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# Roadmap to the Research Hospital of the Future

UHN
Toronto General
Toronto Western
Princess Margaret
Toronto Rehab

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# Introduction

The UHN Research community undertook a major strategic planning exercise in 2002 in response to the release of the Hospital's strategic plan *Strategic Directions 2011: Exemplary Patient Care and Global Impact*. This exercise, entitled *The Future Project*, resulted in several fundamental decisions with respect to the structure of UHN Research. It guided the organization of UHN Research into Research Institutes, most of which would be hospital-based, managed by a Director and a Research Council composed of appropriate research and clinical leadership. Cross-cutting, strategic platforms were also identified to promote and foster inter-institute collaborations:

- Regenerative Medicine
- Health Informatics
- Medical Technology Innovation
- Genes, Proteins and People

In 2012, Research was once again challenged to respond to a new Hospital Strategic Plan, *UHN Strategic Directions 2016: Global Impact – Local Accountability*. The mandate this time was to simply "update" the 2011 plan. More than 250 members of the research community participated in a coordinated series of meetings, retreats, web forums and on-line information exchanges. Existing strategic plans from UHN's Research Institutes and Medical Programs were carefully examined. While there was no change in the fundamental structures of the research enterprise, there was much discussion of the research platforms. The success of the Regenerative Medicine platform, as evidenced by the creation of the McEwen Centre for Regenerative Medicine as a hub for organizing regenerative medicine-focused research, provided the impetus for establishing a similar platform for Experimental Therapeutics. A similar evolution and consideration of the Health Informatics platform led to its expansion and consequent formation of the Informatics and Patient Information & Assessment Platform. Moreover, it was thought that the areas covered by Genes, Proteins and People should be split into two different platforms: Experimental Therapeutics and Mechanisms of Disease. The Medical Technology platform remained and its further development led to the creation of UHN's newest Research Institute, the Techna Institute. Finally, it was determined that an area not identified in previous planning, Health Services Research, should be included in a new UHN-wide platform to recognize the important work being done in this domain. Therefore the updated version of *The Future Project* is *The Research Hospital of the Future*, and it will contain overarching themes:

- Regenerative Medicine

- Experimental Therapeutics
- Medical Technology
- Informatics and Patient Information & Assessment
- Health Services Research
- Mechanisms of Disease
- Education

UHN Research was also challenged by the Hospital to look 10,15 and 20 years into the future and predict what form the research hospital would take, develop a Roadmap to lead UHN down the path to become that hospital, and implement plans to begin that quest. The UHN community was consulted and based on this information each of the newly established themes were expanded to identify trends related to each theme, UHN's current competence, the desired competence, and the pathways to success that will enable UHN to become the Research Hospital of the Future.

# Key Assumptions

***Nature of UHN***

UHN's Hospital of the Future will be a "health system" with ambulatory and hospital services at the hub that is networked to other health care services and facilities in the community.

UHN will have local, regional, national and international profiles. These profiles will be tailored to benefit health in each of these jurisdictions through appropriate use of health care, research and education capacities.

UHN will be a "living laboratory" where care delivery and health improvement can be studied and optimized.

UHN will embrace the full spectrum of health research in a responsible manner with careful consideration of the necessary privacy and ethical issues.

***Nature of Care Delivery***

Patient-centered care will continue to guide UHN care approaches.

Patients and families will have more input into decisions based on better background information and access to their own data.

Clinical decisions will be distributed among health care professionals with appropriate responsibility for the level of clinical decision required.

Care delivery will be guided by consideration of safety, quality, ethics, outcomes and cost-effectiveness.

Care teams will be present in greater numbers.

Personalized/precision medicine treatments, based on patient-specific biological information and applied with precision and accuracy, will be the norm.

Technologies that allow the monitoring and assessment of patients at home will be common.

***Clinical Information***

Clinical data will be better organized and available at all levels.

# Themes and Definitions

**Regenerative Medicine** includes basic and clinical research at UHN that will translate the latest research discoveries into new therapies to repair, replace or regenerate cell types and tissues damaged by disease, trauma or age. This next-generation medicine promises new treatments for a wide range of currently untreatable diseases.

**Experimental Therapeutics** refers to the clinical research cluster at UHN that seeks to understand and improve treatment and to develop “first-in-human” clinical trials. This theme focuses on conditions for which current treatments are unavailable, inadequate or problematic.

**Medical Technology** encompasses a wide range of health care solutions that, in one form or another, are used to detect, diagnose, monitor, treat or prevent disease. These tools include devices, techniques and procedures used to deliver improved medical care and support systems through all stages of care, including palliative care.

**Informatics and Patient Information Collection & Assessment** at UHN is defined as the science of information collection, processing and the engineering of information systems. Included are the structure, behaviour and interactions of systems that store, process, access and communicate information. The goal is to improve patient care based on the integration of clinical databases from UHN clinics, laboratory medicine, research laboratories and external partners.

**Health Services Research** is a multidisciplinary and interprofessional field of inquiry, both basic and applied, that examines the use, cost, quality, accessibility, delivery, organization, financing and outcomes of health care services. This approach will increase understanding of the structure, processes and effects of health services on individuals and populations. This theme requires the collaboration of individuals with different roles and expertise to fully understand complex health care problems and how to fix them.

**Mechanisms of Disease** covers basic biomedical and translational research into understanding the biology, biochemistry, physiology and pathology of normal and disease states. This theme lays the foundations upon which preventive and personalized medicine can be built. Also included are studies of the mechanisms that are involved in all stages of disease, namely preclinical, acute onset and chronic diseases. Moreover, Mechanisms of Disease will help define how genetic and environmental factors work together. As such, this theme is multidisciplinary and cross-disciplinary, spanning the basic sciences, genetics, clinical integrative

physiology, chemistry, imaging, bioinformatics and epidemiology of health and disease. The goal is to elucidate the biomolecular pathways that underlie disease and inform therapeutic approaches.

# Trends Summary

**Regenerative Medicine**

- Modelling human cell and tissue development with pluripotent stem cells will become the best method for generating clinically relevant cell types.
- Modelling human disease with pluripotent stem cells will offer new and unprecedented approaches for studying the earliest stages of human disease.
- Basic research on organ-specific stem cells will lead to novel strategies for the regeneration of human tissues *in situ.*
- Cell replacement and tissue/organ repair will provide new therapies for the treatment of a variety of UHN disease priorities.
- Pluripotent stem cell-derived cell types and tissues will provide novel targets for drug discovery and predictive drug toxicology.

**Experimental Therapeutics**

- There will be new and integrated interprofessional approaches with greater crosstalk between clinical research and basic biomedical discovery.
- Treatment plans will be increasingly based on individual patient data.
- Diagnostic and therapeutic biomarkers will improve diagnosis and treatment at earlier stages of disease and enhance disease surveillance at every stage of disease.
- UHN will have an increased capacity for early stage “first-in-human” clinical trials.
- Biomedical discovery research will increasingly lead to the identification of treatment targets.
- Immunotherapy for cancer, infectious disease, autoimmune disorders and other diseases will be increasingly used in combination with other forms of therapy.
- Disease prevention will be increasingly emphasized in health care.

**Medical Technology**

- Advances in imaging technology will influence all aspects of medicine including detection, diagnosis, intervention and monitoring.
- The promise of Telemedicine will become a reality and will be used to eliminate time and distance barriers and transform the world’s ability to access best-in-class medical services.
- Patients, families and health care professionals will use at-home and mobile monitoring systems to help manage disease conditions.
- The home environment will adapt to assist recovering patients and family caregivers.
- Nanotechnology will continue to improve the delivery of surgery, radiation therapy, drug and biologic therapy in the future.

- Medical robotics will improve accuracy, precision and quality, and enable new interventions.
- Innovations in process automation will lower costs and enable quality and safety.

**Informatics and Patient Information Collection & Assessment**

- Biospecimens will be collected following approved standard operating procedures and will be tightly linked to other patient information including clinical, molecular and demographic data.
- There will be an improved capacity to aggregate and analyze all data, including electronic patient records and clinical and research data, that is integrated across research and clinical programs.
- Integrated diagnostics platforms will emerge that improve the assessment of disease and enable more effective care management.
- Innovative evidence-based clinical practice will be enhanced by better access to and utilization of data and information.
- Timely access to information and clinical decision support will improve patient safety.

**Health Services Research (including system process change)**

- Health services research capacity and output will be intensified and used to improve health care delivery and outcomes.
- The role of health care professionals will evolve and change.
- The population will require different health services due to increased prevalence of patients with multiple chronic conditions.
- There will be greater emphasis on person-focused care.
- There will be increased emphasis on developing cost-effective interventions and this will contribute to sustaining future health care.
- Rehabilitation services will be enhanced and fully integrated across the continuum of care.
- Health care professionals will increasingly rely on networks capable of multi-directional information transfer (multi-way networks) as technologies advance.
- The link between healthy work environments and quality clinical care will be strengthened in order to improve positive patient outcomes.

**Mechanisms of Disease**

- Genomic platforms will improve in cost, accuracy and utility, becoming routine tools for analysis of normal and disease states.
- Epigenetics will become increasingly important for understanding disease mechanisms.
- Proteomic platforms (encompassing all non-gene based “omics” such as metabolomics, degradomics, etc.) will continue to evolve and provide key information for determining the composition of key biochemical pathways in normal and disease states.

- Expertise in medicinal chemistry and structural biology, fortified with academic and private sector partnerships, will be used to identify novel targets and develop therapeutic interventions.
- Nanotechnologies will continue to allow for better understanding of disease by contributions to better imaging, better understanding of specific cell targeting and an increased ability to alter cells and pathways.
- Synthetic biology/metabolic engineering will increasingly be used to manipulate internal molecular pathways to provide novel insights to normal and abnormal cellular/tissue function.
- Animal models of disease will become better and more accurate at predicting human responses.
- Next-generation clinical investigation units that enable mechanistic studies in health and disease through integrative physiology studies in the human.

# Regenerative Medicine

**Trend 1:**

Modelling human cell and tissue development with pluripotent stem cells will become the best method for generating clinically relevant cell types.

The ability to direct the differentiation of hESCs[1] and iPSCs[2] to specific cell types has advanced rapidly in the past few years, largely through UHN's ability to translate key aspects of embryonic development to the differentiation of cultures. With these advances, it is now possible to routinely generate cardiomyocytes, functional liver cells, beta cell progenitors, hematopoietic progenitors and mature blood cells, chondrocytes, different neuronal subtypes and retinal cells from hPSCs[3]. The ability to derive this spectrum of human cell types provides unique opportunities to develop novel cell-based therapies for treating disease.

While the directed differentiation of hPSCs holds great promise for developing new treatments for diseases ranging from diabetes to cardiovascular disease to osteoarthritis, the populations that are generated today are heterogeneous and consist of immature cells that do not function well following transplantation into adult animals. To accelerate the translation of this technology to the clinic, it is essential to expand the effort of developing functional human cell types and tissues from hPSCs, using developmental biology as a guide.

**Current UHN competence:**

- Researchers at UHN's McEwen Centre for Regenerative Medicine are world leaders in developing novel technologies for the directed differentiation of hPSCs towards different cell types including cardiomyocytes, hepatocytes, pancreatic lineage cells, hematopoietic cells and chondrogenic cells. UHN does not have established expertise in the generation of neuronal cells or cell types of the eye.
- UHN has state-of-the-art facilities essential for this research to progress. These include flow cytometry, imaging, genomics, proteomics and animal care.
- UHN has excellent cardiovascular, islet cell and lung cell programs that provide a strong platform for the translation of stem cell biology.
- UHN investigators have established strong interactions with developmental biology and tissue engineering programs at SickKids, Mount Sinai Hospital and the University of Toronto.

**Desired UHN competence:**

[1] human embryonic stem cells
[2] induced pluripotent stem cells
[3] human pluripotent stem cells

- Maintain UHN/McEwen Centre's leadership position in pluripotent stem cell biology research.
- Create UHN/McEwen Centre Neuronal and Vision Stem Cell Biology Programs to interface with clinical programs at TWH. Recruitment of junior faculty with expertise in neuronal, limbal and retinal stem cell biology is essential.
- Create a UHN/McEwen Centre Program in Human Development and Disease to accelerate the development and scalable production of functional human cell types and tissues for preclinical studies.

**Pathway to success:**

- UHN must expand the current research effort in pluripotent stem cell biology. Presently, there are only a few labs carrying out this research, several headed by senior investigators. To maintain UHN's leadership position, recruitment of junior faculty with expertise in specific areas of hPSC differentiation is a high priority.
- The development of the McEwen Centre Program in Human Development and Disease will require space, equipment and technical expertise. This program will interface with investigators at the University of Toronto and engineers at CCRM[4] to develop technologies for the scalable production of clinically relevant cell populations for the generation of functional 3D tissues.

[4] Centre for Commercialization of Regenerative Medicine

**Trend 2:**

Modelling human disease with pluripotent stem cells will offer new and unprecedented approaches for studying the earliest stages of human disease.

The ability to generate differentiated cell types from patient-specific iPSCs[5] and hPSCs[6] offers an unprecedented opportunity to model human disease in a tissue culture dish. This novel platform will provide access to cells at early disease stages; as well, cells that are not readily accessible (e.g. cardiomyocytes) will be provided and will be used to identify novel targets for drug development.

**Current UHN competence:**

- Researchers at UHN's McEwen Centre for Regenerative Medicine are world leaders in developing novel technologies for the directed differentiation of hPSCs towards different cell types.
- UHN's health care professionals treat a vast number of human diseases, which provides researchers with the opportunity to build a large panel of disease-specific iPSCs.
- The expertise of UHN's clinical research provides ample leadership required for determining appropriate goals for targeted cell engineering.
- Partnership with CCRM[7] enables the current production of iPSC lines.

**Desired UHN competence:**

- UHN/McEwen Centre Program in Human Development and Disease becomes the leading centre to develop and support technologies for modelling human disease using hPSCs and iPSCs. This Program will be accessible to all UHN investigators.
- Multiple collaborations will be established between basic and clinical researchers with expertise in genetic diseases.

**Pathway to success:**

- Establish McEwen Centre Program in Human Development and Disease as described in Trend 1.
- Engage the UHN clinical community to establish high priority areas (e.g. unmet clinical needs) where disease modelling using iPSC technology could provide the basis for the development of novel therapy.
- Develop strong links with high-throughput screening platforms to enable the discovery of factors (drugs, antibodies, gene modifiers, etc.) that influence the modelled human disease.

[5] induced pluripotent stem cells
[6] human pluripotent stem cells
[7] Centre for Commercialization of Regenerative Medicine

**Trend 3:**

Basic research on organ-specific stem cells will lead to novel strategies for the regeneration of human tissues *in situ.*

As an alternative approach to cell replacement strategies, regeneration of specific populations within organs through activation of endogenous stem cells or the induction of proliferation of more mature cell types provides the framework for developing new therapies for degenerative diseases. Diseases amenable to such therapies would include neurodegenerative diseases, lung diseases, hematological diseases and certain diseases of the eye as each of these organs contain stem cells. This approach could be expanded to include diseases of tissues for which there are no documented stem cells (e.g. diabetes and osteoarthritis) through identification of signalling pathways or small molecules to induce the proliferation of the affected cell populations (e.g. insulin-producing beta cells and articular chondrocytes).

**Current UHN competence:**

- UHN/McEwen Centre investigators are leaders in lung and hematopoietic stem cell biology.
- UHN/McEwen Centre investigators have pioneered techniques for the direct differentiation of hPSC[8] to different cells types. These cell populations serve as new experimental models for the identification of molecules to promote the proliferation of therapeutically important cells.

**Desired UHN competence:**

- Create UHN/McEwen Centre Neuronal and Vision Stem Cell Programs to interface with clinical programs at TWRI (as described in Trend 1). This program would include investigators with expertise in neural, limbal and retinal stem cells that would help strengthen expertise in deriving these cell types from pluripotent stem cells.
- Expanded UHN/McEwen Centre effort in hematopoiesis and hematopoietic stem cells.
- Expansion of the lung stem cell program to complement existing expertise.

**Pathway to success:**

- Recruitment of junior faculty with expertise in neuronal, limbal and retinal stem cell expertise to build the Neuronal and Vision Stem Cell Programs. This program will contain faculty with expertise in adult stem cells and in generating these cells types from pluripotent stem cells (as described in Trend 1).
- Recruit junior faculty with expertise in hematopoietic stem cells.
- Recruit junior faculty with expertise in lung stem cells.

[8] human pluripotent stem cells

**Trend 4:**

Cell replacement and tissue/organ repair will provide new therapies for the treatment of a variety of UHN disease priorities.

With recent success in deriving different cell types from hPSCs[9], the possibility now exists to develop cell-based therapies for a range of diseases including cardiovascular disease, diabetes and osteoarthritis. UHN is well positioned to lead this new era of cell-based therapies given its leadership position in stem cell research and clinical expertise and strength in cardiology, arthritis, diabetes and organ transplantation.

UHN also has pioneered methods to "renovate" lungs *ex vivo* and restore them to a level of functionality compatible with organ transplantation. This method could significantly expand the number of patients saved by organ transplant today while other techniques are under development.

**Current UHN competence:**

- Researchers at UHN's McEwen Centre for Regenerative Medicine have pioneered technologies for the directed differentiation of hPSCs towards different cell types including cardiomyocytes, pancreatic insulin-producing cells, blood cells and hepatocytes. With this expertise, UHN/McEwen Centre is now able to produce these cell populations for translation to clinical trials.
- UHN clinical programs in cardiology, diabetes and arthritis strongly support cell-based therapy approaches for the treatment of diseases.
- PMCC[10] and McEwen Centre investigators have initiated a clinical trial on cell-based therapy for cardiovascular disease, demonstrating appropriate infrastructure and organizational expertise to support such trials.
- Heads of clinical programs and the Director of McEwen Centre have developed joint initiatives to promote clinical translation of stem cell biology.
- UHN has resources to expand GMP[11]-level facilities to enable the production of clinical grade hPSC-derived cells.
- UHN/McEwen Centre has initiated a collaborative effort with CCRM[12] to produce hPSC-derived cells for preclinical studies.
- UHN has established an organ restoration platform in the Multi-Organ Transplant group which has already achieved clinical success in lung transplantation.

**Desired UHN competence:**

- A formal interface between the UHN/McEwen Centre Program in Human Development and Disease and the CCRM for the scalable production of functional human cell types and tissues for preclinical verification studies.

[9] human pluripotent stem cells
[10] Peter Munk Cardiac Centre
[11] Good Manufacturing Practice
[12] Centre for Commercialization of Regenerative Medicine

- A GMP-level facility for production of clinical grade hPSC-derived cells for transplantation.
- Clinical faculty to support cell-based therapy trials in cardiovascular disease and diabetes.
- Expansion of the organ restoration project to all transplantable organs.

**Pathway to success:**

- Create UHN/McEwen Centre Program in Human Development and Disease.
- Establish a GMP-level facility with the capacity and expertise to produce sufficient clinical grade hPSC-derived cell types for clinical trials.
- Recruit junior clinical faculty with expertise to lead cell-based therapy trials in cardiovascular disease and diabetes.
- Extend organ restoration technology developed for lungs to other solid organs.

**Trend 5:**

Pluripotent stem cell-derived cell types and tissues will provide novel targets for drug discovery and predictive drug toxicology.

Drug development remains a very expensive undertaking. Many promising drugs fail, not because of lack of benefit but because of undesired toxicity. When the toxicity is widespread and severe it would be much better to have an early warning system to eliminate that drug from the pipeline and thereby save resources for more promising candidates. It is also well known that some drugs which benefit many people without side effects must be removed from the market because they are toxic to a subpopulation of individuals—this is mainly due to an inability to predict who will suffer toxic effects. Human cell types derived from pluripotent stem cells offer an opportunity to test drugs for toxicology and, at least in some cases, to identify high-risk populations.

**Current UHN competence:**

- McEwen Centre scientists, at UHN and in other TAHSN hospitals, have pioneered technologies for the directed differentiation of hPSCs[13] towards cardiomyocytes, hepatocytes, pancreatic insulin-producing cells, blood cells and chondrocytes. These different cell types provide unique targets for small molecule and drug discovery.
- Partnership with CCRM[14] enables the production of patient specific iPSC[15] lines for generation of diseased cell types as targets for drug discovery.
- Partnership with CCRM promotes collaboration with the pharmaceutical industry to develop drug discovery and predictive toxicology platforms.
- Core facilities are available to grow large numbers of mature human cells.
- UHN has access to patients with different genetic backgrounds which could provide the basis for differential responses to drugs.

**Desired UHN competence:**

- To have the UHN/McEwen Centre Program in Human Development and Disease interface with CCRM and biotechnology and pharmaceutical partners for the scalable production of functional human cell types and tissues for drug discovery.
- To become a leading centre for drug testing with high-throughput screening platforms for testing drugs on human cells.
- To establish formal interactions with biotechnology and pharmaceutical industries to strengthen drug discovery and predictive toxicology platforms.
- To forge strong alliances with drug development partners to help determine toxicities early in drug development and if “failed” drugs could be reactivated based on better understanding of the distribution of toxicity in populations.

[13] human pluripotent stem cells
[14] Centre for Commercialization of Regenerative Medicine
[15] induced pluripotent stem cells

**Pathway to success:**

- Create UHN/McEwen Centre Program in Human Development and Disease
- Establish formal interactions with biotechnology and pharmaceutical industries to develop UHN's drug discovery and predictive toxicology platforms.
- Continue to build a robust regenerative medicine program able to generate human cells of interest from pluripotent stems cells derived with known genetic backgrounds.
- Establish high-throughput screening platforms to expose human cells to a variety of potential drug compounds.
- Discover and validate appropriate endpoint analysis for predicting toxicity.

# Experimental Therapeutics

**Trend 1:**
There will be new and integrated interprofessional approaches with greater crosstalk between clinical research and basic biomedical discovery.

More efficient and effective integrated interventions (e.g. multi-purpose operating rooms) run by multidisciplinary care teams will replace traditional ("siloed") treatment paradigms. Bioinformatics experts and scientists with unique skill sets not sufficiently held by traditional health care professionals will also be integrated.

**Current UHN competence:**
- UHN has taken a foundational approach to integrating multidisciplinary teams for thematic groupings around disease, i.e. physicians, surgeons, imaging physicians and pathologists are integrated programmatically. There are many excellent examples of this, such as the structural heart disease and vascular intervention programs in PMCC[16], the transplant team in the Multi-Organ Transplant Program, the Krembil Neuroscience Centre at TWH and the various cancer site groups in the Cancer Program.
- UHN is currently testing and developing novel integrated multi-purpose operating rooms (e.g. GTx[17], Gamma Knife radiosurgery, etc.).
- The COMBIEL[18] program at the Princess Margaret Cancer Centre is a research training initiative that informally develops networks to allow trainees from disciplines of epidemiology, biostatistics and medicine to work across disciplines.

**Desired UHN competence:**
- UHN hospitals become global leaders in creating and training multidisciplinary care teams and integrated interventions. UHN should also lead the development and deployment of best practices across programs.
- Personalized therapies will be integrated with basic molecular level research. Basic researchers will also be involved in optimizing novel approaches such as regenerative medicine.

**Pathway to success:**
- Expand GTx and similar programs' research capacity.
- Train health care professionals to function as "care teams" to enable integrated and comprehensive patient care.
- Include biomedical engineers as an integral component of the OR[19] team.

[16] Peter Munk Cardiac Centre
[17] Guided Therapeutics Program
[18] Cancer Outcomes Medicine Biostatistics Informatics Epidemiology Laboratory Medicine
[19] operating room

- Continue to build/upgrade hospital infrastructure to support integrated interventions research and capacity for patient use.
- Encourage each discipline (e.g. medicine, surgery, imaging, pathology, etc.) to cross-train and enrich opportunities for interdisciplinary work. In this manner UHN will promote the future evolution of the roles of physicians and scientists.
- Create linkages between the Centre for Interprofessional Education (UHN) and The Wilson Centre to advance interprofessional approaches that best enable collaboration. These integrated linkages and teams will encompass all aspects of diseases, from precision phenotyping to new therapeutic approaches and the evaluation of outcomes.
- Encourage interprofessional interaction through the following initiatives:
    - Establish disease-specific mini-teams that include a clinician and a basic/translational researcher to encourage greater interprofessional crosstalk.
    - Invite basic research scientists to attend clinical rounds and clinicians to institute research days.
    - Establish pilot grants to support team projects that involve both basic and clinical researchers.
- Build supporting infrastructure for clinical translation research.
- Integrate research into the operations of the hospital at the corporate management level.

**Linkages to other themes:**

- Biomedical engineering expertise for ORs would be available through the Medical Technology capacity.
- Best practice dissemination between groups as well as evaluation of outcomes for new therapeutic approaches with innovative care teams could be facilitated and studied by Health Services Researchers.

**Trend 2:**

Treatment plans will be increasingly based on individual patient data.

Clinical decision-making will be influenced by genomic and proteomic data, including the identification of disease-specific biomarkers, thereby enabling personalized treatment plans that monitor responses to treatment.

**Current UHN competence:**

- UHN has some research capacity in proteomic and high-throughput DNA sequencing but only rarely is this linked directly to clinical decision-making at the present time.
- The Structural Proteomics in Toronto facility supports proteomics research by providing NMR[20] instrumentation for rapid determination of protein structures.
- UHN has some research capacity in high-throughput sequencing through the Applied Molecular Profiling Laboratory, OCI Genomics Centre and the UHN/ Mount Sinai Hospital Clinical Genomics Centre.
- UHN has a large capacity for biobanking but at present this is distributed widely and only in some cases linked to high quality clinical information. The UHN Biobank is an institutional biorepository that supports medical research throughout UHN.

**Desired UHN competence:**

- The ability to collect and analyze large amounts of relevant patient information to guide treatment decisions based on individual traits.
- A UHN biobanking program capable of collecting samples in all disease areas and at every disease stage.
- An integrated IT platform containing clinical and research information.
- A full suite of analytical tools to collect and analyze protein, genomic, metabolomic and epigenomic information following GCP[21] guidelines.
- Understanding of the temporal placement of the patient in the arc of a disease to determine best treatment options at the earliest onset and at every disease stage thereafter.
- Capacity within UHN for systematic warehousing and the clinical integration of data to apply informatics to advance diagnosis.

**Pathway to success:**

- Develop a dedicated centre for clinical “omic” analysis and recruit expert scientists in the field.
- Strengthen links between UHN diagnostics labs with research programs developing novel biomarker associations and clinical programs seeking improved, patient-tailored treatments.
- Foster the integration between clinical and research databases to ensure data is easily accessible for use.

[20] Nuclear Magnetic Resonance
[21] Good Clinical Practice

- Standardize the collection and annotation of biospecimens for current studies and develop a “future-proofed” Biobank for future research.
- Standardize the definitions of disease with clinical imaging and biomarking metrics that are linked to natural history and disease progression.
- Identify specific diseases (e.g. inherited arrhythmia, congenital heart disease, cardiomyopathy) where molecular genetic modelling can be used to diagnose and personalize treatment.

**Linkages to other themes:**

- Support from expertise in the Informatics theme is required to enable clinical “omic” analyses as well as integration between clinical and research databases.

**Trend 3:**
Diagnostic and therapeutic biomarkers will improve diagnosis and treatment at earlier stages of disease and enhance disease surveillance at every stage of disease.

Research is demonstrating that many diseases have genetic, protein or imaging markers that can assist with diagnosis and treatment decisions. The trend towards developing tests that can be routinely used in the clinic will continue.

**Current UHN competence:**
- UHN has a patient population in which acute and late-stage chronic disease dominates. Thus, UHN is able to evaluate the natural history of disease between these two milestones.
- UHN has broad clinical expertise to identify unmet clinical needs and thereby help focus research efforts strategically to maximize clinical impact.
- UHN has a broad range of existing analytical tools and research teams to develop new ones, which provide the opportunity to study any disease of interest.

**Desired UHN competence:**
- To lead in the use of diagnostic and therapeutic biomarkers via better linkage of current assets and the closing of existing treatment gaps.
- Provide earlier opportunities to evaluate biomarkers, including the use of blood tests and biopsies, as well as medical imaging and genomics to denote disease phenotype.
- Increased use of biomarkers in monitoring drug resistance.

**Pathway to success:**
- Study linked patients (parents, children, general population) to follow the natural history model of each disease to understand the sequence of events that will identify the earliest possible therapeutic options and ultimate end stage of disease.
- Use actuarial science and transformative informatics to identify biomarkers across disease stages in the general population.
- Develop “real-time” biomarker assays to bring for more accurate and efficient patient diagnosis.
- Cultivate scientific interest in tracking and exploiting data on the natural history of disease.
- Identify and acquire the required technology and infrastructure to enable the use of biomarkers in a broad context.
- Link animal models with human studies for efficient translation of results to human disease.

**Linkages to other themes:**
- Expertise from Informatics will be critical for enabling novel biomarker-based assays.

**Trend 4:**
UHN will have an increased capacity for early stage "first-in-human" clinical trials.

**Current UHN competence:**
- UHN has a long history of "first-in-human" clinical trials. The use of deep brain stimulation for the treatment of Parkinson's disease, Alzheimer's disease and depression were developed at TWH, as was the development of new small molecule therapeutics for the reduction of brain damage due to stroke.
- UHN has a clinical trial support unit that provides researchers trials at the Princess Margaret Cancer Centre with assistance in case report form completion, database development, Research Ethics Board submission and regulatory document maintenance.
- UHN is home to the largest new drug development program in Canada and is the only center outside the US to have a contract with the NIH[22] for early phase therapeutic studies.
- UHN has pioneered many new surgical and medical approaches in a wide spectrum of cardiovascular, endocrine, respiratory and other disorders.
- UHN has established capacity to develop small molecule and biological therapeutic agents and test them in preclinical and clinical settings.

**Desired UHN competence:**
- Establish a clinical investigation unit focused on providing opportunities for early stage clinical trials in all areas of clinical research at UHN.

**Pathway to success:**
- Identify committed leaders for Experimental Therapeutics to champion early phase clinical translation.
- Broaden and strengthen the activities of the clinical trial support unit to encompass all prioritized diseases.
- Enable early and consistent knowledge translation in this area so as to enhance enduring institutional capacity in early stage clinical trials.
- Establish a drug pipeline that provides "first-in-human" therapeutics in order to fill the gap in therapies for certain diseases.
- Improve UHN's capacity to support intellectual property and commercialization needs related to "first-in-human" trial discoveries.
- Create a "brain trust" with the resources to facilitate and fund important phase 1 trials that would otherwise be ignored by traditional funding sources.
- Develop core research methods that will support trials across UHN by leveraging the strength of the entire network.

[22] National Institutes of Health

**Trend 5:**
Biomedical discovery research will increasingly lead to the identification of treatment targets.

Biomedical discoveries are often made in an environment where their clinical relevance is not fully capitalized.

**Current UHN competence:**
- UHN is home to more than 90 wet bench laboratories undertaking basic biomedical research relevant to the full spectrum of adult diseases.
- UHN has excellent core facilities and its researchers publish original research in top journals. There are examples of excellent basic-translational-clinical collaborations.
- In a few cases, teams have been developed to link basic discovery with clinical relevance; however, such linkages are not always made.

**Desired UHN competence:**
- Create an assessment pipeline where discoveries can be rapidly assessed for downstream clinical impact.
- Enable rapid validation of target identity in relevant preclinical studies. This would include validation in cell and predicative animal models, biobanked tissues and freshly isolated human tissues.

**Pathway to success:**
- Promote close interaction between basic biomedical scientists and clinicians in areas with access to tissues and non-diseased controls.
- Develop a comprehensive, annotated, cross-referenced and easily accessible biobank.
- Build facilities to enable rapid development of preclinical models.
- Maintain a set of validated preclinical models of human diseases of interest.
- Use sophisticated molecular level imaging to serve as surrogate endpoints, in lieu of histopathology or functional outcomes.
- Develop a system that enables research data to be compared, analyzed and easily linked to accessible databases.
- Establish a bioinformatics program to facilitate integration and analysis of genetic data.

**Linkages to other themes:**
- The development of the biobank will require Informatics expertise.
- Sophisticated molecular level imaging will be enabled in part through innovations emerging from Medical Technology.

**Trend 6:**

Immunotherapy for cancer, infectious disease, autoimmune disorders and other diseases will be increasingly used in combination with other forms of therapy.

Using strategies that harness the body's own immune system to treat disease is expected to become a standard treatment option for diseases alongside traditional methods.

**Current UHN competence:**

- UHN has a strong basic immunology research program and is building strength in translational immunotherapy, but currently is not undertaking a significant level of clinical trials in this area.
- UHN is already a member of the US-based CITN[23] and is a member in the newly formed World Immunotherapy Council.
- UHN's Philip S. Orsino Cell Therapy Facility provides GMP[24]-level cell processing capabilities, while the Center for Cell and Vector Production provides GMP-level vector processing. Thus, UHN is well-positioned to undertake human clinical trials using *in vitro* expanded, processed or engineered cells.

**Desired UHN competence:**

- Princess Margaret Cancer Centre becomes an international centre for developing and testing immunotherapy for cancer.
- Immunotherapy programs are enabled for other diseases including diabetes, infectious diseases and autoimmune disorders.

**Pathway to success:**

- Increase the number of clinical trialists with a focus on immunotherapy working in the various clinical programs.
- Increase the number of scientists dedicated to understanding the tumour microenvironment and the immunology of other diseases.
- Expand relationships with pharmaceutical companies developing key immune modulators through investigator-initiated trials.
- Develop and participate in key internationally recognized initiatives.
- Expand the GMP-level cell processing facility and develop best practice operating procedures.
- Launch the GMP-level vector facility.
- Link this program with the development of biomarkers that predict patient responses to immune therapy.
- Expand collaborations between cancer and non-cancer researchers in the cell therapy area.
- Designate research beds to be dedicated for immunotherapy.

[23] Cancer Immunotherapy Trials Network (NCI)
[24] Good Manufacturing Practice

- Establish two new offices: a clinical transfer office and a research transfer office. These offices will contain clinical and basic research leaders that will serve to assist researchers in the translation of research findings.

**Linkages to other themes:**

- The development of immunotherapies will tie into the database of biomarkers developed in Experimental Therapeutics and Informatics.

**Trend 7:**
Disease prevention will be increasingly emphasized in health care.

The population's aging demographic is necessitating improved efficiency and reduced costs in health care. Prevention of disease will play an increasing role in health care services and socialized medicine will create and expand mechanisms that encourage hospital-based health care professionals to engage and educate the public in prevention.

**Current UHN competence:**
While prevention research is common throughout UHN, it is not systematically organized. Primary prevention programs are found at TRI; secondary prevention programs are found in cardiovascular disease, some forms of cancer, transplantation and autoimmune diseases.

**Desired UHN competence:**
- Increased use of preclinical disease prediction in disease prevention.
- Intensified focus on secondary prevention of disease.

**Pathway to success:**
- Develop a centre to support prevention research (e.g. lifestyle, nutrition and injury prevention research).
- Identify and collaborate with partners that are leaders in prevention research.
- Foster relationships with external agencies and partners to effectively communicate prevention research findings to inform policy change.

**Linkages to other themes:**
- The appendix on Technology for Health Safety and Medicine addresses UHN's plans for the use of disease prevention to promote health care sustainability.
- Prevention of workplace injuries for health care professionals is featured in Health Services Research trends.

# Medical Technology

**Trend 1:** Advances in imaging technology will influence all aspects of medicine including detection, diagnosis, intervention and monitoring.

*Screening* – Faster, less invasive and more accurate diagnostic tools will be utilized for population screening. Research hospitals will play a role in tool development and education for use in community based screening centres and/or family health practices.

*Diagnostic* – Advanced diagnostic tools will lead to the generation of highly individualized treatment plans, framed in the context of *personalized medicine*. Research hospitals will develop these diagnostic and staging tools, often in partnership with the private sector, and conduct trials demonstrating their influence on health outcomes. Research hospitals will undertake the cost/benefit analysis of utilizing these tools.

*Therapeutic Interventions* – Imaging technology will continue to improve the ability of interventionalists to provide highly accurate and non-invasive therapy. Research hospitals will be the first to apply new tools and test outcomes in the clinic. Teams of technology developers and medical specialists will define the unmet clinical need and devise answers. The development of image analysis tools to support imaging and intervention will be a key area of innovation.

*Monitoring* – New technologies for monitoring treatment efficacy will enhance follow-up care practice. Rather than wait weeks or months to determine if a particular drug had a beneficial effect, patients will be examined more quickly through the use of image-based biomarkers.

**Current UHN competence:**

- Across its various hospitals, UHN has strong research and clinical platforms that are networked through the research institutes.
- UHN has a strong track record of innovation in systems to visualize, analyze, communicate and transfer imaging information.
- UHN has substantial world-class imaging resources including TRIGOR-A[25], STTARR[26], PET[27]/Cyclotron, MR-PET[28], MEG[29] facility, high-field (7T) MRI[30], NanoMedFab[31] and CT-PET[32].

[25] Translational Research Image-Guided Operating Room - A
[26] Spatio-Temporal Targeting and Amplification of Radiation Response Innovation Centre
[27] Positron Emission Tomography
[28] Magnetic Resonance Positron Emission Tomography
[29] Magnetoencephalography
[30] Magnetic Resonance Imaging
[31] NanoFabrication Centre for Personalized Medicine
[32] Toronto Western Hospital's Computed Tomography Positron Emission Tomography

- Strength in photonics and image-guided therapy with globally recognized programs particularly for translation to clinical application.
- UHN has a strong track record of working with industry in this domain.

**Desired UHN competence:**

- A strong, integrated program in imaging research that links basic and clinical research across the organization.
- A collaborative, clinically engaged research faculty in the domain of imaging science, image processing, computer science and radiochemistry.
- Integration of imaging into clinical trials of novel interventions with strong linkages to other clinical and bioinformatics databases.
- Increased leadership role in the use of imaging for disease intervention.
- Become a coordinator of clinical trials that facilitate the development of new imaging techniques.
- Lead in the development of the use of imaging for clinical decision support and personalized medicine.

**Pathway to success:**

- Consolidation and coordination with partners: establish an organized approach for technology development to enable the coordinated recruitment of individuals with assured access to the imaging resources previously described.
- Establish support from clinical programs to integrate research faculty interested in imaging.
- Forge linkages to the university to assure that trainee engagement is supported in the appropriate university departments.
- Build clinician-scientist capacity in medical imaging.
- Undertake a forum and/or survey of the TAHSN landscape in this area to determine if some goals can be achieved through partnership with existing expertise.
- Build physical science expertise for all technology platforms to assure a deep understanding of the opportunities and risks.
- Expand technological expertise in the field of imaging (MR imaging, biophotonics, nanotechnology and radiochemistry) and combine modalities and interventional platforms (e.g. photonics with other biomedical technologies, imaging, robotics, informatics, IT[33], etc.) into hybrid systems to provide added value and greater clinical impact.
- Better publicize UHN resources, including STTARR, internally and externally to ensure that proper personnel are recruited.
- Leverage the recently developed EXCITE[34] program to build capacity for evaluation of medical imaging technologies.
- Coordinate imaging program development with cGTA[35] to allow for rapid delivery of images across Toronto and Ontario.

[33] information technology
[34] MaRS Excellence in Clinical Innovation and Technology Evaluation

- Integrate across all imaging sectors clinically and in research to establish necessary infrastructure.

**Linkages to other themes:**

- Evaluation of new diagnostic tools and technologies will require collaboration with expertise in Health Services Research to ensure optimal integration with current health care practices.
- Development of data handling systems and image analysis teams will need regular consultation with researchers involved with the Informatics theme.

[35] Connecting GTA

**Trend 2:**
The promise of Telemedicine will become a reality and will be used to eliminate time and distance barriers and transform the world's ability to access best-in-class medical services.

The development of the internet has accelerated the growth of telemedicine approaches to solve many health consultation challenges. High-speed digital networks, low-cost computers, video conferencing technologies and cyber "addresses" now bring a massive opportunity for health care skills to be accessed through high-speed internet from anywhere in the world.

Health care organizations are now challenged to take up their "address in the internet" and offer their services. These products are in demand by individual patients, health care professionals, health care organizations and government agencies seeking services for their populations. Global demand for highly technical elements of health care is at one end of the spectrum and the provision of simple patient-physician consultation is at the other. Health care organizations need to respond to this opportunity to assure they can be competitive as the future model of health care delivery unfolds. In addition, organizations with expectations of global outreach will not succeed in their aspirations of optimal patient care without these capabilities.

Thus, telemedicine provides a rich opportunity to use advancements in technology to provide a communication link between health care provider and patients in remote locations beyond the walls of the hospital.

**Current UHN competence:**
- UHN's medical community is active in global outreach at the personal level (leading volunteer initiatives), academic level (research collaborations and interactions with specific populations) and corporate level (pathology support, JDMI[36], KCCC[37] partnership). In addition, there are strong programs in eHealth[38] and survivorship operating from within UHN (CGEI[39], ELLICSR[40]). Overall, the institution is positioned to rapidly leverage emerging telemedicine[41] technologies.
- The Laboratory Medicine Program has developed a Centre of Excellence in Telepathology, in collaboration with large corporate partners (e.g. General Electric). This Centre of Excellence has provided support to various communities across Canada and provides patients across the province (and UHN partners in Kuwait and other areas) with equitable access to care from sub-specialty pathologists.

[36] Joint Department of Medical Imaging
[37] Kuwait Cancer Control Centre
[38] The use of information and communication technologies to enhance health care
[39] Centre for Global eHealth Innovation
[40] Electronic Living Laboratory for Interdisciplinary Cancer Survivorship Research
[41] The delivery of health care from a distance using electronic information and communication technology

- UHN is an active participant in the delivery of telemedicine through the Ontario Telemedicine Network that connects over 400 video conferencing-enabled Ontario communities.
- The CICC[42] is another substantial resource for the telemedicine initiative by providing peer-to-peer support and by streamlining patient management.
- The SIMS[43] partnership provides a platform to accelerate collaboration with local partners and can be leveraged to assemble more comprehensive telemedicine services.
- THETA[44] is currently engaged with the Ministry of Health and Long-Term Care in evaluating tele-home care for Ontarians.

**Desired UHN competence:**

- Become an international hub for developing, testing and implementing telemedicine technologies to maximize global impact in patient care. This includes much more than the conventional concept of telemedicine and will include the development of interactive, persistent support for tertiary care and bridging patient support back to the primary care HCP[45]. The "telemedical revolution" will require transformation in clinical processes.
- The enhancement of the research enterprise will be aligned with these efforts. Taking patient safety and privacy into consideration, IT systems will allow researchers to use clinical data, images and samples. UHN will lead efforts to span multiple institutions in Toronto and across Ontario.
- UHN leads telemedicine-based restructuring of the current health care delivery model by becoming a facilitator of telemedicine-based interactions and defining new models of interaction between patients and providers.
- UHN links telemedicine to other strategic directions, for example; developing remote robotic surgery, accessing novel pathology methods, performing multi-institutional virtual rounds, enhancing on-line educational programs and enabling teleradiology[46]/second reads will result in hospital knowledge-driven innovations and growth as UHN leverages its expertise. UHN's specialists across Toronto Rehab, the Complex Continuing Care Program and acute care will be actively involved in these programs.

**Pathway to success:**

- Gather intelligence: employ an educational survey to understand how telemedicine could best help patients and then develop a priority list based on those results.
- Build networks: expand capacity and develop or partner in national and global networks enabling telemedicine. This will be tested with UHN's own remote

[42] Centre for Innovation in Complex Care
[43] Shared Information Management Services
[44] Toronto Health Economics and Technology Assessment
[45] Health Care Professional
[46] Teleradiology is the transmission of radiological patient images, such as x-rays, CTs, and MRIs, from one location to another for the purposes of interpretation and/or consultation

partners, including those in Thunder Bay. There are a number of critical elements on the path that need to be addressed:
    - Develop methods for sharing information—similar to cGTA[47], including how information will be represented with proper ontologies and more readily shared between institutions.
    - Create secure distributed networks to allow patient information and caregivers to interact.
    - Change reimbursement methods to models that will accommodate this future.
- Codify knowledge base: develop systematic clinical repositories, specifically case-based reasoning systems that house past cases to aid training and case solving to address the overall growth of evidence-based telemedicine. These systems can be designed using the cGTA model.
- Build an evaluation method for telemedicine technologies including developing best practices and research.
- Establish dedicated programs to influence policy and initiate pilot programs while linking the many experts in these areas within UHN.
- Establish linkages with Education to focus on telestimulation, tele-education etc.
- Managing change: Develop and implement dedicated avenues to manage the transition from HCPs' current practice processes to telemedicine.
- Align payment system for health care providers regarding automation and technology.

**Linkages to other themes:**

- Future directions and implementation of telemedicine technologies in health care will require strong collaboration with Health Services researchers.
- The development of systematic clinical repositories and case-based reasoning systems will require Informatics expertise.

[47] Connecting GTA

**Trend 3:**
Patients, families and health care professionals (HCPs) will use at-home and mobile monitoring systems to help manage disease conditions.

Advances in at-home monitoring will change the way disease conditions are managed treated. This is likely to be a central element of health care in the future as low cost, mobile measurement systems become more commonplace.

*Low-cost Devices* – The proliferation of low-cost health care devices with connectivity enables measurements in the home and community.

*Internet in the Home* – Stable, fast and ubiquitous digital connectivity into the home create stable connectivity for these technologies.

*Cyber-Presence and Social Media* – On-line communities have developed and matured over the past decade with the creation of social media.

*Digitally Capable Health Care Services* – A major impediment to the growth of at-home monitoring systems is the low rate of adaptation of the health care system to integrate novel data sources and accommodate new models of service delivery that require access to information, role changes and support for self-managed care.

**Current UHN competence:**
- UHN is currently able to provide various at-home monitoring systems for diagnostic applications but they do not routinely provide real-time monitoring and connectivity with their caregivers.
- There are research initiatives in the domain of home dialysis and remote/self monitoring for diabetics (CGEI[48]).
- Technology for at-home support and monitoring systems has also been developed within the addictions field to provide extended clinical care and self-management. The Therapeutic Education System, a web-based skills training and psycho-educational system for the substance-using population, has been developed at UHN.
- Innovative home- and self-monitoring research programs at TRI.

**Desired UHN competence:**
- A leadership role in transforming health care models, educating and optimizing patient education, and developing policies to accommodate at-home monitoring technologies and approaches.
- Identify and characterize the value proposition associated with these technologies. UHN leads in the dissemination of this knowledge and influences policy.

[48] Centre for Global eHealth Innovation

- Participate in the development and implementation of smart at-home monitoring systems that provide real-time monitoring and self-management of patient conditions.
- Assist in the integration or adaptation of existing at-home technology to maximize communication with UHN's diverse patient populations.
- Participate in partnerships within the health care industry, including health care delivery organizations, to enable the adoption of these technologies.
- Develop clinical decision support tools for the appropriate use of these technologies and educate clinicians and staff on their use.
- Patients and their families will be adding their own information and driving their own care activity through point-of-care testing at home.

**Pathway to success:**

- Initiate a process to identify priority areas where these technologies and processes will have significant impact on health care (scale, quality and cost).
- Create a dedicated program, with patient care, education and research expertise to support the integration of at-home monitoring technologies and their data into a self-managed medical record.
- Build partnerships with medical device companies and other industries to enable use of these technologies; initiate patient/health care technology education programs.
- Build upon the technology development efforts within UHN (Toronto Rehab's Intelligent Assistive Technology and Systems Lab) that are currently developing intelligent home systems including prompting and fall detection systems. Human factors engineering will help to assess this technology to ensure its usability, and to help UHN capitalize on existing technologies in the home as new points for data collection.
- Develop models for assessment of the value of these technologies to assure a positive return on investment. These models should include the impact of the technologies on the length and quality of hospital stay, number of return visits and clinical outcomes.

**Linkages to other themes:**

- Developing models of assessment will require the expertise of Health Services researchers.
- New models of service delivery and accompanying role changes for digitally capable health care services will also require the expertise of Health Services researchers.
- Informatics will play a significant role in establishing mechanisms to collect remote data streams.

**Trend 4:**
Homes and communities will be adapted to assist recovering patients, aging people and family caregivers.

Whereas at-home and mobile monitoring incorporates the use of technology to provide remote communication between patient and health care provider (Trend 3), devices and environments are being designed to enable family and other supporters to deliver care in the home.

Workplace injuries among nurses are much more frequent than in any other occupation. The physical demands on family caregivers at home are immense and often lead to the failure of home-based care and subsequent admission of patients to long-term care. New technologies promise to lower the burden of implementing health care in the home. These technologies enable re-balancing of how the health care load is distributed within the system. The capacity to confidently release the patient into the community with device-assisted home care will shift health care costs and promises to greatly assist with recovery and improve quality of life for the chronically ill. These devices can range from simple handrails to the implementation of complex systems, such as robots, in the home. As health care shifts toward the home environment, there is an abundance of opportunities for robotic assistance in this field. This could include the preparation of medications to be taken, help with aspects of personal care and the development of a variety of advanced assistive robotic devices.

**Current UHN competence:**
- UHN has a keen understanding of the costs associated with care delivery in the hospital and has access to a network of community collaborators that can assist in guiding the development of these technologies.
- UHN can evaluate these technologies and confirm their design and performance.
- UHN's strong links with the Ontario Ministry of Health and Long-Term Care creates an opportunity to build models and drive policy to accelerate adoption of these approaches.
- TRI's HomeLab is already developing intelligent home systems that can help older adults and people with disabilities stay safely in their homes and help caregivers manage common stressful, physically demanding tasks. Resulting products will be affordable, practical and easy to install without requiring modification or renovation of the home.
- TRI's Intelligent Assistive Technology and Systems Lab is another area of strength.

**Desired UHN competence:**
- To have in place teams that develop more affordable and effective technologies to reduce the physical burden of providing care in institutions and at home, and increase the overall mobility of patients in the hospital and at home.

- To create focused, problem-driven objectives that drive the creation of new technologies to address these challenges. These solutions should address patient and caregiver perspectives.
- To develop innovations which have significant impact and have a viable path to the commercial marketplace.
- To have partnerships to facilitate the appropriate selection, installation and use of these devices in the community.
- To be actively engaged with health technology assessment resources, such as EXCITE[49] and THETA[50], to ensure device usefulness and viability.

**Pathway to success:**

- Perform an environmental survey of the current landscape for the development and deployment of these technologies, including within and outside UHN.
- Establish a UHN-wide resource for the development, deployment, support, and evaluation (cost and outcomes) of these technologies in the community with a mandate to drive further research and innovation.
- Prioritize research projects that increase the ease and safety of lifting, moving and monitoring people in a home setting, including the development of assistive aids that improve the ability of patients to undertake daily tasks.
- Link patients and families prior to discharge for opportunities to participate in new technology trials.
- Consult regularly with EXCITE and THETA networks to ensure device usefulness and viability.

**Linkages to other themes:**

- Assessment of device usefulness and viability will involve participation of Health Services researchers.

[49] MaRS Excellence in Clinical Innovation and Technology Evaluation
[50] Toronto Health Economics and Technology Assessment

**Trend 5:**
Nanotechnology will continue to improve the delivery of surgery, radiation therapy, drug and biologic therapy in the future.

Nanotechnology involves the engineering and creation of tools from materials that are less than 100 nanometers (one-billionth of a metre) in size, especially single atoms or molecules. Nanotechnology holds the potential to use macromolecular structures for advanced diagnosis and detection of diseases, to control molecular interventions (e.g. to target drug or agent payloads), mediate other forms of intervention (e.g. radiosensitization), harness energy for local effect (ultrasound-activated micro-bubble drug delivery) or provide new vehicles for medical imaging. In addition, multi-modal nanoparticles show potential for achieving a number of these tasks.

While promising, relatively few nanoparticle systems have made their way into clinical studies. The development of safe technologies and proper support to advance these into the clinical setting has been a major barrier. Mechanisms to accelerate the safe evaluation of these technologies are critical to the early identification of patient benefit.

**Current UHN competence:**
- UHN has strong programs in nanotechnology that synergize with the efforts at the University of Toronto. Core faculty dedicated to nanotechnology and radiochemistry development are yielding unique intellectual property.
- There is currently a multidisciplinary team of chemists, physicists and engineers developing and testing new nanoparticle agents in collaboration with the large material sciences and nanotechnology communities at the University of Toronto and other Canadian institutions.
- UHN's clinical research resources (including surgery, radiation and imaging) are a major conduit to bringing new developments into the clinical realm.
- UHN is currently building a radiochemistry and cyclotron facility that will enable radiochemistry to be integrated into nanotechnology initiatives.
- UHN has a dedicated nano-fabrication facility that is being developed for the preparation of nanotechnology based agents under GMP[51] conditions to streamline the path for these new technologies to reach clinical trials.

**Desired UHN competence:**
- Establish UHN as the leading institution in Canada for the translation of nanotechnology into clinical practice.
- Integrate nanotechnology into common diagnosis and detection screening methods for cancer and other diseases.
- Support the broad perspective of multi-modal systems that leverage imaging and therapeutic agents, as well as biological targeting to increase effectiveness.

[51] Good Manufacturing Practice

**Pathway to success:**

- Conduct an internal review of UHN's expertise in nanotechnology, to better inform where gaps and opportunities lie. This will allow UHN to market existing nanotechnology and better educate scientists.
- Build upon previous successes (e.g. nano-fabrication facility) and accelerate expansion through recruitment. As appropriate infrastructure are almost in place, UHN needs to ensure appropriate senior faculty recruitment for continued growth and success.
- Promote the development of spin-off companies based on research and development, as commercialization in the nanobiotechnology industry sector is at a very early stage. These commercialization initiatives should synergize with other research directions, including imaging (e.g. contrast agents), immunotherapy and regenerative medicine.
- Work with Health Canada and other government agencies to enable and facilitate first-in-man clinical trials in this field.

**Linkage to Other Themes:**

- Nanotechnology enabled drug delivery may also be considered a novel therapeutic and would likely involve the participation and/or leadership of researchers focused in Experimental Therapeutics.

**Trend 6:**
Medical robotics will improve accuracy, precision and quality, and enable new interventions.

*Robotic Technologies* – The declining cost of robotic technologies has transformed the manufacturing industry, resulting in quality at a remarkably low cost. This trend will also transform health care. Recent innovations in radiation therapy treatment machines clearly demonstrate this pattern. Today, robotic systems allow more complex, patient-specific, redundant and monitored radiation therapy to be delivered faster with the same manpower costs as that of conventional radiation therapy. The same trend is occurring in pharmaceuticals and will reach every aspect of health care that requires physical intervention or manipulation.

*Safety and Quality* – Properly functioning automated devices are more reliable than humans. The focus on efficiency and quality in health care will encourage robot adoption. One example is the electronic health record, as robotics simply need only clear and explicit instructions to execute the task. Robots will also "see", using advances in imaging technologies to ensure high levels of accuracy, precision, safety and quality.

*Education and Human Resources* – Robots will enable health care experts to perform more lengthy and complex procedures and enable HCPs[52] to improve productivity. This will address human resource needs and synergize with the "tele-revolution" of health care.

*Robots at Home* – The potential for more complex assistive devices to enable home care will drive robot technologies into the home. This application of robotics is covered in Trend 4.

Taken together, advancements in medical robotics will enable safer and more reliable treatments to patients and is clearly aligned with the mandate of a research hospital.

**Current UHN competence:**
- Robots have been proven to be very useful for performing repetitive and complex tasks that require high accuracy. For example, The Princess Margaret Cancer Centre has adopted robot technology in the pharmacy for drug mixing. If proven effective and reliable, plans for additional robotic system integration will be developed.
- UHN has experience in robotic surgery using the DaVinci robot with strong clinical engagement. Leadership to drive evaluation of these technologies is in place.

[52] Health Care Professionals

- UHN has a number of research programs in simple and complex robotics that when drawn together represent a significant effort (GTx[53]).
- The development of intensity-modulated, image-guided radiation therapy has intensified the use of radiation-delivering robots. UHN has led the world in this activity. This effort has also enabled the establishment of educational programs as hospital and research centres worldwide seek to adopt these approaches.

**Desired UHN competence:**

- To be a leader in the adoption of robotic systems in drug pharmacy and dispensation to reduce the risk of medication errors and enable quality and more advanced therapeutic regimens.
- Expertise in robotic engineering and control need to be developed if UHN is going to confidently design and implement a robot-enabled future. Institutional linkages to the University of Toronto's Engineering faculty create an ideal place for these skills to develop.
- Capitalize on the opportunity to provide patients with high precision therapy and/or remote therapy.
- UHN must assist in the evaluation of robotic technologies to assure cost-benefit is understood.
- Establishment of UHN as a leader in the rational adoption of robotic approaches in medical intervention.

**Pathway to success:**

- Perform an environmental survey to define subspecialties of robotics at UHN to address stakeholders and provide focused areas for research.
- Build expertise in robotic technologies and control through the recruitment of world class expertise in the field. GTx is an ideal environment for this activity, and skills could cross-fertilize with efforts at TRI in the creation of assistive devices (Trend 4). Drawing on the experience and expertise of the Artificial Intelligence and Robotics team at TRI, who have successfully used advanced techniques from the fields of artificial intelligence, robotics, computer vision and pervasive computing to improve the delivery and outcomes of health care delivery and rehabilitation.
- Implement an "affirmative action" program to look at opportunities to adopt robotic approaches that are driven by the quality, safety and evidence-based agenda.
- Engage industry and government partners in the evaluation of these technologies to assure that the technology is being applied in a cost-effective manner. This will build deep expertise on appropriate use and practice, thereby enabling knowledge transfer opportunities.
- Expand on existing commercial and industrial partnerships and build on spin-off companies.

[53] Guided Therapeutics Program

**Linkages to other themes:**

- The evaluation of robotic technologies to assure cost-benefit as well as appropriate use and practice will require the participation of Health Services researchers.

**Trend 7:**
Innovations in process automation will lower costs and enable quality and safety.

Automation is the use of machines, control systems and information technologies to optimize productivity in the production of goods and delivery of services. Information intensive and repetitive tasks are strong candidates for automation—this is the domain of computer-aided techniques and process automation. Health care today involves substantial manpower expenses not directly related to patient interaction. The potential for significant improvements in quality and efficiency can be enabled by automating tasks ranging from the evaluation of medical images, the generation of synoptic reports, creation of radiation treatment plans, and the scheduling of clinical appointments. Health care organizations that adopt automation technologies (artificial intelligence, data mining, standardized nomenclature, computer-controlled technologies) will benefit from data-driven management and release resources for patient-centred initiatives and strategic priorities.

*Computerization* – The maturation of digital medicine will facilitate automation. Digital storage of information will allow processing by computer algorithms to assure procedure compliance, confirm data collection and facilitate patient management.

*Multi-scalar Automation* – Computerization involves the transition from health IT systems that collect and store data to HCCEs[54] that process this information continuously for the benefit of an individual patient, patient cohort, health care professional, health care enterprise and the research enterprise contained within.

*Data-driven* – Synthesis of knowledge from this continuous analysis by HCCEs will create a data-driven enterprise with tangible benefits.

*Human-Machine Interface* – The benefits of automation will encourage the adoption of a nomenclature standard. This will enable decision support and case-based reasoning support systems. The potential for artificial intelligence technology with the capacity for integrating natural language processing and understanding would allow human and machine to collaborate successfully.

**Current UHN competence**:
- UHN has a comprehensive health care footprint to enable automation of processes that bridge across the health care delivery.
- Depth in informatics and operations research at UHN and the University of Toronto hold promise for growing automation.
- The Radiation Medicine program leads the world in the automation of treatment plan design. The program has demonstrated clinical impact and commercialization.

[54] Health Care Computational Engines

- Multiple systems that use artificial intelligence are currently in place for research purposes. These systems are used for machine learning, data mining and case-based reasoning support.
- UHN recognizes the need for information technology advancement and, given the competencies listed above, the timing for the integration of automation and computer-aided methods is excellent.

**Desired UHN competence:**

- Clearly define the potential for automation at UHN and identify the current assets and processes that could be leveraged.
- Build expertise in computer science and engineering to support automation methods, including decision support.
- Build partnerships with industrial collaborators to bring technologies forward that can integrate into UHN's existing clinical data systems.
- Expertise in federation of data sources and building relevant workflows that leverage UHN's expertise base, legacy data and data production rates are needed competencies.
- Serve as a model for the integration of clinical and research data for the accelerated advancement of health care innovations. These link the basic science and technology innovation fronts.
- Leading in low-cost, high quality data collection in the process of care delivery and follow-up. This should include operational data. Automation initiatives will drive data mining and machine learning as a first step towards deploying such a system to aid clinicians and health care providers.

**Pathway to success:**

- Coordinate IT infrastructure with clinical/research processes to enable the development of a UHN-wide vision for a key role of automation in UHN's mission.
- Recruit appropriate expertise in health care computing and informatics to make informed decisions in the design of IT systems.
- Move these concepts to the clinic and gain experience in automated analyses and decision support within UHN by starting small and building. Waiting for an IT solution from elsewhere will not allow UHN to reach its objectives. TRI's Artificial Intelligence and Robotics Team can help to advance outcomes to the clinic.
- Define the size of the capital investment required to achieve this trend. Create processes to evaluate benefit to the patient (e.g. metrics such as increased patient volumes, wait times and patient satisfaction scores).

**Linkages to other themes:**

- Expertise in federation of data sources as well as health care computing will be enabled through the Informatics and Patient Information & Collection theme.

# Informatics and Patient Information Collection & Assessment

**Trend 1:**
Biospecimens will be collected following approved standard operating procedures and tightly linked to other patient information including clinical, molecular and demographic data.

In the normal course of delivering health care to patients, UHN collects an incredible amount of information. In many cases, the amount of information collected exceeds that required for current clinical care but is collected for research purposes to better understand disease and improve outcomes. Patient information is found in the hospital's EPR[55] and/or in one of many research databases developed by individuals or groups.

In addition, some patient specimens are also collected and stored to be analyzed either immediately or in the future. Biospecimens are defined as a human sample or molecular derivative that is collected for research and stored in a biobank.

Biobanks are defined as a collection of human specimens and molecular derivatives for research. This includes, but is not limited to, organs/tissues, blood, urine, saliva and other body components collected and stored under a variety of physicochemical conditions. Molecular derivatives include, but are not limited to, extracted biomolecules such as DNA, RNA, proteins, lipids, carbohydrates or other metabolites.

Access to all patient information is tightly regulated following privacy and ethical guidelines.

**Current UHN competence**:
- UHN has access to a wealth of clinical material; there is wide variation on how well this material is organized. In several cases excellent databases focused in specific diseases or sites have been developed and populated with valuable information.
- UHN has many biomedical researchers with expertise to utilize biospecimens.
- There is broad consensus to create a UHN-wide biospecimen program with a strong central hub. Important steps have been taken to enable this approach through the creation of a high level executive committee to oversee this process and the creation of the position of Director of UHN Biospecimen Sciences.

[55] Electronic Patient Record

- The CFI[56]-funded Advanced Therapeutic Research Platform has formed a steering committee (including SIMS) to provide a pathway to a federated system that captures all UHN clinical and research databases able to link these to the biospecimen program.

**Desired UHN competence:**

- To achieve UHN-wide integrated biospecimen collection, annotation and molecular characterization with a coordinated and centralized processing, storage, maintenance, quality control and distribution for qualified research projects.
- To integrate internal patient information with external information from patients flowing through the system.
- To develop, maintain and expand data linkage systems that connect to health information integration networks (such as cGTA[57]).
- To build capabilities for comprehensive molecular characterization and data analysis of biospecimens (such as "omics" technologies and bioinformatics).The federation of biospecimen, clinical and demographic data will respect the relevant issues of consent, privacy and ethics.

**Pathway to success:**

Critical to the success of a centralized and integrated biospecimen collection initiative, the following measures will be implemented:

- Organization
    - Develop an institutional policy framework to move ahead with decisions regarding consent, collection, maintenance and access to specimens. This framework needs to flow from stated UHN priorities relating to research and patient care.
    - The Director of the UHN Program in Biospecimen Sciences will oversee a centralized biobank and the integration of pre-existing collections throughout UHN in a federated network of banks.
    - Deploy a governance model.
    - Develop UHN-wide IT platforms for implementation.
- Collection of data
    - Ongoing development of advanced clinical documentation will be incorporated into this model.
    - Develop and adopt a UHN-wide research consent process**.**
    - Streamline processes for research consent, specimen collection, storage, annotation, quality control and distribution.
    - Develop standards of quality assurance and best practices to ensure optimal and accurate collection of outcomes data.
    - Develop database systems for data storage and federation between primary biospecimens and derived research data (such as molecular or imaging data).

[56] Canada Foundation for Innovation
[57] Connecting GTA

- Data analysis
    - Develop a new class of personnel for the analysis of collected biospecimen data.
    - Develop and acquire capabilities for comprehensive molecular characterization of biospecimens.
- Integration
    - Integrated biospecimen collection will accompany patients throughout their interactions with UHN as both inpatients and outpatients.
    - Develop capabilities for patient-centered integrated and longitudinal biospecimen collection for research across all UHN campuses.
    - Build informatics integration of biospecimen IT systems and research programs with UHN clinical research annotation tools, diagnostic pathology IT systems and patient EPRs[58].
    - Develop IT systems to interface with Biospecimen Research Programs at provincial, national and international levels.

[58] Electronic Patient Record

**Trend 2:**
<u>There will be improved capacity to aggregate and analyze all data, including electronic patient records and clinical and research data, that is integrated across research and clinical programs.</u>

**Current UHN competence:**
- Current UHN-wide EPR[59] is limited in its ability to support and enhance research at UHN. For example, UHN EPRs collect a minimum dataset suitable only for baseline clinical care that is not rigorous enough for research demands.
- A number of clinical databases have been developed by individual clinical programs including: eCare, Dados, Caisis and CDM[60]. These systems have generally been tailored to specific needs which are more or less effective for other programs. The IT steering committee has reviewed the spectrum of existing databases and has provided a recommendation for the creation of a federated database platform to integrate these. Implementation of this plan is well underway.

**Desired UHN competence:**
- Establish an efficient and 100% reliable system for collection of all data linked with research throughout UHN. All gathered data should be stored with structure and effective quality control to allow for reliable use. All gathered clinically relevant data and EPRs will be analyzed and stored following strict guidelines dictated by provincially and federal mandated policies and practices to safeguard personal health information. Establishment of a central data repository will encourage data sharing by providing access across all research sites. Integrate with similar regional and provincial platforms that are currently under development (e.g., cGTA[61] and Central Toronto Community Care Access Centre). All research and clinical staff should be fully trained in the use of data collection system.

**Pathway to success:**
- Integrate all existing databases and ensure ease of access across all institutions while maintaining sufficient security measures (related to privacy and ethical commitments). Initially, a suite of 4 UHN endorsed programs, including eCare, Dados, Caisis and CDM, will be integrated. All new database projects will be encouraged to use one of these programs.
- Develop point-of-care systems to collect clinical data in real-time, while identifying the type of data collected and how it should be stored. This development should follow the model established by the existing *medidata* system of The Princess Margaret's Drug Development Program. These practices and abilities will be included with new data collection systems developed at UHN.

[59] Electronic Patient Record
[60] Clinical Data Management
[61] Connecting GTA

- Develop mobile data capture systems to allow for efficient data collection that conforms to rigorous quality control. This system will allow for the integration of data, including EPRs, with all research programs. Interfaces for these systems should be user-centric to allow for efficient and accurate data collection.
- It is inefficient for all research demands to be front and center with clinical data collection. Thus, special consideration will be taken to balance data collection for research with effective clinical practice.
- Provide knowledge translation to UHN staff to highlight significance and impact of health care due to effective clinical data collection. These measures will ensure buy-in and optimal data collection.
- Invest in computing infrastructure and manpower resources to satisfy the needs and demands of data collection and analysis.
- Engage with industry partners to help develop innovation solutions

**Linkages to other themes:**

- Integration of data capture systems into medical devices will require the expertise and capacity identified in the Medical Technology theme.
- Balancing data collection for research with effective clinical practice and care delivery could be a Health Services Research focus.

**Trend 3:**
Integrated diagnostics platforms will emerge that improve the assessment of disease and enable more effective care management.

**Current UHN competence**:
- In most cases, UHN currently follows the traditional hospital diagnostic paradigm in which patient information is collected by various speciality labs and integrated at the level of the care provider.

**Desired UHN competence:**
- To lead in the development of integrated and reliably diagnostic platforms that guide clinical decisions for both short and long term management of disease. Such information should also be tightly linked to research databases which will be used to better understand diseases and to improve therapy and outcomes.

**Pathway to success:**
- Develop a multi-year plan to coordinate current diagnostic capacity at UHN into a federated multi-department with an integrated work plan.
- Establish a multidisciplinary diagnostic technology development group.
- Expand diagnostic capacity to include advanced clinical informatics (i.e. Advanced Diagnostics Center in pathology) and expertise to analyze complex clinical and “omics” information to inform care.
- Increase capacity to provide the Most Responsible Physician with results from “predictive” tools based on individual assessments.
- Develop capacity to predict optimal treatment plans for patients based on drug responsiveness and disease diagnosis.
- Recruit computational researchers to aid in the development and integration of diagnostics platforms.
- Take advantage of existing regional and provincial initiatives to impact the success of this trend.

**Trend 4:**
Innovative evidence-based clinical practice will be enhanced by better access to and utilization of data and information.

**Current UHN competence:**
- UHN values technology and leverages it to advance its core function—excellent and efficient patient care. UHN is a leader in the generation, analysis and dissemination of real-time outcomes, evaluation metrics and forecasting for workload measurement and staffing, quality care and patient satisfaction. Through early adoption of computerized provider order entry, UHN introduced clinical decision support in order to improve medication administration safety.
- UHN was an early adopter of clinical alerting through the co-development of Mysis Insight. UHN is a leader in medication reconciliation.
- The Radiation Medicine Program has pioneered and developed low cost web based systems that facilitate real-time treatment planning and research protocol eligibility. Through ACD[62] UHN plans to vastly improve data capture at point of care and access through a relational CDR[63].

**Desired UHN competence:**
- Identifying, improving, refining, optimizing and evaluating the use of quality outcome metrics is a corporate priority. Health care providers are afforded the time and technological support to gather, absorb, reflect on and synthesize the information. Technology in patients' homes and across health care settings is maximized, enabling HCPs[64] to monitor, educate and manage care remotely.

**Pathway to success:**
- Develop an evaluation framework and processes to support, operationalize and optimize the collection, continuous improvement and use of quality metrics to inform innovative models of care, advance patient safety and foster healthy work and care environments.
- Explore information technology advancements for their potential to meet the changing characteristics of patient populations and the health care workforce.
- Establish agreement with provincial and federal agencies to provide access to governmental information and registries.
- Invest in federated systems and expand existing investments in federation tools.
- Determine how to scale integrated systems and interfaces across the organization, building on existing pockets of success and leadership.

**Linkages to other themes:**
- Developing an evaluation framework and processes to support, operationalize and optimize the collection, continuous improvement and use of quality

[62] Advanced Clinical Documentation
[63] Clinical Data Repository
[64] Health Care Professionals

metrics will be undertaken with strong support from Health Services researchers.

- Health Service Research will also be critical for exploring the potential for IT advancements to meet the changing characteristics of patient populations and the health care workforce.

**Trend 5:**
Timely access to information and clinical decision support will improve patient safety.

**Current UHN competence:**
- Many processes at UHN are manual and are prone to human errors. Current EPR[65] in-box functionality does not allow for efficient and timely access of urgent or critical results by clinicians. There is lack of ability to react to critical results without going through digital or paper entry, as well as documentation and phone calls. Consequently, these processes and associated errors are time-consuming.

**Desired UHN competence:**
- Reduction of human error and inefficiency is of critical importance to research hospitals. Develop a number of integrated and automated systems to reduce the number of overall errors involved in data collection and analysis, for UHN's research and clinical focuses. Enable effective patient safety across the health care system through shared resources.
- Real-time access to guide decision-making including "daily" drivers and safety information.
- Lab results automated to changes in drug doses (i.e., coagulants, insulin).

**Pathway to success:**
- Identify highest risk areas that would be most likely to benefit from reduction of human error or increased efficiency through automated or computerized processes.
- Consult with in-house UHN expertise for the establishment of a number of processes that would allow for increased efficiency, including:
  - Integration of information systems into daily research and clinical workflows.
  - Development of on-line management of patient booking.
  - Centralization of data collection and documentation.
  - Link with other incident reporting systems.
  - Clinical decision support tools: Test processes in 1 or 2 clinical sites as a pilot (e.g. heart, cancer, rheumatology, etc.)
- Provide access for health providers in Ontario to the developed patient safety processes.
- Examination of factors that enable technology adoption or any changes in current technology.

**Linkages to other themes:**
- Health Service Research will be a critical supporting factor in realizing and evaluating new processes that would support increased efficiencies.

[65] Electronic Patient Record

# Health Services Research (including system process change)

**Trend 1:**
Health Services Research capacity and output will be intensified and used to improve health care delivery and outcomes.

Health care decision-making by clinicians, managers and policy-makers must be informed by data on the appropriateness, feasibility, cost and effectiveness of interventions. Health Services Research will synthesize and contextualize existing knowledge, and will generate new knowledge to optimize care delivery and outcomes.

**Current UHN competence:**
- Health Services Research is conducted at UHN across its organizations, research institutes and divisions or departments. UHN has excellent research in several areas, but Health Services Research is fragmented with little coordination. For example, UHN researchers have established leading programs in key areas of Health Services Research such as large population-based cohort studies, health technology assessment, cost-effectiveness analysis, pragmatic clinical trials and knowledge translation.
- UHN's care spans the spectrum of care from intensive in-patient through to out-patient, chronic care, primary care and rehabilitation. With high patient volumes, there is a significant amount of data that can be used for Health Services Research.

**Desired UHN competence:**
- Become a recognized leading centre in Ontario in generating, pilot testing and implementing Health Services Research.
- Coordinate Health Services Research across disciplines and sites and reduce redundancy in Health Services Research.
- Utilize integrated, interactive and comprehensive databases to aid in the documentation of health outcomes of health care interventions provided to average people in typical settings; apply Health Services Research to patients in Ontario who receive care in actual care settings.
- Have a strong research environment that integrates scientists from diverse disciplines including biostatistics, epidemiology, economics, and the social sciences to incubate new collaborations and methodologies for Health Services Research.
- Become a resource for stakeholders seeking information on the effectiveness of health services provided to patients in Ontario.
- Deploy quality improvement initiatives to effect improvement in health outcomes across all programs and departments.

- Apply novel methodologies to evaluate health technologies, such as medical devices, when conventional methods of health technology assessment have not provided effective guidance.
- Follow patients' care paths to fully understand their recovery over a longitudinal period.

**Pathway to success:**

- Establish a Centre for Health Services Research to promote collaboration, recognition and resource sharing for such research across all HCP[66] disciplines and clinical departments. Establish an evaluation system appropriate for Health Services Research recognizing its differences from other more traditional types of research. Develop a model where principal investigators, clinical leads and managers work together and are linked via administration accordingly to make Health Services Research truly a team effort.
- Establish process to evaluate how UHN developed Health Services Research impact health care.
- Promote models that are not disease specific so that robust trends in parallel research programs can be easily identified.
- Develop mechanisms to promote knowledge implementation and build research capacity. For example, establish a centralized cost recovery service that generates rapid knowledge syntheses and provides consultation and mentoring for various Health Services Research methods including qualitative research, systematic reviews and knowledge translation.
- Perform local, national and international landscape analyses of potential partners for joint projects.
- Perform a landscape analysis of potential collaborators/partners (e.g. Dalla Lana, Li Ka Shing, IHPME[67]) to jointly support scientist positions.
- Establish linkages with other Health Services Research organizations, such as the Institute for Clinical Evaluative Sciences (ICES[68]), to increase access of UHN scientists to administrative health data. ICES is an independent, non-profit organization that uses population-based health information to produce knowledge on a broad range of health care issues.
- Encourage knowledge exchange between researchers and research users (clinicians, managers) to allow research to address programmatic and organizational priorities. Develop a searchable database of Health Services Research resources (i.e. a roster of resources), Health Services Research researchers and their projects at UHN and in Toronto.
- In order to include UHN data, make Health Services Research searchable on CAPCR[69].

[66] Health Care Professional
[67] Institute of Health Policy, Management and Evaluation
[68] Institute for Clinical Evaluative Sciences
[69] Coordinated Approval Process for Clinical Research

- Promote Health Services Research at UHN to the general public via UHN Public Affairs. Inform staff and stakeholders of Health Services Research initiatives and accomplishments via newsletters, publications, Health Services Research -specific interprofessional rounds and through creation of a research day.
- Actively recruit personnel—trainees, support staff and researchers—in the field of Health Services Research and provide dedicated support.

**Trend 2:**
The role of health care professionals will evolve and change.

The health care system is faced with advances in technology as well as changes in demographics and disease profiles of the patient population through an increase in the acuity and complexity of cases. As governments look for efficiencies in the health care system, roles and scope of practice of health care providers will shift and expand. For example, Bill 179 (Regulated Health Professions Statute Law Amendment Act, 2009) has introduced a significantly expanded scope of practice for Nurse Practitioners. There is movement towards the American model where advanced practice nurses with masters or doctoral degrees deliver primary and other types of health care services.

As part of adapting to these changes, collaboration between professionals and across different settings will be intensified to ensure a continuum of care.

**Current UHN competence:**
- A number of UHN programs examine new technologies for improved health care communication and process improvement.
- UHN offers interprofessional, shared care cancer conferences for breast, lung, prostate and other cancers. Other models include Balance Falls and Mobility, expanded Family Health Team and Bariatric Team
- Princess Margaret Cancer Centre, the DART[70] initiative and the HELP[71] program are designed to engage patients and other members of a care team.
- UHN has identified professional development (as one of its five strategic directions for 2011 – 2016) as a means to build organizational capability and capacity and has established recognition and retention programs through training and promotion:
    - In partnership with York University, UHN established the York-UHN Academy, a virtual and physical centre providing a gateway to new research and educational opportunities for nurses and other HCPs[72] affiliated with both organizations.
    - UHN has also partnered in other innovative educational programs such as the Nipissing Scholar Practitioner Program and the De Souza Institute for Oncology Nursing.

**Desired UHN competence:**
- To have HCPs, including laboratory technologists, imaging technologists and allied health groups, who are trained/mentored and well-equipped to adapt to and adopt new technologies.
- Interprofessional collaboration is nurtured and supported for both practice and research:
    - Clinician-manager-researcher partnerships are promoted.

[70] Distress Assessment and Response Tool
[71] Hospital Elder Life Program
[72] Health Care Professional

    - Interprofessional collaboration informs decisions regarding which team members are best suited to plan and provide care for specific populations (e.g. chronic disease management). Such partnerships enable more rapid innovation that leads to improved care delivery and outcomes.
- UHN retains expertise through expanding the scope of practice and by creating effective leadership succession opportunities such as scholar practitioner roles.
- Improve access for internal and external patient education resources.
- UHN leads in the evaluation of scope of practice changes while remaining focused on both patient safety and organizational efficiency.

**Pathway to success:**

- Create an environment where health care professionals can work to their full and extended scope of practice. For example, where advanced practice nurses can teach and counsel patients to understand their health problems and what they can do to get better (greater focus on prevention), provide and coordinate care and advocate for patients in the complex health care system, and refer patients to physicians and other health care providers when necessary.
- Consider new and innovative educational pathways for advanced practice HCPs such as those in the United States, tailored to nurse practitioners, clinical nurse specialists, certified registered nurse anaesthetists and certified nurse midwives.
- Equip HCPs with the knowledge and skills to enable them to adapt to and work with new technologies, new care delivery models, collaborative networks and with populations whose demographics and disease profiles may differ. Collaboration with TRI's CareLab will help to train these professionals.
- Develop and apply processes for choosing, using, monitoring and reporting on new technologies that are integrated with patient safety and quality improvement.
- Recruit scientists with expertise in care delivery models or multi-/interprofessional care delivery and innovation and embed scientists in management or clinical departments to help introduce health care innovations and optimize care delivery.
- Provide direction for transitions to new care delivery models by engaging the Board, executives, managers and staff in identifying and prioritizing areas where transitions may already be naturally occurring or warranted.
- Provide managers with continuing professional development and resources to enable transitions to new care delivery models.
- Maintain existing research and education support resources. Identify and leverage additional external grants, scholarships and other revenue sources to support research and education at all levels, including the point of care. Foster formal mentoring, practitioner-scholar positions and tuition support and flexible schedules for doctoral or postdoctoral education.

- Provide senior leadership with training and resources that enable staff to work to full scope of practice, cultivate academic practices and create evaluation and education plans to integrate these roles.
- Develop efficient and effective technology training programs that can be geared towards diverse groups/disciplines of professionals.
- Facilitate better communication between clinical departments to identify suitable internal education resources. Identify existing external patient education resources. Provide easy access for patients to these resources.
- Build in an evaluation system to determine if education/training programs are effective.

**Trend 3:**
The population will require different health services due to increased prevalence of patients with multiple chronic conditions.

New modes of care will be developed to accommodate the shift from acute to post-acute chronic care. This increase in services will be affected by new medical advances that lead to more procedures being done on an out-patient basis and increases in day-surgery combined with ongoing follow-up; fiscal constraints that drive hospitals to seek efficiencies by establishing community partnerships to deliver chronic or ongoing care; and an emphasis on patient self-management and caretaker support to enhance functional and health-related quality of life outcomes.

**Current UHN competence:**
- UHN is well-positioned to further diversify health services because of its multiple hospital sites, large and diverse clinical staff, and commitment to multidisciplinary care approaches makes it an ideal testing ground for innovative health delivery models. The CICC[73] at UHN creates and assesses innovative new technologies and modes of care for internal medicine, including care for patients with multiple chronic conditions.
- UHN has established links to external groups/organizations interested in using measures and evaluating outcomes to enhance and improve the efficiency of care (e.g. WSIB[74] through Altum Health, Institute for Work and Health, pharmaceutical companies, international groups interested in best-care practices).

**Desired UHN competence:**
- Develop new models of care delivery such as “shared care” networks in which UHN collaborates with and links patients and their caregivers to primary care and community organizations that provide ongoing support and follow-up.
- Develop, implement and evaluate self-management programs that optimize patient-reported and functional outcomes.
- To be a recognized leader in testing novel health delivery models.

**Pathway to success:**
- Implement network infrastructure and applications that enable data sharing among HCPs[75], primary care and community organizations to allow new shared delivery models that support interprofessional and shared care patient management.
- Identify and overcome logistical/technical roadblocks to data sharing (e.g. identify community care partners that still use paper records).

[73] Centre for Innovation in Complex Care
[74] Workplace Safety and Insurance Board
[75] Health Care Professional

- In order to be responsive to shifting health priorities, expand the scope of continuously collected data and analyze it periodically to describe and forecast trends in patient care so that services can be restructured in a responsive manner.
- Extend care via establishment of an enhanced outcomes measures group that is focused on patient re-integration with society (e.g. participation in physical activity, education).
- Explore partnerships with Public Health Units that are engaged in similar work or have similar aims from the perspective of identifying local needs and and/or population health measures.
- Identify existing innovative methods and modes of care within UHN. Provide training in knowledge translation to staff developing these practices and modes to more effectively share these results and institute more effective care.
- Develop a system for more comprehensive reporting on co-morbidities within UHN, while allowing for community data to be linked and shared with UHN data.
- Build an “Office of Connectivity” or identify a unit at UHN that will facilitate building of partnerships with people in the community (e.g. family practitioners or health care professionals, in remote communities), companies and community health care providers (e.g. Bridgepoint Health). Also recognize these partnerships by creating new credentials for them.

**Linkages to other themes:**

- Network infrastructure and applications that enable data sharing would be supported by expertise from the Informatics and Patient Information Collection & Assessment theme.

**Trend 4:**
There will be a greater emphasis on person-focused care.

Patients and their caregivers will desire increased information about their health care and a greater involvement in the decision-making process for their treatment. The general public will play a greater role in making decisions about the way services are delivered and evaluated.

**Current UHN competence:**
- UHN is a patient-focused organization that consciously positions health care as a partnership with patients and families.
- UHN has established patient/family education kiosks at all of its physical sites and also provides web-based patient/family focused educational material.
- UHN provides education, leadership and mentoring to support a culture where health care providers strive to adopt the patient's perspective on issues that are of importance to them.
- UHN has established extensive networks that are focused on patient-centered care, including the Health Equity Council, which provides leadership and direction to clinical teams in an effort to improve the access and quality of care provided to marginalized patients and their families; the Patient Portal, which is a foundational project that strives to enable and empower patients with access to their own personal health information and provide opportunities for patients to contribute to their health information as they work alongside their providers as partners in care; and the creation of a Patient and Family Advisory Council as a means to improve the patient experience with health services; tools were created including an orientation package for Council members, an orientation manual for staff, and a two day skills orientation curriculum to help Council members understand how to be effective in their roles.

**Desired UHN competence:**
- Improved access to services for high risk and vulnerable groups, including those with socioeconomic and other barriers to health care.
- Increased patient and caregiver involvement in decision-making, and health system planning and evaluation. The patient voice and perspective is represented in planning and programming initiatives, and patients and families are viewed as critical partners in planning, research, education, policy and clinical initiatives and programs.
- Increased accountability to the public through patient-focused outcomes and reporting mechanisms.

**Pathway to success:**
- Provide training and decision-making support tools for patients and families to help share responsibility for care with health care providers.
- Evaluate patient-centered care delivery and measure and incorporate patient reported outcome indicators in regular performance reporting. Use these data

in the design of systems, structures, policies and processes that align with patient and family priorities.

- Create network infrastructure and applications that enable patients and their caregivers to access personal health data and support in different settings to enhance patient access to care, the ability of patients to self-manage conditions and participate in the decision making process.
- Establish a citizen panel and a patient advisory board to provide input on the selection of performance measures, quality improvement plans and development of patient-centered care delivery.
- Increase public accessibility to hospital and quality of care information.
- Investigate current treatment patterns, forecast future patient profiles and use this information for planning future service organization and delivery.
- Establish a database of willing patients/family members that could be drawn upon for consultation (including higher level planning and evaluation by serving on strategic planning committees or evaluation teams).

**Linkages to other themes:**

- Network infrastructure and applications that enable data sharing would be supported by expertise from Informatics and Medical Technology themes.

**Trend 5:**
<u>There will be increased emphasis on developing cost-effective interventions and this will contribute to sustaining future health care.</u>

With the advent of new therapeutics, the cost of future drugs and treatments may be prohibitively expensive and current treatment strategies could become financially unsustainable over time. Health Services Research will be vital for deciding which treatments constitute effective care. From a personnel standpoint, the current pressures placed on every level of HCP[76] are immense and continues to grow with increased demand for health services.

**Current UHN competence:**
- UHN comprises four hospital sites (and 6 additional care facilities) with different focuses of care; UHN-wide integration has allowed for effective streamlining of available health services.
- UHN's Office of Performance Measurement and Decision Support provides evaluative and analytical expertise to UHN programs and departments.
- Extensive access to provincial, regional and hospital-specific data sets is used to retrospectively assess quality, efficiency and effectiveness of services.
- Increasingly, analysis is also focused on prospective, predictive studies to assess the impact and outcome of UHN interventions and therapeutics.

**Desired UHN competence:**
- Generate and/or have timely access to data/research on cost-effectiveness and use that information to drive decisions about the purchase and use of new technologies/treatments.
- Create the capacity to conduct prospective comparative effectiveness research to monitor outcomes longitudinally that will help identify which products/treatments/processes are most cost-effective.
- Establish a framework for health ministries to evaluate and report the return on investment of health innovations, from the perspective of the MOHLTC[77] and from a societal perspective.

**Pathway to success:**
- Creation of the UHN Centre for Health Services Research will promote evidence-based research that assesses new technologies and care plans.
- Create framework for implementing the use of efficiency and cost-effectiveness data for decision-making about purchases, treatments and monitoring.
- Recruit interdisciplinary experts trained in evaluating health outcomes and associated factors using approaches and models that may be quantitative (comparative effectiveness, economists, biostatisticians) and qualitative (sociologists, cognitive psychologists, health care engineers).

[76] Health Care Professional
[77] Ministry of Health and Long-Term Care

- Develop advanced training programs on economic analysis for PIs.
- Forge greater alliances with existing University expertise (e.g. THETA[78]) to inform/synergize with existing efforts.

**Linkages to other themes:**

- Data from these health economics studies can identify areas of need to drive research in other areas (e.g. experimental therapeutics, medical technology).

[78] Toronto Health Economics and Technology Assessment

**Trend 6:**
Rehabilitation services will be enhanced and fully integrated across the continuum of care.

**Current UHN competence:**
- Basic and clinical research has provided insight into the causes and potential hurdles to treatment for many common conditions, including cardiac failure, brain and spinal cord injury, communication deficits, balance disorders and neurological conditions. Good treatment strategies have been developed thus far to improve the overall quality of life for these patients.
- UHN provides rehabilitation treatments requiring intensive support from doctors and therapists and has strong rehabilitation research programs including those at TRI and the Goodlife Fitness Centre of Excellence in Cardiovascular Rehabilitation Medicine.

**Desired UHN competence:**
- Enhance the delivery of rehabilitation health services, including integration of current advancements in technology.
- Expand the availability of rehabilitation programs to people's homes that will reduce hospital stays. Identify novel treatments that can help those with co-morbidities. Develop remote monitoring systems for inpatient and community-based assessments.
- Extend projects related to acute care to determine the rehabilitation needs of ICU[79] survivors and their family caregivers as they transition into long-term care where researchers can test the efficacy of a supportive supervisory intervention.
- Assess the effect of new technologies on disease outcome and health care efficiency.

**Pathway to success:**
- Create state-of-the-art research laboratories that can advance UHN's capacity for rehabilitation research into conditions such as speech disorders, spinal cord injury and neurological disorders.
- Develop robotics for stroke rehab and intelligent systems for cognitive rehabilitation.
- Apply rehabilitation interventions, tools and therapeutic programs for a number of common conditions (e.g. cardiac rehabilitation among patients with comorbidities; diagnosis and characterization of mild TBI[80] impairments; interventions for ABI[81] survivors; treatment of sleep disorders).
- Improve accessibility to health care for those in isolated and rural regions through advanced technologies (e.g. remote programming of hearing aid, remote access to speech and language therapists and audiologists), while

[79] Intensive Care Unit
[80] Traumatic Brain Injury
[81] Acquired Brain Injury

extending a number of these services to aid community based and disease management strategies.

- Promote the application of rehabilitation research to improve patient outcome across the continuum of care at UHN—including acute care as well as post-operative/preventative applications and for care of those with chronic conditions. Examples include: application of functional electrical stimulation to recovery of walking, trunk control and stroke; electrical stimulation to treat conditions that include seizures, Parkinson's disease, depression and memory loss; develop person-centered rehabilitation models of care for hip fracture patients and those with osteoporosis; and assess and apply exercise interventions in patients receiving chemotherapy.
- Create Health Services Research data and decision-making tools for determining appropriate discharge destination for rehabilitation (i.e. inpatient rehabilitation bed, home-care, outpatient, etc.).

**Linkages to other themes:**

- Advanced technologies for remote care as well as robotics and rehabilitation interventions would be supported by expertise from Informatics and Medical Technology themes.

**Trend 7:**
Health care professionals will increasingly rely on networks capable of multi-directional information transfer (multi-way networks) as technologies advance.

The reliance of health care professionals on networks capable of multi-directional information transfer (multi-way networks) will increase as technologies advance, work is geographically dispersed and new and innovative models of care are identified. These networks will link health care professionals across client-focused areas and those relating to learning and research.

**Current UHN competence:**
- UHN has established innovative networks that focus on patient-centered care and sharing leading practices and resources. Examples include the Patient and Family Education Network and Library, which improves access and quality of patient and family teaching/resources for purposes of knowledge and understanding of disease and treatment, symptom management, ability to cope, self-management and self-care, improved health outcomes, and enhanced quality of life; the CICC[82], which is a program dedicated to studying how to improve the entire process of care for patients with multiple problems; the purpose is to engage patients and clinicians to identify problems with current health care practices and develop solutions for addressing them through innovative research and evaluation in a real clinical environment and Patient-Centered Care Complex Rounds which is a forum to focus on patient-centered care practice experiences and challenges and to engage in candid and honest discussion without fear of judgment or repercussion.

**Desired UHN competence:**
- Multi-way HCP[83] networks are integrated into operations to advance clinical care, maximize efficiencies and mobilize knowledge and innovation.
- Develop and sustain networks that are embedded in job enhancement planning and processes.
- HCPs that provide acute and sub-acute care in the community leverage networks to build the management, technology and education skills necessary to meet the needs of their increasingly complex patients.

**Pathway to success:**
- Ensure that all stakeholders—patients, families, employees and the public—are involved in building and fostering networks.
- Identification of network opportunities is rewarded and participation in network building is embedded into roles.
- Engage partners in Health Services Research to support the assessment of such networks including THETA[84].

[82] Centre for Innovation in Complex Care
[83] Health Care Professional
[84] Toronto Health Economics and Technology Assessment

- Develop innovative ways of multi-way communication.
- Define current video conferencing capabilities (e.g. Skype) at UHN. Facilitate/educate regarding the use of Skype, including best practices.
- Enable researchers to participate in national and international initiatives by facilitating web conferencing. This includes enabling this capacity at individual work stations and by developing a staffed/resources-centralized facility.

**Trend 8:**
The link between healthy work environments and quality clinical care will be strengthened in order to improve positive patient outcomes.

**Current UHN competence:**
- UHN believes employee health is a critical factor in the hospitals' ability to achieve excellence in patient safety and quality care, and has programs in place to promote staff health and wellness. The UHN Wellness Centre offers a variety of exercise, lifestyle and skill building workshops that aim to promote a healthy business culture, while the UHN eLearning Centre portal provides staff access to these courses and activities.
- UHN also has a code of ethics and policies in place to ensure a safe, equitable and hazard-free workplace. These efforts have collectively and consistently placed UHN within Canada's Top 100 Employer's list.
- Expertise in research and development for methods and devices to reduce health care-related injuries in nurses, therapists and other practitioners exists within UHN at TRI through CareLab and other programs.

**Desired UHN competence:**
- Projects and programs to enhance healthy work environments for employees will be blended with those focused on advancing clinical care and patient safety.
- Quality improvement cycles and program evaluation will include indicators that measure impact on employee, patient, family and public health, safety and wellness.
- UHN will set itself apart as a workplace with high levels of employee health and satisfaction through the development of innovative health and wellness programs linked to the prevention of chronic disease and workplace injuries.

**Pathway to success:**
- Foster a culture where the health of all stakeholders is viewed as equally important and co-dependent. Expand the focus on achieving exceptional patient outcomes to enhancing the health of all.
- Integrate programs that enhance healthy work environments for employees with those focused on advancing clinical care and patient safety. This will further emphasize the importance of staff wellness at UHN by incorporating these aspects into a variety of more professionally focused courses.
- Program and quality evaluation programs should include indicators of employee health, safety and wellness.
- Provide managerial and employee incentives to create and sustain a healthy workplace.
- Enhance workplace satisfaction by further fostering a culture of fitness (e.g. identify and support staff "fitness champions" and promote their ability to foster health and wellness).

- Establish a program to evaluate the impact that health and wellness programs have on staff and establish an appropriate level of funding based on return on investment.

# Mechanisms of Disease

**Trend 1:**
Genomic platforms will improve in cost, accuracy and utility, becoming routine tools for analysis of normal and disease states.

**Current UHN competence:**

- The Molecular Profiling and Clinical Genomics groups at UHN have used a number of lower-complexity screens to look at various cancer mutations to help in diagnosis and prognosis, but newer technologies are now available that would accelerate and enhance these efforts. Research efforts have focused on mature technologies such as microarrays, qPCR and NanoStrings traditionally, but new and emerging technologies are now being adopted.
- UHN also has access to functional genomic platforms such as the COLT[85] program and the siRNA screening facility at the SLRI[86]. The OCI Genomics Centre has partnered with COLT to provide high-throughput sequencing based readouts of these screens to accelerate research programs. UHN is currently developing an RNAi screening capacity to complement these facilities.
- OCI has made investments into research and clinical genomics, specifically in the area of high-throughput sequencing, with two Illumina HiSeq 2000 sequencers. Further, a lower-throughput Illumina MiSeq has been purchased for the Clinical Genomics group. Additional investment in computational infrastructure and informatics personnel has also taken place.
- OCI has embarked in a screening program at the clinical level where patient samples will be screened for a panel of more than 200 known cancer-related mutations. Further expansion of this program is warranted.
- The high-throughput sequencing landscape in Toronto is fairly large (OICR[87], Centre for Advanced Genomics at SickKids, SLRI, CCBR[88]) but the available capacity is still limited with even simple projects often taking over six months to complete.

**Desired UHN competence:**
The overall goal is for UHN to have access to the latest screening platforms and routinely use these to investigate the genetic differences between normal and disease states. Specifically:

- Access to the latest genomics technologies with sufficient capacity to ensure rapid turnaround for both research and clinical operations.
- Access to multiple technologies to cover a spectrum of needs (high content, high resolution screening vs. lower content rapid turnaround screening).

[85] Centre for Cellular and Biomedical Research – Ontario Institute for Cancer Research Lentiviral Technologies
[86] Samuel Lunenfeld Research Institute
[87] Ontario Institute for Cancer Research
[88] Centre for Cellular and Biomedical Research

- Secure, high performance computing and data storage infrastructure with the requisite IT personnel to ensure continual access and reliability.
- Technologies that allow for genomics screens to be carried out at the single cell level, or from diminishingly small clinical samples.
- Technologies that allow for genomics screens to be carried out on circulating tumour cells or tumour nucleic acids.
- Sufficient wet-lab personnel to ensure rapid turnaround, and high quality data production.
- World class informatics team to allow for both research-based and clinical genomics screens to be analyzed, mined and interpreted.
- Automation to ensure rapid reproducible development of libraries for sequencing.

**Pathway to success:**

- Invest in additional sequencing capacity including the latest technologies from both Illumina and Ion Torrent for both clinical and basic research groups.
- Ensure sufficient investment in maintenance programs to ensure maximal operational capacity of the instruments.
- Invest in gene expression profiling technologies such as NanoString Counter to allow for rapid quantitative validation of genomic hits and rapid screening.
- Invest in single cell genomic technologies such as Fluidigm to allow for screening at the single cell level using sorted cells, circulating tumour cells, DNA and RNA.
- Ensure compatible technologies between the CLIA[89] certified Clinical Genomics laboratory and the basic research groups to allow rapid translation of discovery into the clinic.
- Establish a translational genomics program at UHN that includes imaging and integrative physiology to bring information about environment to genetics testing.
- Recruit new investigators with expertise in next-generation sequencing for the translational genomics program.
- Build on the strong foundation of the nascent OCI Bioinformatics group by recruiting informaticians in order to transform the group into a world-class resource.
- Investment in automation solutions for preparation of sequencing libraries.

**Linkages to other themes:**

- Access to the latest genomic technologies will aide initiatives in Experimental Therapeutics to better inform clinicians for improved diagnosis and treatment planning.

[89] Clinical Laboratory Improvement Amendments

**Trend 2:**
Epigenetics will become increasingly important for understanding disease mechanisms.

Epigenetic abnormalities contribute to disease etiology and provide new opportunities for the development of novel treatment strategies. While the genome is essentially static, the epigenome is dynamic and can be affected by environmental cues and aging. A full understanding of disease therefore requires an analysis of the epigenetic mechanism. Furthermore, epigenetic changes offer promising targets for therapeutics.

**Current UHN competence:**
- The Structural Genomics Consortium has developed a number of molecules that can target specific epigenetic regulators.
- UHN has invested in developing a strong epigenomics program through the recruitment of two junior Scientists and one senior Scientist with epigenetics expertise in the area of histone marks, DNA methylation and long non-coding RNAs.
- To support new recruits and expand the capacity for UHN epigenetics research, the OCI Genomics Centre and has been equipped with 2 Illumina HiSeq 2000 sequencers to expand the scope of services that will soon be available, including next-generation DNA sequencing, ChIP-seq, DNA methyl-seq RNA-seq, etc.
- UHN has some capacity for bioinformatics expertise in this area through the recruitment of the new Scientists and a Manager of Bioinformatics at OCI.
- Informatics pipelines for the analysis of ChIP-seq and meth-seq data are established and implemented through the laboratories of the new epigenomics recruits.
- Computing infrastructure to support epigenomics data analysis has been established.
- UHN has researchers studying ubiquitylation and sumoylation based epigenetic modifications via MS[90].

**Desired UHN competence:**
- Establish UHN as an internationally recognized centre for epigenetics research.
- Strong leadership in the development of cutting-edge new technologies in the area of epigenetics.
- Increased epigenomics capacity, including sequencing systems, computer infrastructure and resources.
- Access to technologies that allow for epigenomic profiling at the single cell level or in small numbers of cells.
- Focus epigenetics research on human disease and advance research results to patient care.

[90] Mass Spectrometry

- Develop new therapeutic approaches based on novel insights in the epigenetics of disease.
- Further growth in the area of epigenetics at both the technical and theoretical levels.

**Pathway to success:**

- Recruit new scientists with expertise in epigenetics, including those at the senior level with established leadership capabilities.
- Recruit additional informatics personnel to the OCI Bioinformatics core
- Hire people at the OCI Genomics Centre to integrate advanced capabilities in next-generation sequencing and computational biology.
- Identify new epigenetic targets as the basis for a new class of therapeutics.
- Invest in new infrastructure in the OCI Genomic Centre, part of which can be accomplished by the new CFI[91] award to the Centre for Cancer Epigenetics.
- Survey the local and international landscape to establish appropriate partners to help determine how epigenetic abnormalities can contribute to disease etiology and provide new opportunities for the development of novel treatment strategies. Potential local partners include OICR[92], the Cancer Stem Cell Centre and the Structural Genomics Consortium.
- Provide all UHN researchers with ready access to epigenetics research tools and expertise.

**Linkages to other themes:**

- Defining the epigenetic basis of disease will provide Regenerative Medicine with new approaches to model human diseases with stem cells, as well as novel therapeutic targets for efforts within the Experimental Therapeutics theme.

[91] Canada Foundation for Innovation
[92] Ontario Institute for Cancer Research

**Trend 3:**
Proteomic platforms (encompassing all non-gene based "omics" such as metabolomics, degradomics, etc) will continue to evolve and provide key information for determining the composition of key biochemical pathways in normal and disease states.

**Current UHN competence:**
UHN has broad competency in proteomics, covering aspects of protein expression, protein-protein interaction, protein modification and protein structure. Expertise in areas that are adjunct to proteomics such as metabolomics is less well developed.

- UHN has in-house expertise in functional proteomics and protein complex dynamics; post-translational modifications (ubiquitin, SUMO, phosphorylation and glycosylation); global proteomics and organellar/membrane dynamics; and biomarker discovery.
- UHN has a strong tradition in structural proteomics both in terms of infrastructure as well as expertise. The structural biology program is supported by the Structural Proteomics in Toronto facility, which has both NMR[93] and x-ray crystallography instruments available.
- In 2006, UHN made a strong commitment to improving proteomics capability in the area of MS[94]. Continual investment, through recruitment of experts in the area of protein expression, protein biomarker screening, protein modification and protein degradation have allowed for highly effective use of these resources. This group has continued to attract funds and partnerships that have allowed for the installation of state-of-the art MS equipment.
- Multiplexed affinity based detection methods for signalling proteins, cell surface markers, cytokines and chemokines are also available. The UHN Antibody Core Facility provides rapid cost-effective development of monoclonal antibodies to cell surface markers. This facility also provides screening services of cell surface markers using a panel of nearly 400 antibodies. The OCI Genomics Centre offers multiplexed protein expression analysis using the Luminex 200 bead-based array system. This system can also be utilized to determine phosphorylation of key signalling proteins.
- UHN has a number of researchers interested in aspects of metabolism, and the effects of redox pathways, and hypoxia. A Seahorse XFe capable of measuring redox metabolism in cultured cells is available to researchers interested in this area. More global characterization of the metabolome at this point is carried out primarily via third-party commercial or academic partners. UHN does however have the instruments necessary to carry out these sorts of studies.

[93] Nuclear Magnetic Resonance
[94] Mass Spectrometry

**Desired UHN competence:**

Despite the strong position of UHN in the area of proteomics, further investment is desired to help grow this group, increase access to more researchers and develop competence in the area of global metabolomics. Desired competence in this trend would include:

- Expertise in targeted and/or data independent proteomics and metabolomics.
- Strong research in ligand/receptor interaction proteomics for signalling pathways and/or novel drug targets.
- Increased access to MS for proteomics analysis.
- Continually maintained instrumentation including long-term maintenance contracts.
- Secure, high performance computing and data storage infrastructure with the requisite IT personnel to ensure continual access and reliability.
- Sufficient wet-lab personnel to ensure rapid turnaround, and high quality data production.
- World class informatics team to allow for both research based and clinical proteomics and metabolomics screens to be analyzed, mined and interpreted.
- Access to world-class metabolomics profiling services and infrastructure.
- Improved access to affinity based detection and screening systems.

**Pathway to success:**

- Drive further investment into the maintenance of key instruments such as the NMR, X-ray crystallography and MS machines.
- Create a larger footprint and improved facility for the MS group allowing for the acquisition of additional instruments.
- Attract further laboratory personnel to help to run the MS instrumentation as a service thus increasing access to these instruments.
- Improve informatics support, through both personnel and hardware to allow for large-scale projects and meta-analyses to be carried out efficiently.
- Obtain further affinity-based detection systems such as the MesoScale Sector Imager and Biacore instruments to further empower UHN researchers.
- Recruit expertise in targeted and/or data independent proteomics.
- Recruit an expert to lead a team of metabolomics researchers and make use of the strong infrastructure position of the UHN.
- Integration of genomics, proteomics and bioinformatics programs.
- Formal tool for integration of genomics/proteomics/bioinformatics programs with disease sites for biomarker discovery and validation and to enable access to clinical specimens.

**Linkages to other themes:**

- Identification of pathways in disease states will inform the diagnostic and therapeutic biomarker trend in Experimental Therapeutics.
- Identification of pathways responsible for normal and disease development will align with the aims of Regenerative Medicine.

**Trend 4:**
Expertise in medicinal chemistry and structural biology, fortified with academic and private sector partnerships, will be used to identify novel targets and develop therapeutic interventions.

Research hospitals and academia will be indispensable in identifying and validating novel targets as well as generating therapeutic strategies.

**Current UHN competence:**
- UHN currently has moderate capacity at the Centre for Molecular Design and Preformulation and the Campbell Family Institute for Breast Cancer Research in computer modelling, synthetic chemistry and preformulations and is currently adding to capacity in these areas at the Krembil Discovery Tower. Medicinal Chemistry facilities at UHN Shanghai are available to UHN staff as well.
- Some capacity in core facilities, such as those for chemical compound characterization and high-throughput screening, exists.
- UHN has world-class capacity in structural biology for rapid characterization of novel targets.

**Desired UHN competence:**
- Rapid characterization and development of therapeutic strategies to address the challenges of personal medicine.
- Integration of computer modelling, synthetic chemistry, structural biology and *in vitro* target validation for efficient development of chemical probes.
- Multidisciplinary teams integrating medicinal chemistry, disease animal models and preformulation characterization for effective identification of potential therapeutic agents.
- Integrated IT platform for chemoinformatics, animal models and clinical information linked to disease mechanisms and clinical outcomes. Enhanced core facilities in chemistry and integrated computer modelling/computational chemistry infrastructure.

**Pathway to success:**
- Develop and integrate infrastructure for synthetic chemistry and preformulation for efficient deployment of resources.
- Increase access to world-class skilled scientists in the areas of preformulation and drug discovery either through recruitment or partnership.
- Develop strategies for regular cross-talk between medicinal chemistry, biology and clinical research groups for promoting multidisciplinary culture.
- Develop strong private sector partnerships to increase access to resources and expertise.

**Linkages to other themes:**

- Therapeutic interventions developed through this trend directly benefits initiatives within the Experimental Therapeutics theme and will be translated into clinical use.

**Trend 5:**
Nanotechnologies will continue to allow for better understanding of disease by contributing to better imaging, better understanding of specific cell targeting and an increased ability to alter cells and pathways.

Biological processes, including the events necessary for life and those that lead to disease, occur at the nanoscale. Nanotechnology provides scientists with the opportunity and potential tools to study and manipulate macromolecules in real time and during the earliest stages of disease progression. It can provide rapid and sensitive detection of disease-related molecules, enabling researchers to detect molecular changes even if they occur only in a small population of cells. It can enable cell tracking (circulating cells, stem cells, immune cells, neurons, metastatic cells, cell migration, etc.) and offer the ability to influence these cells and their microenvironment and dissect their role in normal and disease development. Nanotechnology has the capacity and potential to contribute significantly to the evolution of the study of cell biology from static observation to dynamic and interactive observation thus revealing the temporal, simultaneous interplay of events on cell surfaces with those in the intracellular and nuclear environment. Nanotechnology also has the potential to generate new and highly effective therapeutic agents. It has the potential to enable personalized disease diagnosis, treatment planning and therapy by imaging disease progression through biomarker-based analysis, predict disease phenotype and aggressiveness, as well as by influencing the disease progression at the genetic level through RNA therapeutics (e.g., siRNA, shRNA, miRNA). Nanotechnology based (lab-on-chip) sensing allows for rapid, high-fidelity identification of individual disease profiles, a critical enabler for personalized medicine.

**Current UHN competence:**
- UHN has a dedicated NanoMed Fab Facility which supports nanotechnology research and development including nanoparticle fabrication, characterization, evaluation modules and targeting ligand synthesis—all with a distinct focus on biomedical applications. It is a GMP[95]-level facility that is unique in Canada.
- STTARR[96] provides state-of-the-art imaging technology for cellular studies at the level of DNA and proteins, as well as multi-modality imaging of preclinical models.
- UHN also has a strong repertoire of animal models of disease for research supported by a state-of-the-art Animal Resources Centre.
- The Toronto area has strong academic expertise in “Lab-on-a-Chip” technology and *ex vivo*/*in vitro* detection of nanoscale events. There are a number of separate collaborations that exist that pursue research in nanotechnology in molecular biology but these are few and disparate.

[95] Good Manufacturing Practice
[96] Spatio-Temporal Targeting and Amplification of Radiation Response Innovation Centre

**Desired UHN competence:**

- A critical mass is required in nanotechnology based molecular imaging and therapeutics. Hybrid researchers with appropriate expertise in molecular biology, chemistry and material sciences who would be able to understand the biological environment and design probes for cellular processes and nanoscale structures/substructures are critical for realizing the potential capacity of nanotechnology.
- Multidisciplinary collaborations that foster nanotechnology research and progress pertaining to understanding disease across UHN/Toronto.

**Pathway to success:**

- Recruit dedicated expertise in nanotechnology based molecular imaging to support nanotechnology research at the cellular level.
- Establish a formal tool for supporting and identifying multidisciplinary collaborations that foster nanotechnology research and progress pertaining to understanding disease across UHN/Toronto.

**Linkages to other themes:**

- Nanotechnology as a tool to investigate the basis of disease will provide novel tools for the Medical Technology and Experimental Therapeutics themes.

**Trend 6:**
Synthetic biology/metabolic engineering will increasingly be used to manipulate internal molecular pathways to provide novel insights to normal and abnormal cellular/tissue function.

Synthetic biology involves the creation of novel functions or systems and the modification of existing ones for new purposes. While often thought of in the context of industrial applications involving index organisms such as bacteria and yeast, such principles can also be applied to understand and manipulate human health-related entities. Such changes can be realized on a variety of levels from alterations of DNA using recombinant viruses to pharmacologic manipulations of metabolic or catabolic pathways to elucidate functions and determine outcomes. For example, "Gain of Function" emphasis can be re-directed to impact immunotherapy applications. Here antibodies can be made or potent cytokines can be added that engineer novel immune functions in individuals directed at a variety of tissue targets relevant to human disorders. Cells can also be engineered to secrete therapeutic factors that allow for systemic correction of metabolic or catabolic defects.

**Current UHN competence:**
- UHN has an existing vector core facility that has the ability to engineer and implement novel recombinant vectors to overexpress factors along with shRNA approaches to decrease factor expression in relevant human health-related target cells and tissues. There is also the capacity to engineer multiple outcomes at once to elucidate factor interactions or to add multiple functionalities to target effectors.
- There is a UHN GMP[97] Cell and Vector Facility, which is currently being built, for clinical scale-up and approved implementation.
- UHN researchers currently have access to medicinal chemistry and synthesis capacities through overseas UHN partnerships.
- There is a top-notch UHN Animal Resources Centre and staff to facilitate generation, manipulation and propagation of compelling animal models.
- Relationships with private partners enabled through TDC[98] access novel compounds and delineate end-point users of interesting technological breakthroughs developed by UHN researchers.

**Desired UHN competence:**
- Expanded capabilities in antibody generation. Capacity to facilitate translation of such novel reagents into viable therapeutics—either alone or in conjugation with other pathway modifying reagents. For example, expanded capacity for conversion of promising antibodies to develop novel chimeric antigen receptors that can be used to re-direct T-cell specificities against defined targets.

[97] Good Manufacturing Practice
[98] UHN's Office of Technology Development and Commercialization

- Expanded capacity to generate a wider range of vectors that modify cells in different manners that may allow definition of alternative cellular pathways or therapeutic goals.

**Pathway to success:**

- Strengthen internal UHN capacity for generating animal models to gauge clinically related outcomes.
- Explore partnerships with centres having expertise in animal model generation and in particular high-throughput methodology in this area.
- Expand UHN animal pathology capacity to provide full work-ups of novel models and therapeutically treated animals to satisfy toxicology analysis requirements for Health Canada and other regulatory agencies.
- Foster working collaborations between basic researchers with clinicians to inform model generation/interpretation.
- Expand resources of TDC to capture the full commercial and marketing potential of this valuable intellectual capital.
- Expand “omics” platform to include capacity to evaluate and analyze lipidomics and other metabolites/catabolites of biological processes.

**Trend 7:**
Animal models of disease will become better and more accurate at predicting human responses.

Animal models remain an important source of information in understanding how organs, cells and molecular mediators interact resulting in normal or abnormal systems. Some animal models reflect human responses more accurately than others and research examining this question remains an important component of UHN programs.

**Current UHN competence:**
- UHN has multiple animal facilities run at the highest level of care as evidenced by receiving the highest level of certification from the Canadian Council on Animal Care.
- UHN has extremely proficient animal care staff across the institution ensuring that animal-based experiments are carried out in an ethical and scientifically valid manner.
- UHN researchers receive sophisticated advice on almost any procedure from extremely experienced and highly trained veterinary doctors.
- UHN has several research groups with expertise in genetic manipulations of animals to create disease models.
- UHN has state-of-the-art facilities, including STTARR[99], for studying animal disease models.
- Individual investigators have developed and use specific animal models of human disease for their specific research programs. Only a few large animal models are used and nearly all are acute rather than chronic models.

**Desired UHN competence:**
- Increased cross-talk between researchers using animal models and clinicians to increase the accuracy of models to predict human disease.
- Increased awareness of best-in-class animal models to ensure the optimal use of animals.
- Systematic and rigorous analysis of animal models which when validated can best predict either mechanisms of disease and/or therapeutic targets in humans. Sharing of these insights across all institutes and medical programs to both refine required animal research and to reduce less informative (predictive) animal research.
- Development of chronic animal disease models that more closely portray the natural history of human disease.
- Development of large animal models that more closely mimic human pathophysiology.

[99] Spatio-Temporal Targeting and Amplification of Radiation Response Innovation Centre

**Pathway to success:**

- Organize an animal model working group with researchers, veterinary experts and human disease experts to continually assess the accuracy of models and suggest ways to improve models.
- Continue to support animal resource facilities at the highest standard.
- Increase animal pathology support for researchers.

**Trend 8:**
Next-generation clinical investigation units (CIU) will enable mechanistic studies in health and disease through integrative physiology studies in the human**.**

Next generation clinical investigation units (CIU) that enable integrative physiology studies in the human will be needed to validate pre-clinical data sets. These will include minimally invasive *in vivo* and completely non-invasive monitoring devices, as well as multi-modality imaging technologies such as PET[100], MEG[101], structural and functional MRI[102], and specific molecular imaging probes. These CIU-based studies will focus on discovery of fundamental mechanisms underlying function in health and disease. Towards this goal, the CIU will allow for integration of physiological data with behavioural, cognitive, and imaging data.

**Current UHN competence:**
- A few isolated research beds are employed by select investigators in specific sites.
- Pockets of scientific, technical, and clinical expertise in basic physiology, imaging, and psychology (e.g., EEG[103] and brain imaging scientists and clinicians at Toronto Western Hospital).
- Imaging facilities for PET, MRI, and MEG (under development)
- TRI is home to the Balance and Mobility Clinic that integrates research and clinical care in one program.
- Sleep lab is a dedicated facility for assessing sleep disorders and determining the underlying mechanism that causes them.

**Desired UHN competence:**
- To have a dedicated multidisciplinary group of basic, translational and clinical investigators, including physicians, nurses imaging and other laboratory technologists, bioethicists and biostatisticians to design and conduct mechanistic studies in UHN patient populations.
- To develop a “one stop shop” facility whereby researchers can undertake multidisciplinary studies with access to a full complement of essential support services and consultation (e.g., study design, statistics, technology/device development, ethics, recruitment)
- To have dedicated space in appropriate clinical areas (including beds) and operating infrastructure (equipment and personnel) for the CIUs.
- To create an efficient, low cost, and dedicated UHN in-house Research Participant Recruitment Centre to facilitate human based mechanism of disease studies including both patients and healthy subjects. The main function of the Centre would be to identify, screen and recruit appropriate study participants.

[100] Positron Emission Tomography
[101] Magnetoencephalography
[102] Magnetic Resonance Imaging
[103] Electroencephalography

**Pathway to success:**

- Recruit required personnel including basic, clinical investigators, translational scientists, physicians, nurses, imaging/other lab technologists, bioethicists and biostatisticians as required to establish CIU teams.
- Engage Medical Program Directors to establish priority areas of investigation and develop a combined resource base to fund CIUs.
- Secure dedicated space to house the CIUs, including beds and other facilities associated with implementing CIU studies (e.g., testing rooms, analysis and meeting rooms)
- Recruit personnel and establish dedicated space to house a Research Participant Recruitment Centre

# Research and Education

In recognizing the long history and strength of research in health professions education at UHN, in collaboration with the University of Toronto, the following document outlines the strategic directions for a seventh Theme (“Pillar”) in Research in Health Professions Education, which will be incorporated into the Roadmap, and overseen by the Vice President, Education.

# UHN Research Roadmap: Educational Research Pillar 7
# "UHN: research hospital of the future"
# Draft Version v.2

**Preamble**: As part of the UHN's Strategic Planning for the "Research Hospital of the Future" the Vice President of Research has led a process that identified key pillars. These are: medical technology, informatics, health services research, experimental therapeutics, technology, safety and medicine. (*Final categories remain under discussion)* Recognizing the long history and strength of research in health professions education at UHN, in collaboration with the University of Toronto, this document outlines the strategic directions for the "7th pillar": Research in Health Professions Education. Pillars 1-6 are part of the Strategic Plan overseen by the Vice President, Research. Pillar 7, Research in Health Professions Education will be overseen by the Vice President, Education as part of the larger Educational Strategic Plan for UHN.

## Trends in Education Research

Trend 1: Growth of Patient and Family Education

With increased demand on Canada's health care system, there will be in an increased demand for patients and families to take a more active role in healthcare. Approximately half of all Canadians are living with at least one chronic health condition and more than one in 4 report having two or more chronic conditions. Canadians are also seeking more information on their health: 64% of internet users have gone online to find health or medical related information (Canadian internet use survey, Statistics Canada 2010). As well, low health literacy has been linked to: less use of preventative services, delayed diagnosis, less adherence to care, poor self-management, higher healthcare costs and poorer health. Research in patient education is more and more critical.

Trend 2: Educating for Interprofessional Team Competence

(a) Health professionals are increasingly expected to work in teams. Interprofessional approaches to care have been associated with better patient outcomes, greater patient safety and enhanced quality of work life. Health professions training programs are moving away from mono-professional curricula to integrated, interprofessional curricula. Assessment of competence is moving from one based on individual competence to notions of team-based and collective competence. Research in interprofessional education, team-based competence and training is a priority.

(b) Health scientists are also increasingly expected to work in teams. Interdisciplinary research has been associated with better research and therefore better health care. Health research training is moving away from a mono-disciplinary focus towards an interdisciplinary one. It is crucial to better understand interdisciplinary research collaboration in the health field to improve knowledge outcomes and patient care.

Trend 3: Humanism in Healthcare/Educating for Compassionate Care

Health professions education is increasingly understood as a process of professional socialization. Health professionals must balance the technical and compassionate dimensions of care, the biological/psychological and social determinants of health and illness and master not only the knowledge and skills necessary to care for individual patients and families but also to

understand how health and illness interact with social and cultural determinants. Research in the social humanities and compassionate aspects of healthcare is a priority.

Trend 4: Evolving Best Practices in Technology-Enhanced Education
Education of health professionals is rapidly changing with the introduction of new technologies. New communications technology, social media, simulation technologies, electronic learning (eLearning), virtual reality distributed and distance education and many other technologies are changing the face of health professions education. Research about the role, design, and use of technology and education is essential in ensuring technology provides value in improving learner performance.

Trend 5: Understanding and Optimizing Clinical Reasoning
The education of healthcare professionals involves the development of expertise in clinical decision-making and management. An enhanced understanding of the cognitive processes that underlie the development of expertise can enhance both the effectiveness and the efficiency of teaching. It can also provide educational approaches that align with the goal of training master practitioners.

Trend 6: Articulating the Role of Outcomes in Health Professions Education
The institutions in which health professionals work are increasingly concerned with quality, patient safety, and optimizing patient outcomes. Increasingly, educational programs and approaches focus on demonstrating improved clinical outcomes. Research related to measurement and evaluation of clinical outcomes in education for staff is needed and presents methodological challenges that require a balance between learner-centered and patient-centered outcomes.

Trend 7: Understanding How and What Health Professionals Learn
Training to become a competent health professional requires the acquisition of an increasing amount of knowledge, skills, and attitudes relevant to patient care. A better understanding of the processes by which clinicians develop motor skills and clinical knowledge, function in various emotional states, and develop expert reasoning and judgment continues to be essential for informing curricular innovations. Furthermore, the study of what information and knowledge should be taught to trainees continues to be relevant in an ever-changing clinical environment.

## Current UHN Strengths in Education Research

In 1997, the University Health Network, together with the University of Toronto, created the Wilson Centre for Research in Education, which has grown to be the largest centre for health professions education research internationally. The scientists and cross-appointed scientists of the Wilson Centre lead programs of research aimed at better understanding the theory and practice of health professions education. They also contribute to numerous hospital and university educational committees and programs. Members of the Wilson Centre represent a wide-range of professions and health disciplines and more than 35 fellows train in 2-5 year full-time fellowship programs (including masters and PhD degrees at the Wilson Centre). Current research streams include: global health, professionalism, hidden curriculum, interdisciplinarity,

clinical reasoning, self-regulated learning, patient safety, motor control, stress, knowledge translation, history of medical education, to name just a few. Wilson Center scientists and fellows have a high-degree of grant capture from national agencies, including regular tri-council (CIHR, SSHRC, NSERC) funds as well as a high productivity in publications.

The Temerty/Chang Telesimulation Centre was created in 2010. This centre pioneered the development of the use of telesimulation technology first for minimally invasive surgery and now in other areas such as nursing, emergency medicine, anesthesia and maternal health and is expanding its applications. It is accompanied by a robust research program.

The Ho Ping Kong Centre for Educational Excellence and Practice (CEEP) was established in 2010 to foster educational work in academic General Internal Medicine with a clinical focus on Ambulatory Care in Internal Medicine. CEEP has focused on innovation and research in practice-oriented educational projects and is a pioneer in the use of simulation in Internal Medicine education. Its established areas of research include: the art of medicine, simulation for clinical skills, clinical reasoning, and assessment of competency. CEEP has established strong national and international collaboration across medical specialties and has implemented projects on research on cross-professional teams. Its members are recipients of several national and international educational awards. The Ho Ping Kong Centre has a strong commitment to scholarship in education

The Centre for Interprofessional Education was founded in October 2009 as a partnership between the University Health Network (as the lead hospital for the Toronto Academic Health Sciences Network, TAHSN), Toronto Rehabilitation Institute (TRI), and the University of Toronto. This Centre is responsible for the Interprofessional Education (IPE) curriculum across all University of Toronto health professions (over 3,500 students from 11 programs) and an internationally renowned professional development program that builds capacity for IPE, Interprofessional Care (IPC), systems leadership, quality, and simulation. The Centre has also contributed substantially to research in the area of IPE and IPC, with an increasing focus on the impact of these fields on patient care.

In 2011, Patient Education at UHN merged from an individual hospital-based activity to an integrated corporate program across UHN and became knows as Patient and Family Education. Work is underway to develop an organizational wide-approach and a strategic plan that will foster research. Research in Heath Professions Education is also undertaken within the Collaborative Academic Practice portfolio (Joy Richard VP Professional Practice and CNE), through many specific health professional groupings at UHN (Nursing, the Health Professions, Medical Education, etc).

## Desired UHN Competence (Where education research should go)

UHN clearly has significant existing strength in health professions education research. The various centres and programs described above have a strong track record in this area. Many of these programs are already internationally recognized as leaders. There is potential for further synergies between these groups and opportunities to raise the profile of health professions education research and patient education research internationally.

## Pathways to Success (How to make it happen)

Most important is to recognize and celebrate the research in education done at the University Health Network for what it already is: cutting edge research and training of the next generation of scientists, clinical researchers, and leaders. As in most research areas, continuing to identify long-term funding for these programs is important from variety of sources including the hospital and university but also through philanthropy, grant capture and innovative sources of revenue generation.

There are also opportunities to connect research activity in UHN centres and programs with educational development more broadly at the UHN. For example, there is opportunity for development of programs ranging from an introduction to literacy in health professions education research through to basic skills development and eventually participation in a graduate education and research.

### Appendix: UHN Centres with Substantial Education Research Activity

| | Date Established | Annual Operating Budget | Endowment | Annual Research Grants | Annual Publications | Staff, Faculty and Fellows |
|---|---|---|---|---|---|---|
| **The Donald R. Wilson Center for Research in Education (Wilson Centre)** | 1997 | $1 million | $6.2 million<br>Currie Chair<br>BMO Chair<br>Reznick Research Day Fund | >70/year | 100/year | 10 scientists<br>36 fellows<br>160 members |
| **The Temerty/Chang Telesimulation Centre** | 2010 | $200,000 | $5 million | 1-2/year | 5/year | 1 coordinator<br>2 research fellows<br>10 collaborators |
| **The Ho Ping Kong Centre for Educational Excellence and Practice (CEEP)** | 2009 | $100,000 | $5 million<br>Chang Chair | 1-2/year | 20/year | 3 fellows<br>20 members |
| **The Centre for Interprofessional Education (CIPE)** | 2009 | $750,000 | $750,000<br>Kalmar Centre | 3-5/year | 10/year | 5 scholars<br>many collaborators |

# APPENDIX

The following documents are provided by and represent input from TRI, Nursing & Allied Health and other UHN sources. They will be appended in full with the final draft of this Roadmap.

- **Technology for Health, Safety and Medicine (TRI)**
- **Globalization and Society**
- **Nursing & Allied Health**

# GLOSSARY OF TERMS & ABBREVIATIONS

| *Term* | *Definition* |
|---|---|
| ABI | Acquired Brain Injury |
| ACD | Advanced Clinical Documentation |
| CAPCR | Coordinated Approval Process for Clinical Research |
| CCRM | Centre for Commercialization of Regenerative Medicine |
| CDM | Clinical Data Management |
| CFI | Canada Foundation for Innovation |
| CCRB | Centre for Cellular and Biomedical Research |
| CGEI | Centre for Global eHealth Innovation |
| cGTA | Connecting GTA |
| CICC | Centre for Innovation in Complex Care |
| CITN | Cancer Immunotherapy Trials Network |
| COMBIEL | Cancer Outcomes Medicine Biostatistics Informatics Epidemiology Laboratory |
| COLT | Centre for Cellular and Biomedical Research – Ontario Institute for Cancer Research Lentiviral Technologies |
| CLIA | Clinical Laboratory Improvement Amendments |
| DART | Distress Assessment and Response Tool |
| EEG | Electroencephalography |
| eHealth | The use of information and communication technologies to enhance health care |
| EPR | Electronic Patient Record |
| ELLICSR | Electronic Living Laboratory for Interdisciplinary Cancer Survivorship Research |
| EXCITE | MaRS Excellence in Clinical Innovation and Technology Evaluation |
| GCP | Good Clinical Practice |
| GMP | Good Manufacturing Practice |
| GTx | Guided Therapeutics Program |
| HCCE | Health Care Computational Engines |
| HCP | Health Care Professional |
| HELP | Hospital Elder Life Program |

| | |
|---|---|
| hESC | Human Embryonic Stem Cells |
| hPSC | Human Pluripotent Stem Cells |
| ICES | Institute for Clinical Evaluative Sciences |
| ICU | Intensive Care Unit |
| IHPME | Institute of Health Policy, Management and Evaluation |
| iPSC | Induced Pluripotent Stem Cells |
| JDMI | Joint Department of Medical Imaging |
| KCCC | Kuwait Cancer Control Centre |
| MEG | Magnetoencephalography |
| MOHLTC | Ministry of Health and Long-Term Care |
| MRI | Magnetic Resonance Imaging |
| MR-PET | Magnetic Resonance Positron Emission Tomography |
| MS | Mass Spectrometry |
| NanoMedFab | A Nanofabrication Centre for Personalized Medicine |
| NIH | National Institutes of Health |
| NMR | Nuclear Magnetic Resonance |
| OICR | Ontario Institute for Cancer Research |
| OR | Operating Room |
| PET | Positron Emission Tomography |
| PMCC | Peter Munk Cardiac Centre |
| SLRI | Samuel Lunenfeld Research Institute |
| STTARR | Spatio-Temporal Targeting and Amplification of Radiation Response Innovation Centre |
| TBI | Traumatic Brain Injury |
| TDC | UHN's Office of Technology Development and Commercialization |
| telemedicine | The delivery of health care from a distance using electronic information and communication technology. |
| teleradiology | Teleradiology is the transmission of radiological patient images, such as x-rays, CTs, and MRIs, from one location to another for the purposes of interpretation and/or consultation |
| THETA | Toronto Health Economics and Technology Assessment |
| TRIGOR-A | Translational Research Image Guided Operating Room-A |
| TWH CT-PET | Toronto Western Hospital's Computed Tomography Positron Emission Tomography |

| | |
|---|---|
| WSIB | Workplace Safety and Insurance Board |