

Data & Analytics Student Program Guide for Master of Applied Science (MASc) with Focus on Healthcare Engineering

In Partnership with the UHN Data & Analytics Student Program

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University Health Network

Transforming lives and communities through excellence in care, discovery and learning.



Providing care to the community for more than 200 years, UHN is a major landmark in Canada's healthcare system and a teaching hospital of the University of Toronto

#5 in the World
Toronto General Hospital



#9 Specialized Hospital in the World
Princess Margaret Cancer Centre



#1 in Canada
Research and Commercialization



International Gold Winner
Green Hospital



5 Hospitals

- Toronto General Hospital
- Toronto Western Hospital
- Princess Margaret Cancer Centre
- Toronto Rehabilitation Institute (6 sites)
- West Park Healthcare Centre

2 Collaborative Centres

2 Foundations

- UHN Foundation
- The Princess Margaret Cancer Foundation

6 Research Institutes

1 School

Michener Institute of Education at UHN

9

Education Centres of Excellence

1,258 Beds
43,625 Inpatients
1,441,322 Outpatient Visits
125,927 ED Visits
\$2.6B Revenue
\$405M External Research Funding
14,318 Employees
1,690 MDs
2,078 Research Personnel
11,000 Students

15 Clinical Programs

- Ajmera Transplant
- Altum Health
- Emergency Department
- Joint Department of Medical Imaging
- Krembil Brain
- Laboratory Medicine
- Long Term Care/Transitional Care
- Primary Care
- Princess Margaret Cancer
- Rehabilitation
- Schroeder Arthritis
- Sprott Surgery & Anesthesiology
- Medicine
- Mental Health
- Peter Munk Cardiac

**Transforming lives and communities
through excellence in
care, discovery and learning**



UHN Data & Analytics

Enabling UHN in transformative, measurable and data-informed healthcare improvement.



UHN Data & Analytics supports UHN's growing demand for data and data-driven insights and helps TeamUHN ensure the needs of patients come first

VISION

Enabling insight

MISSION

To enable UHN in transformative, measurable and data-informed healthcare improvement.



MICHAEL CAESAR
CHIEF DATA & ANALYTICS OFFICER

UHN DATA & ANALYTICS

Overseeing UHN's Data & Analytics Department and Co-chairs UHN's Data Governance Committee.



TERRA IERASTS
DIRECTOR

PERFORMANCE IMPROVEMENT & EXCELLENCE

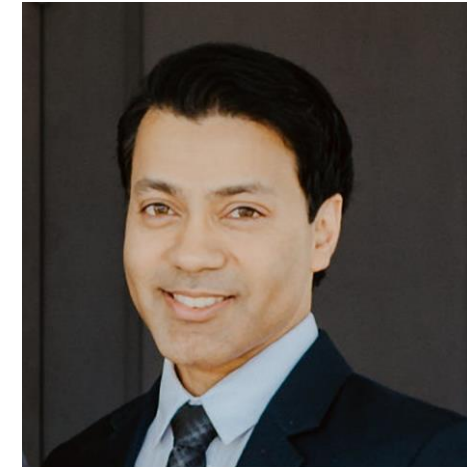
Understand & partner with TeamUHN providing performance insight and opportunity for improvement that help TeamUHN solve problems and improve the effectiveness, quality and safety of care by using data.



TAHA KHAN
MANAGER

STRATEGY & TRANSFORMATION

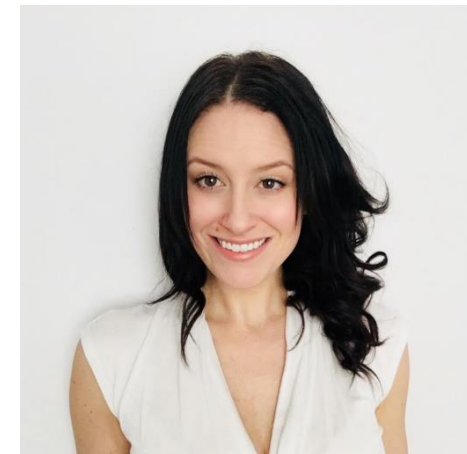
Facilitate the development of department-wide strategies and translate these into actionable plans, monitor their performance, and report on the effectiveness.



ANDRÉ D'PENHA
DIRECTOR

DATA STRATEGY, GOVERNANCE & ANALYTICS

Establish data governance, advance data literacy, and leverage predictive and simulation-based analytics to address care and operational challenges.

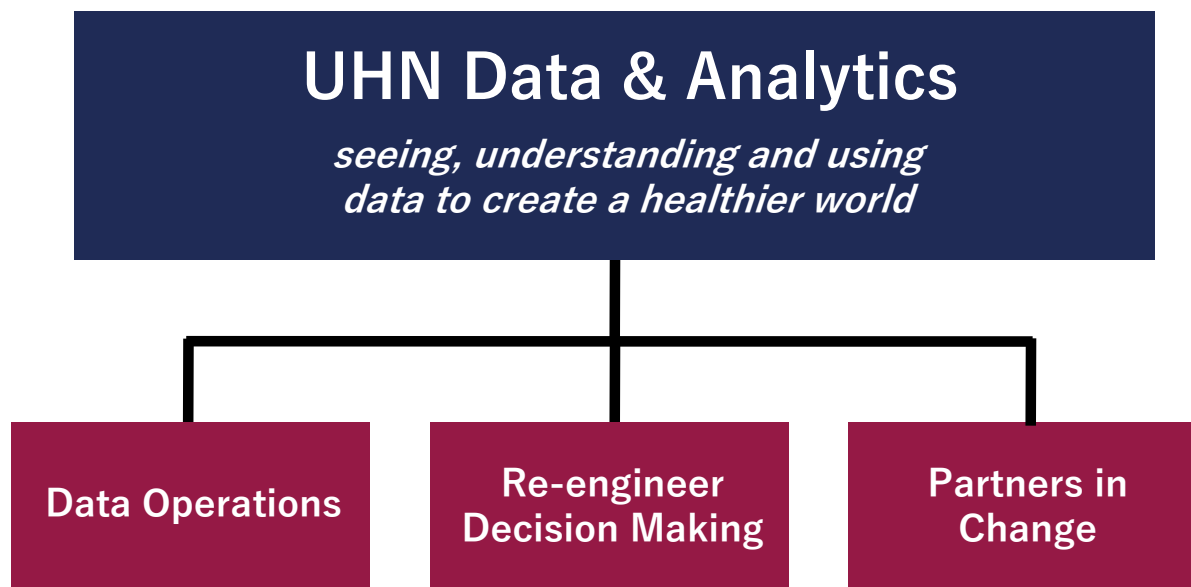


SHANNON DOUGLAS
DIRECTOR

BUSINESS INTELLIGENCE & AUTOMATION

Design, build and deliver data analytics, automation and decision tools to improve decision making and support on-going strategic initiatives and hospital operations.

About UHN Data & Analytics



Key Synergies

- Support impactful delivery of value to the health system
- Discover, validate, design and deliver opportunities of change
- Contextual awareness to ensure successful implementation

Building Organizational Capabilities

Data Operations

- Support manage data stores
- Enable access and use of data
- Support the organization in understanding ontologies and data definitions
- See and understand data quality
- Manage the data life-cycle - capture, use, purge

Re-engineering decision making

- Support decisions & enabling transparency in all that we do
- Build and implement new tools (descriptive, diagnostic, predictive, prescriptive)
- Data literacy - improve the understanding and use of data
- Enable the organization to make better, faster, more accurate decisions

Partners in change

- Understanding of the business (operations & strategy)
- Performance improvement - support focused and measurable improvement
- Understand, anticipate, interpret & translate business processes
- Support the convergence of enterprise and local strategies
- Manage risk and highlight opportunities

UHN Data & Analytics Student Program

Bridging academia, research and analytics to drive learning, improve outcomes, and support data-informed decisions.

UHN Data & Analytics Student Program



9 Years of Partnership



45 Undergraduate Students



15 Graduate Students



8 UHN Departments & Programs

A Collaborative Partnership with Academia

By connecting academia, research, data and technology the program creates opportunities for learning and discovery that enable UHN to better understand operational processes, improve patient outcomes and inform clinical decision-making.

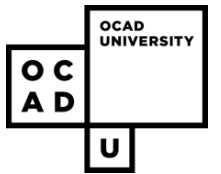
SUPPORTED STUDENTS

- Master of Applied Sciences (MASc) & PhD
- Master of Engineering
- Master of Health Informatics (MHI)
- Master of Business Administration (MBA)
- Health Information Management Students
- Capstone Engineering Students
- Undergraduate Summer Students
- Graphic Design Students

OUR PARTNERS



Institute of Health Policy, Management and Evaluation
UNIVERSITY OF TORONTO



UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING



UHN Canada's Hospital

Program Opportunity & Value



COLLABORATE within the UHN ecosystem to build analytics capability and capacity that supports care, learning, discovery, and operational insights



ACCESS rich and complex clinical data that is of interest to the broader analytics community



CREATE mechanisms to unlock the value of data generated during the provision of care or completion of operational activities



DEVELOP skillsets in simulation, predictive modeling, automation, statistical analysis, process improvement, project management and change management



TRANSLATE theoretical knowledge into practical solutions that benefit healthcare and patient communities



NETWORK with key UHN clinical, corporate, and technical contacts to further future career opportunities

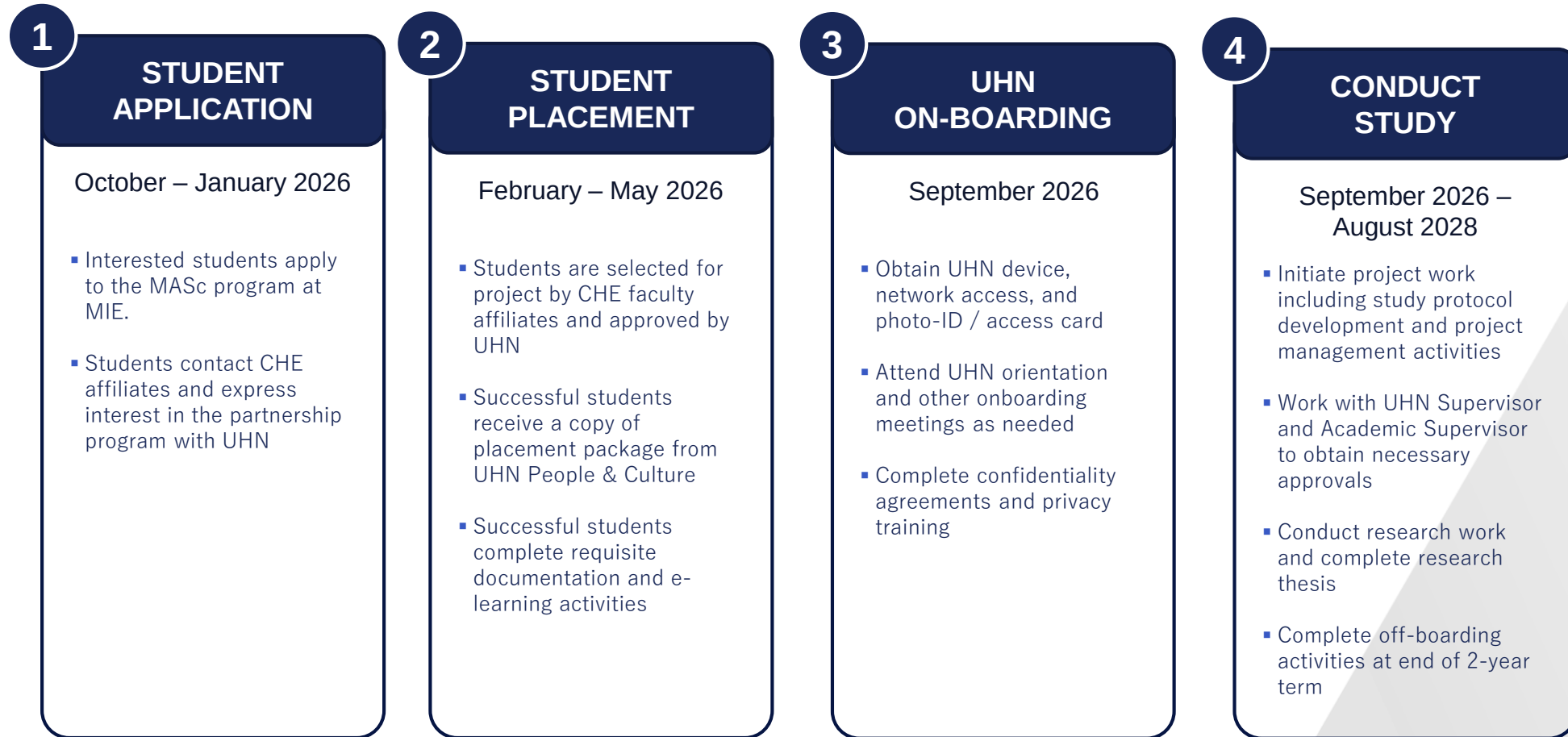
WHO IS ELIGIBLE?

- MASc Candidates at MIE

DETAILS

- Two-year funded full-time [MASc program at MIE](#) supervised by a CHE faculty affiliate
- One- or two-year part-time placement at UHN
- Research topic related to areas of priority at UHN, which could be fundamental in nature, or applied, incorporating creative design

Timeline & Placement Process



Recent MASc & PhD Student Projects

PATIENT FLOW AND FORECASTING: AI APPLICATION



Emma PIENAAR
MASc, UofT (June 2018)

Define and validate a generalized hospital simulation model, define and test over-capacity protocols, and expand the model to include real-time forecasting

INNOVATION IN LOW BACK PAIN CARE



Jing GUO
MASc, UofT (June 2018)

Evaluate the ISAEC model for its clinical and economic benefits for low back pain patients in Ontario

READMISSION PREDICTION & PREVENTION



Emma ZHANG
MASc, UofT (December 2019)

Understand the impact on readmission rates in liver disease patients when given additional follow-up care from the NP-led post discharge program

BED CAPACITY PLANNING MODELING



Melina FARTAJ
MASc, UofT (January 2022)

Develop and implement general hospital simulation models that inform medium and long-term bed capacity planning decisions through simulation and scenario testing

QUALITY & SAFETY PRIORITIES FOR IMPROVEMENT ANALYTICS SOLUTION: OPERATIONALIZATION



Jared CHIU
MASc, UofT (August 2024)

Improve patient safety by leveraging machine-learning models contextualized for clinical and operational decision-making

QUALITY & SAFETY PRIORITIES FOR IMPROVEMENT ANALYTICS SOLUTION: RISK STRATIFICATION



Shehnaz ISLAM
MASc, UofT (August 2024)

Leverage natural language processing-based prediction models for event severity and risk factors based on free-text incident reports within UHN's Safety Event Reporting System

CRITICAL CARE PREDICTED OCCUPANCY MODEL



Susana SU
MASc, UofT (August 2026)

Leverage predictive and prescriptive analytics to forecast ICU demand, optimize resource allocation and support proactive, system-level decision-making across UHN's critical care network

CLASSIFICATION OF SAFETY EVENTS PHASE II



Rob CHEN
PHD, UofT (August 2027)

Enhance machine learning models trained on historical SERS data to accurately classify and rank safety events by severity and risk management codes, improving incident triage and enabling more targeted safety interventions

Recent Awards, Publications & Recognitions

AWARDS

- 2x Student Recipients of the King Charles III Coronation Medal from Ontario's Ministry of Health
- 2024 HIROC Safety Grant Recipient

PUBLICATIONS

- Naghshbandi M, Huang S, Shah H, et al. Evaluation of a nurse practitioner-led post-discharge transitional care program for patients with liver disease: A retrospective cohort study. *Canadian Liver Journal*. 2024;7(4) <https://utppublishing.com/doi/10.3138/canlivj-2024-0020>
- Chui J, Sarhangian V, Tosoni S, et al. Associations of hospital unit occupancy with inpatient falls and fall-risk assessment completion: a retrospective cohort study. *International Journal for Quality in Health Care*. 2025; 37(2) <https://doi.org/10.1093/intqhc/mzaf028>
- Pozzobon L, Tattersall A, Tosoni S, et al. A balanced approach to using organizational patient safety incident data for research. *Healthcare Management Forum*. 2025; 38(4) <https://doi.org/10.1177/08404704251331179>

OTHER

- Using Machine Learning and Natural Language Processing to Classify Patient Safety Event Reports; Oral Presentation at Centre for Quality Improvement and Patient Safety (CQIPPS) Annual Symposium (2024)
- Canadian Healthcare Technology. Students help improve patient safety at UHN. 2024. <https://www.canhealth.com/2024/08/14/students-help-improve-patient-safety-at-uhn/>

Centre for Healthcare Engineering, UofT

Pioneering data-driven research to improve system efficiency and enhance patient care



UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING
Centre for Healthcare Engineering



UHN Canada's
Hospital

CENTRE FOR HEALTHCARE ENGINEERING



The Centre for Healthcare Engineering at the University of Toronto supports industrial engineering professors who pioneer data-driven research to improve system efficiency and enhance patient care.

The Centre provides a bridge between academia and the healthcare sector, translating the latest research findings to impact practice and offering educational opportunities for students and practitioners.



UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING
Centre for Healthcare Engineering

Centre for Healthcare Engineering

Founded in 2008 at the
Department of Mechanical and
Industrial Engineering (MIE).

Affiliated graduates to date:

- **17** Postdoctoral Fellows
- **45+** PhD
- **90+** MASc
- **6** MHSc
- **60+** MEng
- **85+** Undergraduate Thesis
- **170+** Undergraduate Summer
- **290+** Undergraduate Capstone

Research outputs:

- **300+** Journal Publications
- **650+** Distinct Media Mentions

Operations Research



Carter



Khalil



Chan



Lee



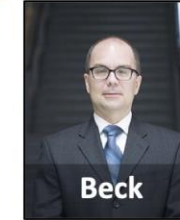
Frances



Rao



Sarhangian

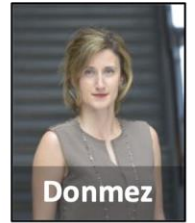


Beck



Sanner

Human Factors



Donmez



Alfred



Milgram



Chignell



Montague



Cohen

Information Engineering



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Centre for Healthcare Engineering

High Priority Areas of Interest at UHN

Example projects for prospective MASc students and their professors



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Centre for Healthcare Engineering



UHN Canada's
Hospital

High Priority Areas of Interest at UHN

	 CARE VARIATION - SURGERY	 BLOOD DRAW OPTIMIZATION	 GERIATRIC CARE PREDICTION MODEL	 PRE-OPERATIVE RISK SCORE	 INFECTION PREVENTION & CONTROL
PROJECT DESCRIPTION	Investigate where surgical care variation exists and its impacts on quality and resources	Explore opportunities to strike a balance between essential diagnostic information and minimizing the burden on patients	Explore opportunities to predict delirium and likelihood for admission with prolonged length of stay for geriatric ED patients	Explore opportunities to predict patient risk level and required interventions prior to surgery in order to reduce risk, support resource allocation and improve outcomes	Explore opportunities to optimize ED flow and resources to minimize respiratory virus spread and predict/simulate outbreak risk.
STUDY DELIVERABLES	Conduct a retrospective study to determine the areas of surgical care variation at UHN and their main drivers Develop an optimization model to maximize quality of care while minimizing cost and/or other resource utilization	Analysis of inpatient bloodwork to compare against best practices, peers Conduct an analysis to identify a threshold for excessive testing and assess correlation of draws with anemia risk Create a proposal to reduce instances of blood draws	A model that predicts risk for delirium, prolonged LOS, and preventable readmissions to help prioritize geriatric care Recommendations for how the risk model can be embedded into ED triage or clinical decision-making workflows	A prediction model to identify patient risk level with required interventions to manage risk and support resource allocation to highest need patients Strategy for implementing the risk model into surgical scheduling and triage workflows	Conduct a retrospective study on the spread of respiratory infections in the ED and their main drivers. Develop an optimization model to minimize hospital acquired infections. Develop simulation and prediction models to assess risk.

Care Variation – Surgery

SEPT 2026 to AUG 2028

PROBLEM STATEMENT

- There is a need to understand where surgical care variation exists and its impacts on quality and resources.
- There is a need to understand how to optimize standards to reduce variation, improve quality and optimize resources.

CURRENT STATE

- An analysis was conducted to investigate resource utilization across various surgical procedures.
- The implementation of cost standardization aims to optimize and reduce the overall expenses associated with surgery while maintaining quality.

CURRENT CHALLENGES

- Resource utilization within the surgical program varies between surgeons.
- The potential impact of standardizing resources on the quality of surgical procedures remains uncertain.

KEY PLAYERS

- UHN Surgical team
- UHN Finance
- Ms. Terra Ierasts, Director of Performance Improvement & Excellence

POTENTIAL SOLUTIONS

- Conduct a retrospective study to determine the areas of surgical care variation at UHN and their main drivers.
- Develop an optimization model to maximize quality of care while minimizing cost and/or other resource utilization.

RESEARCH QUESTIONS

- To what extent does variation in resource utilization among surgeons within the surgical program impact the quality of performed surgeries, and how might the implementation of further standards influence surgical outcomes and resource utilization?

Blood Draw Optimization

SEPT 2026 to AUG 2028

PROBLEM STATEMENT	CURRENT STATE	CURRENT CHALLENGES
▪ Inpatient blood ordering and sample collection practices often lead to an excessive number of blood draws per patient. This frequent blood drawing not only poses discomfort to patients but also contributes to increased risk of hospital acquired anemia. ▪ There is a need to optimize these processes to strike a balance between obtaining essential diagnostic information and minimizing the burden on patients.	▪ Increased blood orders heighten the risk of hospital-acquired anemia, impacting patient experience. ▪ Some blood tests may be redundant, contributing to unnecessary draws without significantly altering patient management or treatment plans. ▪ Excessive investigations may occasionally delay patient discharge, highlighting the need for resource optimization.	▪ Excessive blood draws can lead to patient discomfort, increased risk of complications (e.g., infection, anemia) and decreased overall satisfaction with the healthcare experience. ▪ Changes in reducing bloodwork may be perceived as a reduction of autonomy for ordering physicians. ▪ Patient complexity would be considered a factor in preparation of recommendations.
KEY PLAYERS	POTENTIAL SOLUTIONS	RESEARCH QUESTIONS
• Dr. Kathryn Tinckam, Physician-in-Chief • Vice President Clinical • Ms. Terra Ierasts, Director of Performance Improvement & Excellence	▪ Analysis of inpatient bloodwork to compare against best practice and peers and to assess correlation of blood draws and risk of hospital-acquired anemia. ▪ Analysis on the time of day samples with respect to other workflows (e.g., rounds). ▪ Conduct an analysis to identify a threshold for excessive testing. ▪ Create a proposal to reduce instances of blood draws.	▪ Is there a significant correlation between the blood draws and the heightened risk of hospital-acquired anemia, impacting patient experience? ▪ How can modifications to order sets be proposed to optimize resource utilization while addressing concerns about perceived reduction in autonomy for ordering physicians and considering patient complexity as a factor in preparation of recommendations?

Geriatric Care Prediction Model

SEPT 2026 to AUG 2028

PROBLEM STATEMENT

- Older adults are over-represented in ED visits, often presenting with complex, atypical and non-specific symptoms.
- The UHN Seniors' Emergency Medicine Centre is designed to intervene early with multi-disciplinary care to reduce non-medical admissions, shorter hospital lengths of stay, and prevent adverse outcomes such as delirium for a subset of older ED patients.
- Current risk assessment tools have a high rate of false positives, while less structured assessments are time-consuming and not suited to the unique challenges of modern EDs.

CURRENT STATE

- There is a wealth of new and current information at triage that can be used to calculate a risk score in the background and identify the crucial subset of patients, acting as an evidence based adjunct to provider judgment.

CURRENT CHALLENGES

- Conditions like delirium, frailty and functional decline are difficult to identify upon initial patient presentation.
- Identifying which patients would benefit maximally from early intervention is not well understood, although some screening tools do exist.
- The allied health team and the physical space in the SEMC are both finite resources, making it all the more important to choose carefully which patients get the most intensive interventions.

KEY PLAYERS

- Dr. Tessa Ringer, Medical Director, Myrna Daniels Seniors Emergency Medicine Centre
- Alexa Boblitz, Data Lead, Myrna Daniels Seniors Emergency Medicine Centre
- Dr. Lauren Lapointe-Shaw, Director of Research, Myrna Daniels Seniors Emergency Medicine Centre
- Sylvia Quant, Quality Improvement Lead, Myrna Daniels Seniors Emergency Medicine Centre
- Ms. Terra Ierasts, Director of Performance Improvement & Excellence

POTENTIAL SOLUTIONS

- NLP or discrete classification models that categorize patients based on triage data, clinical notes and/or patient history to identify those patients who would benefit most from early intervention as well as intervention type.
- Risk stratification scores for each delirium, likelihood of readmission and prolonged LOS.

RESEARCH QUESTIONS

- Is it possible to predict geriatric patients most likely to succumb to delirium while in ED?
- Is it possible to predict geriatric patients who would benefit most from early intervention to reduce likelihood of admission, prolonged length of stay or re-admission?
- Can a prediction model recommend the type of early intervention that would provide maximum benefit based on patient presentation?
- Is it possible to create risk scores for delirium, readmissions and prolonged LOS?

Pre-Operative Risk Score

SEPT 2026 to AUG 2028

PROBLEM STATEMENT

- Surgical patients vary in complexity and may require different levels of pre-operative care.
- Ability to stratify patients by risk level and identify appropriate care interventions can help target resources to highest need patients enabling an outcomes-focused approach.
- Example populations for focus include orthopedic surgical patients, highly complex surgical patients and/or patients currently requiring low lengths of stay that with appropriate interventions could move to same day discharge.

CURRENT STATE

- There is no standardized, data-driven tool to stratify surgical patients by risk level.
- Resource allocation is currently determined by procedure type; opportunities exist to create personalized care experiences and allocate resources based on specific patient needs and targeted outcomes.
- A standardized patient-reported questionnaire launching Fall 2025 offers an opportunity to collect additional data to inform a predictive model.

CURRENT CHALLENGES

- Increasing surgical volumes strain pre-op teams, making accurate and efficient triage processes and resource allocation more critical than ever.
- Patient information collected during pre-admission and patient medical history is not currently leveraged for predictive analytics.
- Additional work is required to identify the specific patient population to target as well as desired outcomes.

KEY PLAYERS

- Dr. Keyvan Karkouti, Head, Department of Anesthesia and Pain Management
- Dr. Tariq Esmail, Director, Quality & Safety, Department of Anesthesiology and Pain Management
- Dr. Kyle Kirkham, Director, Informatics, Department of Anesthesiology and Pain Management
- Ms. Terra Ierasts, Director of Performance Improvement & Excellence

POTENTIAL SOLUTIONS

- Develop a predictive stratification model to identify patient risk level with required interventions to manage risk and support resource allocation to highest need patients.
- Identify a strategy for implementing the risk model into surgical scheduling and triage workflows.

RESEARCH QUESTIONS

- Can medical history combined with patient-reported information be used to develop a risk stratification score and identify appropriate care interventions?
- Can algorithm-driven stratification scores inform clinical workflow, resource allocation and overall inform post operative planning?
- Can the use of a prediction model help to improve patient outcomes and reduce strain on limited healthcare resources?

Infection Prevention & Control

SEPT 2026 to AUG 2028

PROBLEM STATEMENT

- Respiratory illnesses such as influenza, RSV and COVID-19 pose risks to patients in the emergency department (ED) and can contribute to hospital-wide outbreaks as well as community spread.
- The ED is a primary point of hospital entry that experiences high patient volumes, crowding and extended wait times, all of which amplify the challenge of containing respiratory illness spread.
- Ability to optimize flow, bed placement and allocation of resources can help to minimize infection spread.
- Ability to predict likelihood of spread and simulate risk can also help to minimize future outbreaks.

CURRENT STATE

- Allocation of resources, such as isolation beds, is based on hospital policy and triaging based upon risk.
- Optimization, simulation or prediction models are not currently used to manage infection spread in the ED and between the ED and other hospital areas.

CURRENT CHALLENGES

- The ED is a complex environment with physical limitations impacting the ability to isolate and high patient traffic/movement.
- Patients visiting the ED may present with respiratory symptoms, but the exact nature at triage is typically undeclared.
- Although in general the drivers of infection spread are understood, little is known of their respective impact to contribute to spread within the ED.

KEY PLAYERS

- Dr. Beate Sander, Chair Health System and Policy Research Collaborative Centre
- Dr. Susy Hota, Division Head Infectious Diseases, UHN and Sinai; Medical Director IPAC, UHN
- Ms. Carly Rebelo, Director, IPAC & Antimicrobial Stewardship
- Dr. Alon Vaisman, Infectious Diseases and Infection Control Physician
- Ms. Terra Ierasts, Director of Performance Improvement & Excellence

POTENTIAL SOLUTIONS

- Conduct a retrospective study on the spread of respiratory infections in the ED and their main drivers.
- Develop an optimization model to minimize hospital acquired infections.
- Develop a simulation model to simulate risk of infection spread for different bed holding locations.
- Develop a prediction model to assess risk of infection spread from ED cases and ED acquired cases to other inpatient units and the community.

RESEARCH QUESTION

- What are the main drivers of respiratory virus infection spread in an ED setting and what is their respective contribution to illness spread?
- How can the spread of infections be optimally minimized and how should resources be allocated within these optimal scenarios?
- Can risk of virus spread within and external to EDs be proactively assessed?
- Can the likelihood of virus spread be predicted for inpatient areas and the community?

QUESTIONS? CONTACT US

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