GRAND RIVER HOSPITAL
Advancing Exceptional Care

UNIVERSITY OF WATERLOO

2017 Research Report

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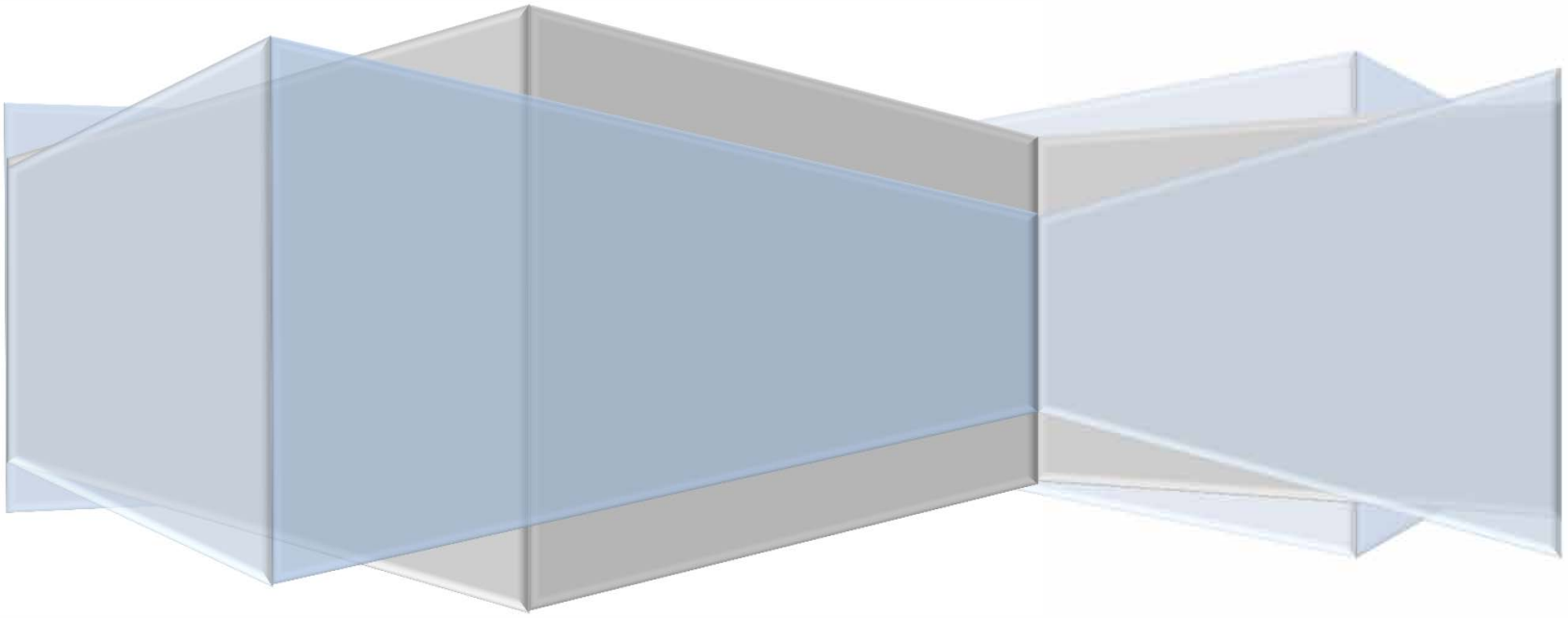


This report recounts the many successes of 2017 and progress achieved through the partnership between Grand River Hospital and the University of Waterloo. There has been significant work to strengthen existing relationships and building new ones, putting into place infrastructure where there was none, building understanding and trust between functional areas of our institutions, all the while supporting the applications for new funding for studies, guiding and introducing new studies at the hospital, as well as facilitating the smooth path to completion of research studies.

Approved and/or Activated Studies

Care of Frail, Acutely Ill Older Persons: Making Health Care Work Like a System (interRAI Acute Care Pilot Subproject) – Dr. John Hirdes, School of Public Health and Health Systems and Ms. Chantelle Archer, Clinical Nurse Specialist Medicine, partnered on a study to better understand the trajectory of care (what makes older persons vulnerable and what are risk factors for admission to hospital and intensive care units) once admitted, what determines their long term function and how they recover from acute illness. It is anticipated that the study will yield strategies to provide evidence to assist clinicians in discussing treatment choices and plans of care for frail older persons. The study will also provide insights about predictors of alternate level of care (ALC) status that can be identified in the emergency department or on admission to an inpatient bed. This study is part of a pan-Canadian study funded by the Canadian Frailty Network. The results from this study will identify those individuals at higher risk of requiring an acute hospitalization, predict the need for nursing home resources after an acute episode of hospitalization and define the added value of a standardized geriatric assessment to predict outcomes after an acute care hospitalization. The study has been funded by the Strategic Impact Grant Program from the Canadian Frailty Network. The total study budget awarded to Dr. Hirdes is $900,000, with a local budget of $451,000. GRH specific local budget totals $43,300.

Determinants and Outcomes of Psychiatric Youth Readmission (DETOUR) – Dr. Mark Ferro, Canada Research Chair in Youth Mental Health and Assistant Professor, School of Public Health and Health Systems will partner with Dr. John Vanderkooy, Child & Adolescent Inpatient Psychiatrist. The main research question aims to understand the determinants and outcomes associated with psychiatric readmission among youth. The researchers will recruit a cohort of youth aged 10-16 years who are currently inpatients for a first psychiatric hospitalization at McMaster Children's Hospital and Grand River Hospital. Youth will be followed for 12 months after discharge and tracked for readmission by collecting data from youth and their guardians during their first hospitalization and again at 1, 3, 6, and 12 months post-discharge. The utility of the primary data will be enhanced by linkage to provincial health records. The myEXP mobile app will capture patients' perspectives on hospitalization(s). This will allow the researchers to more comprehensively identify at-risk youth, inform services offered during hospitalization and at discharge, and improve coordination of care in an effort to reduce psychiatric readmissions and system burdens. The study has been funded by the Ministry for Research, Innovation and science with a total budget of $1,290,000. The local portion of the study budget is $656,971. GRH is providing services in-kind to support the research project.

Toolkit for Assessing Human Balance and Mobility – Collaborators Dr. Bill McIlroy, Kinesiology, Dr. Don Cowan, Computer Science and Dr. Doug Dittmer, Medical Director Rehabilitation are undertaking a project that will test a toolkit for assessing human balance and mobility at the Freeport campus outpatient rehabilitation clinic. The toolkit was one of 31 projects to receive funding from the Canadian Centre for Aging and Brain Health Innovation, operationalized through Baycrest Health Sciences through its Spark program. Using a tablet and wearable technologies, the toolkit will allow health care professional to capture data from each session with a patient for analysis. The system samples and synchronizes from multiple inexpensive wearable devises and generates a patient assessment and possible actions to improve the health of the patient. The system will also produce a large data set of clinical results (big data) that can be analyzed for further insights into frailty and other medical

conditions related to balance. The study has been funded by the Canadian Center for Aging and Brain Health Innovation through Baycrest Health Sciences. The total study budget is $50,000, with a local budget of $3,200 to GRH.

Ongoing Studies

Determination of Electroencephalogram (EEG) Signatures of Gait Initiation and Imagination for a Brain Computer Interface (BCI) for Rehabilitation of Freezing of Gait in Parkinson Patients – Dr. Ning Jiang, Systems Design Engineering UW and Dr. Abhishek Narayan, GRH, have partnered on a study which aims to determine potential electroencephalogram (EEG) signal modalities or signatures associated with gait initiation and imagination of gait initialization in healthy elderly participants, in people with Parkinson's Disease (PD), and in PD with Freezing of Gait (FOG). FOG is characterized by the inability to initiate gait (walk from standing), and stand from sitting. From an EEG signal baseline in healthy subjects, algorithms will be developed to detect gait initialization intention of participants in real time. The recorded EEG signals will be compared to signals for PD patients during gait initialization (either actual movement or attempts). The EEG signatures will be used in future research of a brain-computer interface (BCI) for a lower-limb robotic exoskeleton that will be used to retrain the neuromotorsystem to perform walking steps to reverse FOG and restore normal walking. During this first year of this study, the team has noted difficulty in recruiting patients that meet the study inclusion criteria. In an effort to increase the success of study recruitment, the study team has initiated discussions with a neurologist at GRH to help identify appropriate patients for inclusion in the study.

Cerebellar Contributions to Spatial and Sustained Visual Attention – Dr. James Danckert and Dr. Britt Anderson, both from the UW Psychology Department have partnered with Ms. Diana Brodrect, GRH Team Lead Medical Imaging. This study will include study participants who have suffered a head injury. The research team has partnered with the community to recruit study participants. The study hypothesizes that patients with damage to the cerebellum will show significant deficit in sustained and spatial attention when compared to age-matched controls. Additionally, the team hypothesizes that these attentional impairments may result from area-specific damage to the cerebellum, and that different kinds of attentional impairments may correlate with damage to different areas of the cerebellum. This stage of the research will address the basic science questions of the role of the cerebellum in attention. In allowing researchers to better understand which regions of the cerebellum are involved in spatial and sustained attention, the study results will aid in the development of models of cerebellar function, as well as better diagnosis and treatment of patients with cerebellar injury. To date the study has recruited 23 participants. The study team has presented preliminary findings at a conference presentation at the Cognitive Neuroscience Society, San Francisco, California.

Impact of Patient-Specific Multi-Strategy Interventions on Adherence to Antiepileptic Medications Among Patients in Primary Care: A Pilot Study – Dr. Tejal Patel, School of Pharmacy has partnered with Dr. Scott Sloka, GRH neurologist. This is an exploratory pilot study, designed to determine the effect size of a multi-strategy intervention to address adherence to a medication regime among patients with epilepsy. Non-adherence to antiepileptic medications can result in loss of seizure control and therefore has several implications on morbidity and mortality. Tackling non-adherence requires an approach that tailors adherence improvement strategies to patients' needs. This pilot study is designed to determine the effect size of a multi-strategy adherence intervention in improving adherence. The effect size from this study will be used to determine sample size in a larger study design to investigate the effectiveness of this strategy. Finally, the results from this study will also inform the feasibility to conduct a large study to investigate the clinical effectiveness of the specific multi-strategy adherence intervention. The study remains active for recruitment but has noted significant challenges in recruitment. Of the anticipated recruitment strategy of 125 participants, only five have been recruited as of mid-year. The study team plans to review the study eligibility criteria to determine in an amendment is necessary to address this

challenge.

Patient Decisions Regarding Dialysis: A Review of Factors Associated with Survival and Attrition in Dialysis Patients: A retrospective study – Dr. Helen Chen, School of Public Health and Health Systems has partnered with Ms. Kim Hendrick, Interim-Program Director Renal. The purpose of this study is to complete a retrospective analysis of dialysis patient characteristics and their corresponding treatment outcomes. The objectives of the study are: i) To determine the attrition rate and factors associated with discontinuation of dialysis; ii) To establish a survival model for CKD patients, iii) To identify determinates that influence patient treatment and survival outcome; and iv) To promote a more informed decision making process for patients in planning dialysis care. Observing and quantifying the attrition and survival of chronic kidney disease (CKD) patients at GRH through the analysis of historical utilization, enable increasingly reliable forecasting and consequently improved resource planning for future patients.

A Pilot Study of a Nurse and Pharmacist Led Ontario Telemedicine Network (OTN) Based Clinic for Management of Prostate Cancer Patients on Oral Therapy. Dr. Stacey Hubay, Medical Oncologist, GRRCC, is working with Prof. Tom McFarlane, School of Pharmacy. The team of researchers has developed a randomized, open label study to evaluate a nurse- and pharmacist-led clinic conducted remotely from Grand River Regional Cancer Centre (GRRCC) using OTN teleconferencing as a platform for patients with metastatic prostate cancer receiving oral chemotherapy agents. The primary outcome will be a comparison of patient satisfaction with overall care utilizing a validated scale between the group of patients using the OTN clinic and a matched group of control patients receiving conventional care at GRRCC. The secondary objectives will be to examine the feasibility of use of the OTN platform with a semi-structured interview conducted with patients in the OTN cohort at the conclusion of the study, and to present a descriptive analysis of toxicity-related interventions made in patients on the trial. The measurement of the effectiveness and acceptability of the use of the telemedicine modality between clinicians and patients will inform future decisions on the feasibility of this modality to increase accessibility to care for patients. To date, 20 of the total 80 patients have been recruited to the study with 12 patients randomized to the OTN arm of the study.

Predicting Aggressive Behaviours of Cancer Cells from the General Blood Circulation. Dr. Mala Bahl, Medical Oncologist, GRRCC, has teamed with Dr. Jonathan Blay, School of Pharmacy. The team is studying the potentially aggressive behaviours of cancer cells that are circulating in the peripheral blood of colorectal and breast cancer patients. These behaviours will be detected by providing the cells with protein factors that favour their vascular capture and development into metastases. Twenty patients diagnosed with stage IV Colorectal or Breast Cancer are being recruited by the medical oncologists at Grand River Regional Cancer Centre, the blood collection occurs at Grand River Hospital, the blood is then transferred to Dr. Blay's Lab at the UW School of Pharmacy for purification and analysis of the circulating cells. As a result of this study the researchers hope to be able to identify features of the circulating tumor cells that will provide information with respect to patient prognosis and treatment of cancer. To date, 16 patients have been recruited to the study and recruitment will continue throughout 2018.

User Evaluation of Modeling and Control of Human-Robot Rehabilitation System for the Upper Extremity – Dr. John McPhee and Dr. Borna Ghannadi, post-doctoral student, both from UW Systems Design Engineering have partnered with Ms. Ellen Richards, GRH Clinical Manager Stroke. The objective of this research is to improve the performance of the upper extremity stroke rehabilitation robot with novel controllers. These results are pertinent to modern-day rehabilitation of stroke survivors in a clinical environment. The long term goal of this research is to elicit motor recovery of the shoulder and elbow joints of post-stroke patients by repetitive programmed exercises. The benefits, should this innovation bear the anticipated results, would include improved motor control, muscle strength, and

range of motion in a systematic approach. This study has taken a significant amount of time to prepare for activation. While the GRH administrative approval process occurred in a four-week period, the joint ethics review between THREB and UW ORE requested that the human-robot rehabilitation system undergo a safety review that, as we understand, took longer than anticipated to complete. In addition, staffing changes within the ORE inadvertently delayed the normal review and approval process. In January 2018, the study team has reconnected with the GRH team with the aim of moving forward with study activation.

Completed Studies

Monitoring walking with wireless inertial measurement units during stroke rehabilitation – Dr. Dana Kulic, Department of Electrical and Computer Engineering worked with Dr. Doug Dittmer, GRH Medical Director Rehabilitation on this study. The study purpose was to test the ability of a wearable Inertial Measurement Units-based motion capture system (IMU) in a clinical environment to record gait data of post-stroke patients during rehabilitation. Based on the data, an algorithm which reliably estimates the joint angles of the lower body from IMU data for gait patterns was developed.

Results of the study have supported the development of a novel method to estimate lower body pose during gait using data from wearable inertial measurement units. The developed Rhythmic-extended-Kalman-filter algorithm is able to estimate pose and to learn a rhythmic motion model online and then use the learned model to improve pose estimation. The research approach was validated in simulations with healthy participant and with collected stroke patient gait assessment data. The Rhythmic-extended-Kalman-filter is able to estimate joint angles of healthy participants outperforming traditional goniometry and visual observation techniques currently used by physiotherapists. In addition, using the estimated pose and frequency, walking speed can be computed accurately and used as a performance measure during patient rehabilitation. The research team has published the results of their research with the Institute of Electrical and Electronics Engineers (IEEE).

Upcoming Projects

KA Imaging –From GRH, Dr. Darrin Knibutat, Medical Director and Chief of Medical Imaging, Dr. Ernest Osei, Director Medical Physics, and Mr. Andre Fleck, Medical Physics, in partnership with Dr. Karim Karim, Mr. Amol Karnick, Mr. Sina Ghanbarzadeh of KA Imaging, a University of Waterloo spin-off company, have conducted pilot testing of KA Imaging's innovative low-cost, high resolution digital X-ray imager for use initially in developing countries to improve global health but with great potential for far reaching benefits on a global basis.

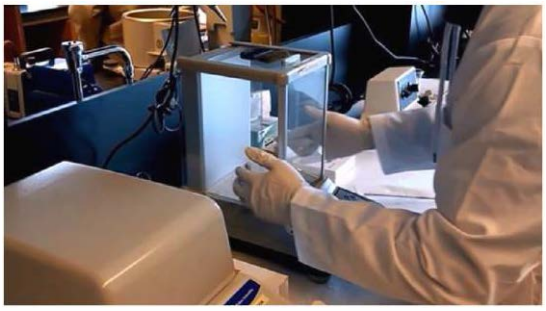
Results demonstrated that the KA Imager achieves the same level of accuracy as conventional imagers, at a lower X-ray dose and lower cost with the potential to revolutionize medical imaging. As a follow-up to this pilot, planning is underway for the first clinical study of the system.

Assessing the Vision Needs of the Freeport Hospital Population – Dr. Susan Leat and a team from the School of Optometry and Vision Science together with Dr. Abhishek Narayan and team from the

Freeport Campus have begun exploratory work to develop a research proposal to assess the vision needs of the patient population at the Freeport campus. While the project proposal is still under development, early identified purposes of this cross-sectional study is to assess potential prevalence of unmanaged or undiagnosed ocular disorders, the vision care requirements and current levels of vision among patients using an oral questionnaire and a brief vision screening. The anticipated use of this data is to demonstrate the prevalence of vision loss in this population, to determine the value of establishing a screening tool for use on an on-going basis to identify patients with vision loss, to illustrate the need for full eye examinations which could take place in a proposed out-patient clinic, and to determine the most effective components of a screening tool to identify patients with vision loss for whom precautions to prevent falls should be implemented and/or patients who are not receiving current optometric or ophthalmological care or whose vision has changed since receiving ophthalmic care and who would benefit from a full eye examination and possibly vision rehabilitation. Of note, this research partnership came to fruition as a result of a presentation from Dr. Leat at a Pizza with the Profs event held in February of 2017 at the Freeport campus.

Non-Human Research Activities

Biodistribution and Efficacy of Gold Nanoparticles for Prostate Cancer Targeting. Project leads include Dr. Ernest Osei and Mr. Andre Fleck, both from GRRCC Medical Physics Department, Dr. Shawn Wettig, School of Pharmacy, Dr. Tony Mutsaers, Ontario Veterinary College at the University of Guelph. Through a research partnership between GRH, the University of Waterloo, and the Ontario Veterinary College, a team of researchers are fine-tuning a treatment to use gold nanoparticles to target prostate cancer. The project is now completing a bio-distribution and toxicity studies in mice. In the near future, the team members hope to offer the treatment to canines that have terminal prostate cancer. A successful treatment of the canine will then help translate the model to the human population. An abstract of this research was presented at the ICCI Cancer Research Symposium at the Ontario Veterinary College on May 25, 2017.



Imaging Guided Radiation Therapy. Dr. Runquing Jiang, GRRCC Medical Physicist is working in collaboration with Prof. Mark Servos, Department of Biology, University of Waterloo, on a research project to improve the CT imaging and radiotherapy (via sensitization) of tumor tissue to further the efficacy of image guided radiation therapy (IGRT) for precision prostate cancer treatment.

Quantum Physics and Cancer. Dr. Ernest Osei, Director of the Medical Physics department at Grand River Hospital has started a research initiative in collaboration with Dr. Raymond LaFlamme, Mike and Ophelia Lazaridis "John von Neumann" Chair in Quantum Information and Director of the Canadian Institute for Advanced Research (CIFAR) Quantum Information Processing program at University of Waterloo. The purpose of this research is to initiate the exploration of the potential interactions between Quantum Physics and Cancer and how Quantum Physics tools could be utilized to improve the treatment/diagnosis of cancer. A few areas being explored amongst others are: a comprehensive literature review of quantum applications in cancer treatment/diagnosis; the feasibility of increasing precision in targeting cancer tumors in radiation treatment delivery by using both amplitude and phase control; the study and application of machine learning techniques to historic treatment planning information stored at Grand River Regional Cancer Centre (GRRCC) and the utilization of the outputs in choosing the optimal radiation treatment route.

Grant Applications and Research Funding

The GRH research office supported a number of grant applications and letters of support in 2017.

- Dr. Hamid Tizhoosh, System Design Engineering, has submitted a grant proposal to the Ontario Research Fund: Research Excellence for a project entitled "Computational Peer Review through Identification and Captioning of Gigapixel Digital Pathology Scans". The grant application is an academic, clinical, and corporate partnership between Dr. Tizhoosh, Dr. Adrian Batten, GRH Medical Director for Laboratory Medicine, and Huron Digital Pathology. If successful, the hospital is committed to providing an in-kind contribution of space and staff time valued at $526,500.
- Dr. Paul Stolee, School of Public Health and Health Systems, has submitted a grant proposal to the Canadian Institutes of Health Research Project Scheme award competition for a project entitled "Improving Care Transitions for Older Rehabilitation Patients: The InfoRehab Model". Dr. Stolee has partnered with Ms. Kate Kobbes, Program Director Complex Continuing Care and Rehabilitation. The proposed research intends to use a co-design approach to engage stakeholders in order to improve communication, care continuity, and coordination across the health care system. If successful, the hospital has committed to providing an in-kind contribution of $108,000 to support the research activities.
- Dr. Sarbast Rasheed, Systems Design Engineering has submitted a project entitled "Development of a novel electromyography (EMG) system for clinical practice" to the Canadian Institutes of Health Research (CIHR). Both GRH neurologists and EMG technicians will participate as collaborators for the project. If successful, the results of the research could have major positive impacts on the cost and time needed to provide EMG services.
- Dr. Elizabeth Irving, School of Optometry and Vision Sciences has submitted a grant proposal to Collaborative Health Research Projects (CHRP) for a project entitled "Development and clinical validation of a miniaturized wearable eye-tracker (MWET) for use in medical diagnostics and assistive devices for individuals with communication challenges." Ms. Pamela Andersson, Clinical Team Lead Speech Language Pathologist, and Ms. Jacqueline Chin, Occupational Therapist Communication Technology Clinic, will participate as collaborators on this project.
- Dr. Catherine Burns, Center for Bioengineering and Biotechnology has submitted a grant proposal to NSERC CREATE for a project entitled "Training in Global Biomedical Technology Research & Innovation". The CREATE proposal focuses on the training of biomedical engineering graduate students from a 'needs first' clinical perspective.

Other Activities

MRI Exploration – In very early stages of discussion, the hospital was approached by Dr. Ben Thompson, Associate Professor and Acting Associate Director for Research with Optometry & Vision Science to discuss a potential partnership in the establishment of a jointly shared MRI facility to support both clinical and research activities. The Vice President Cancer, Diagnostics, and Renal is exploring the topic further with Dr. Thompson.

Research Partnerships – As GRH continues to grow its research and innovation program, exploration of potential partnerships are being explored with both the Research Institute for Aging (RIA) and the Center for Community, Clinical and Applied Research Excellence (CCCARE). Both organizations are well aligned with GRH's strategic priority to continuously pursue excellence in the quality of care. We are hopefully that fruitful partnerships will development from our first initial meetings and discussions.

Staffing - In support of the GRH/UW partnership, UW amended the service agreement for the Research Office Administrator increasing the position from a 0.3 FTE to a 0.5 FTE. Grand River Hospital also increased its support to research by adding a new permanent role, Manager Research (0.5 FTE), to the department.

University of Waterloo Commercialization office - A number of productive meetings were held with WatCo through 2017 in order for GRH to learn about its service offering, discussing with the leadership matters of how our two institutions would intersect with respect to patents and commercialization efforts, and beginning the work to layout an understanding of points of necessary communication, agreement processes, among many other detailed steps in the management of intellectual property and commercialization. This work is in process but progress has been made and a good working relationship is established between the UW Director Watco and GRH Manager Research and Oncology Clinical Trials.

University of Waterloo Hack4Health - Hosted by the University of Waterloo Faculty of Applied health Sciences and the Murray Alzheimer Research and Education Program, GRH VP Research and Innovation was invited participate as mentor and judge for the hackathon over the weekend of November 10 – 12, 2017. It was an exciting opportunity and experience to see the process of the hackathon, interact with the diverse group of participants those with lived-experience, UW students, and other health care providers.

Presentations and Conferences

Ms. Carla Girolametto, Manager of Research and Clinical Trials presented at two conferences during 2017. At the Cancer Care Ontario Joint Clinical Council and Provincial Leadership Council Spring Planning Day 2017 with a presentation on "Person centered care, community collaboration, research and innovation: The OTN Study". Additionally, "Reaching Our Patients Through Innovation: The Path to Change - A Pilot Study of Nurse/Pharmacy Led Telemedicine Clinic for Patient Receiving Oral Chemotherapy" was presented at the Canadian Association for Nurses in Oncology (CANO) Annual Conference on October 30, 2017.

May 2017 was the fourth annual Waterloo-Wellington Clinical Research and Quality Improvement Symposium. The yearly symposium was devoted to research ad quality improvement in the Waterloo-Wellington region. It brought together local students, clinicians, professionals and researchers who are working to improve clinical care in the region. Keynote speakers for this year's event included Dr. Joanne Ho, Geriatrician and Dr. Tom Hupel, Orthopedic Surgeon, both credentialed physicians at Grand River Hospital. Ms. Sarah Laferriere, GRH Research Office Administrator participated as a member of the planning committee and moderator for the podium session entitled, "Practice Changes and Challenges."

"Pizza with the Profs"

In partnership with the UW Centre for Bioengineering and Biotechnology (CBB), 2017 was our second year for our lunch and learn sessions. Pizza with the Profs are held the second Wednesday of the month to promote the exchange of information between the clinical and academic communities. UW researchers are eager to learn about clinical problems from the GRH community and to test their ideas/innovations. Clinical staff have the opportunity to provide input on academic research to address their clinical needs. Seven sessions were held in 2017, with an average of 37 participants at each session.

The 2017 presenters and topics presented for Pizza with the Profs and University of Waterloo presenters included:

Dr. Lora Giangregorio
Kinesiology
Osteoporosis: Management through Exercise

Dr. Susan Leat
Optometry & Vision Science
Low Vision & Hospital In-patient Falls

Dr. Jennifer Boger
Systems Design Engineering
Zero-effort Ambient Vitals Monitoring

Dr. Michael Barnett-Cowan
Kinesiology
Towards Novel Fall Assessment and Prevention: Perceived Timing of Multisensory Events during a Fall

Dr. Paul Stolee
School of Public Health & Health Systems
Geriatric Health Systems Innovation

Dr. Stewart McLachlin
Mechanical & Mechatronics Engineering
Putting the Pieces Together: A Collaborative Approach to Spine Biomechanics

Dr. Bill McIllroy — *Kinesiology*
Dr. Don Cowan — *Computer Science*
Assessing Balance in Clinical Settings: New technology to achieve an old objective

In support of continuing education, participants received a "Certificate of Participation" at the end of the calendar year for clinicians to include within their professional development portfolio. In 2018 we will expand "Pizza with the Profs" to include sessions at the KW campus – tapping into clinical programs beyond rehabilitation and complex continuing care. Two dates are confirmed for presentations to the Stroke and Pharmacy programs.

Conclusion

The activities of the research office continue to grow as the organization builds out its research program. The success of the research partnership with the University of Waterloo will be celebrated in 2018 as the three-year memorandum of understanding comes to a conclusion. Both organizations have agreed to a renewal of this memorandum of understanding and with confidence in this relationship, expanding the agreement to a five-year term.

It has been a rewarding year and as we look forward to our renewed partnership, it is with great excitement that we refresh and build out our shared research agenda that will guide our work together. There is no doubt that in our partnership, we will continue to make significant contribution to improve care for our patients, building a stronger health system of care for our community and beyond.