though most participants thought the benefits of these technologies outweighed the risks, there was still concern about how data would be collected, used, and protected.¹⁵ Participants were also concerned about using technology to replace human interaction, although many acknowledged these types of technologies would be of benefit to those living alone.¹⁵

In a series of focus groups with older adults and those involved in their care, researchers found that successful smart home technologies are those which prioritize the wishes and needs of older adults during development and deployment, are accepted by users, and provide tangible benefits.²¹ Implementation was reported as successful when attitudes and policies embraced the technology, technologies were selected to match specific needs or individuals, and people were empowered to use the technology.²¹ Organizationally, success was also perceived to occur if sufficient funding was available, the technology was made available en masse, and time was taken to evaluate program outcomes.²¹

Related Developments

The idea of using smart home technologies like Emerald is not new and has been widely studied, including in systematic reviews.^{17,18} Applications

of smart home monitoring include falls detection, cognitive decline, mental health, and chronic conditions.

Since 2008, the European Union's Active Assisted Living Joint Programme has been funding projects to support aging in place.²⁵ As of 2019, the program has resulted in 62 projects moving into commercial development. The projects and technologies are diverse, are intended for a variety of age groups, and support outcomes of interest such as symptom severity in dementia, balance, falls prevention, caregiver burden, and changes in the activities of daily life. However, few of these technologies have made it to market.

Looking Ahead

The Emerald system is a novel concept in wireless home monitoring; however, further study is necessary before its role in aging in place is understood.

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See references on page 15.

Mini-Roundup: Recent Reports From CADTH and Other Agencies

CADTH

- *Health Technology Update*, Issue 23, March 2019:
 - MR-linac for Radiation Therapy for the Treatment of Cancer
 - d-Nav Insulin Guidance System: A New Way to Manage Insulin Requirements
 - CustomFlex ARTIFICIALIRIS: An Iris Prosthesis for People with Aniridia
 - PolypDx: A Urine-Based Metabolomic Test for Colorectal Cancer Screening
 - A Robotic Exoskeleton for Gait Rehabilitation After Stroke
- *Issues in Emerging Health Technologies: An Overview of Clinical Applications of 3-D Printing and Bioprinting*
- *Horizon Scan Roundup 2018* — an annual compilation of publications on new and emerging health technologies from around the world

Recent Horizon Scanning Reports From Other Agencies

Agencies included in the mini-roundup that follows:

- European Network for Health Technology Assessment (EUnetHTA), Europe
- Healthcare Improvement Scotland, Scottish Health Technologies Group (SHTG), UK
- National Institute for Health and Care Excellence (NICE), UK
- Patient-Centered Outcomes Research Institute (PCORI), US
- Royal College of Surgeons of England, UK

Cardiovascular

- *The OPTIMIZER smart system for managing heart failure* (NICE)

Dermatology, Wounds, and Injuries

- *Accel-Heal for the management of non-healing venous leg ulcers* (SHTG)
- *SEM Scanner for pressure ulcer prevention* (NICE)

Kidney and Urology

- *StoneChecker for kidney stone evaluation* (NICE)

Other

- Custom-made or customisable 3D printed implants and cutting guides versus non-3D printed standard implants and cutting guides for improving outcome in patients undergoing knee, maxillofacial, or cranial surgery (EUnetHTA)

Respiratory

- *C-Reactive Protein Point-of-Care Testing (CRP POCT) to Guide Antibiotic Prescribing in Primary Care Settings for Acute Respiratory Tract Infections (RTIS)* (EUnetHTA)

Trends, Forecasts, and Strategic Initiatives

- *High Potential Disruption Report May 2019* (PCORI)
- *Horizon Scanning Status Report March 2019* (PCORI)
- *Horizon Scanning Status Report June 2019* (PCORI)
- *Future of Surgery* (RCS)Canada)

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