2020/05/28

Re: NSERC Alliance COVID-19 Grant entitled "*Clinical Triage Protocol for Major Surge in COVID-19 Pandemic - Aiding and Recording Patient Management Decisions"*

Dear COVID-19 Alliance Grant Review Committee,

The enclosed application for funding of the project is a collaboration between faculty at the University of Ottawa and the Ottawa Department of Medicine, not-for-profit (Ottawa DOM) organization. Ottawa DOM is seeking to collaborate with the faculty to develop and deploy a digital tool to assist in clinical implementation of the Ontario Health's *Clinical Triage Protocol for Major Surge in COVID Pandemic.*

The tool will serve two roles:

1) Aid healthcare teams in real-time decision making of which patients presenting with COVID-19 should be admitted to the intensive care unit (ICU) or be maintained in the ICU and which patient should be discharged, to optimize clinical outcomes (survival) based on patient clinical information and ICU occupancy.
2) Capture information on actual admission decisions to measure adherence to the protocol, gauge outcomes and inform modifications of the triage protocol to improve clinical outcomes. The analyses will integrate with ICU utilization databases and health record to empower data-driven improvements to the triage protocol.

The primary objective of this program is to enable optimal ICU resource utilization in the event of a surge in COVID-19 cases. Nevertheless, the tool will enable to capture data also during stable phases of the pandemic to inform planning. This tool will build a lasting infrastructure for future pandemics and other healthcare challenges in which a surge in demand requires effective, proportional and fair triaging.

Ottawa DOM is mandated to assist translation of medical research into clinical practice. Ottawa DOM is in advanced stages towards formalizing an agreement with Microsoft Canada to collaborate of tools to combat COVID-19. As part of this agreement, Microsoft has agreed in principle to make computing and software development resources available to Ottawa DOM and its collaborators free of charge (estimated value ~$250K). While the proposal assumes that this agreement be ratified by the end of June 2020, Ottawa DOM and the University of Ottawa have access to alternative computing resources and software development knowhow to meet the objectives laid herein.

The team is comprised of subject matter experts that can confidently complete the project in a short time frame imposed by the current pandemic.

Sincerely,

Ran Klein, PhD Elec Eng
University of Ottawa, Department of Medicine

Natural Sciences and Engineering Research Council of Canada | Conseil de recherches en sciences naturelles et en génie du Canada

Institutional Identifier		Date
System-ID (for NSERC use only) 441406753	**FORM 101 Application for a Grant PART I**	2020/06/01

Family name of applicant	Given name	Initial(s) of all given names	Personal identification no. (PIN)
Klein	Ran	R	**Valid** 282850

Department	Institution that will administer the grant
Medicine, Faculty of	Ottawa

Language of application: [X] English [ ] French

What is the proposed cost-sharing ratio for this application? 100%

Type of grant applied for: Alliance Grants

Title of proposal: Clinical Triage Protocol for Major Surge in COVID-19 Pandemic - Aiding and Recording Patient Management Decisions

Provide a maximum of 10 key words that describe this proposal. Use commas to separate them.

COVID-19, Triage, Decision support, Mobile application, Data collection, Resource allocation

Research subject code(s)		Area of application code(s)	
Primary	Secondary	Primary	Secondary
9000	2804	1101	1211

CERTIFICATION/REQUIREMENTS

If this proposal involves any of the following, check the box(es) and submit the protocol to the university or college's certification committee.

Research involving : [X] Humans [ ] Human pluripotent stem cells [ ] Animals [ ] Biohazards

Indicate if any phase of the proposed research takes place outdoors and if you answered YES to a), b), c) or d), you must complete and attach Appendix A. See instructions for the Environmental Information Form. [X] NO [ ] YES

TOTAL AMOUNT REQUESTED FROM NSERC

Year 1	Year 2	Year 3	Year 4	Year 5
50,000	0	0	0	0

SIGNATURES (Refer to instructions "What do signatures mean?")

It is agreed that the general conditions governing grants as outlined in the NSERC *Program Guide for Professors* apply to any grant made pursuant to this application and are hereby accepted by the applicant and the applicant's employing institution.

Applicant

Applicant's department, institution, tel. and fax nos., and e-mail

Medicine, Faculty of
Ottawa
Tel.: (613) 7614072
rklein@toh.ca

Head of department

Dean of faculty

President of institution (or representative)

The information collected on this form and appendices will be stored in the Personal Information Bank for the appropriate program.

PROTECTED B WHEN COMPLETED

Canada

Personal identification no. (PIN)	Family name of applicant
Valid 282850	Klein

CO-APPLICANTS

I have read the statement "What do signatures on the application mean?" in the accompanying instructions and agree to it.

PIN, family name and initial(s)	Organization	Signature
572168, Downar, JASD	Ottawa	
Tanuseputro, PT	Ottawa	

Personal identification no. (PIN)	Family name of applicant
Valid 282850	Klein

Before completing this section, read the instructions for the definition of collaborators in the Eligibility Criteria section of the Program Guide for Professors.

COLLABORATORS

PIN, family name and initial(s)	Organization / Department
Wu, S	Ottawa Department of Medicine, Not-for-profit,
Dhillon, D	Ottawa Department of Medicine, Not-for-profit,
Menon, A	Ottawa Department of Medicine, Not-for-profit,
Carrington, A	Ottawa Department of Medicine, Not-for-profit,

Personal identification no. (PIN)	Family name of applicant
Valid 282850	Klein

SUMMARY OF PROPOSAL FOR PUBLIC RELEASE (Use plain language.)

This plain language summary will be available to the public if your proposal is funded. Although it is not mandatory, you may choose to include your business telephone number and/or your e-mail address to facilitate contact with the public and the media about your research.

Business telephone no. (optional): 1 (613) 7614072

E-mail address (optional): rklein@toh.ca

The COVID-19 pandemic has been the most devastating medical crisis since World War II, forcing health care professionals to make challenging and ethically-driven decisions as the pandemic brings a surge in critically ill patients to hospital emergency rooms around the world. In response to the medical emergency, Ontario Health developed a Clinical Triage Protocol for Major Surge in COVID-19 Pandemic, led by Dr. James Downar, the Head of Division of Palliative Care at the University of Ottawa. The Clinical Triage Protocol is a decision tool that would be used by health care providers if a major surge in demand for critical care resources required them to make difficult decisions about how to ration critical care beds and ventilators. The objective of this project and proposed partnerships is to develop a digital decision tool which provides physician access to the most updated COVID-19 Triage Protocol in Ontario and across Canada. This will be achieved by converting a complex triage algorithm into a user-friendly digital platform that doctors across Canada can use at the bedside during surge and non-surge periods. In addition, the digital tool will enable collection and sharing of data on the use of the triage protocol, allowing for feedback and informed revisions and data-driven improvements of the protocol itself. The proposed partnerships among the Ottawa Department of Medicine (Ottawa DOM) not-for-profit and a planned collaboration with the Microsoft Corporation (partner of the Ottawa DOM), will ensure rapid development and distribution of the application. Access to the state-of-the-art technologies, algorithm development and technical support will be utilized in tandem with the academic advisory services offered by Ottawa DOM in order to enable timely project development. Our proposed digital platform will aid in the appropriate allocation of critical care resources and capacity planning across the region based on the degree of patient admissions and levels of triage in different facilities. This system will help implement better pandemic preparedness overall as well as allow better planning for hospital resources for COVID-19 and possible future pandemics.

Other Language Version of Summary (optional).

Clinical Triage Protocol for Major Surge in COVID-19 Pandemic - Aiding and Recording Patient Management Decisions

Relevance and expected outcomes

With around 200,000 deaths across the world, the COVID-19 crisis has been the most devastating medical crisis since World War II, forcing doctors to make very challenging decisions. As the pandemic brings floods of critically ill patients to hospital emergency rooms around the world, physicians are struggling to triage the patients and trying to determine which ones will need intensive care. News reports from Italy and New York City have contained harrowing stories of physicians and nurses needing to make difficult ethical decisions to ration critical care beds and ventilators in light of COVID-19, often with little preparation or clinical guidance. A triage protocol can help in saving lives through implementation of a standardized guideline that applies to patients who may need critical care resources, providing guidelines that would maximize the benefit of scarce medical resources.

The Ontario Government has developed a "triage protocol" in the case of a surge of demand for intensive care unit (ICU) beds that exceeds capacity, to be used by doctors who may be forced to make ethically fraught decisions over how to ration critical care beds and ventilators, shaping life-or-death choices over which patients to prioritize. Dr. James Downar, Head of Division of Palliative Care at the University of Ottawa, led the development of Ontario Health's *Clinical Triage Protocol for Major Surge in COVID Pandemic*[1] (attached). It has subsequently been adopted by other provinces, including Quebec, British Columbia and Newfoundland and is expected to undergo revision based on new data and feedback.

The protocol is based on the three key principles of Utility, Proportionality and Fairness and has three levels, depending on the degree of the surge in demand, with each level having 13 criteria that identify those least likely to survive even with critical care resources. At Level 1, the criteria – which are supplemented by clinical judgement – aim to exclude or discharge those with greater than 80% predicted mortality. At Level 2 and Level 3, exclusion based on expected mortality is revised to 50% and 30%, respectively. These criteria would be applied to new referrals, as well as to patients already admitted to the ICU.

Although triage decisions are fairly common in medicine (e.g. emergency waiting rooms, organ waiting lists), a Critical Care triage system has never been implemented on a large scale for a viral pandemic. Triage systems are clinical decision tools, but they are heavily value-laden and there is a public concern in determining whether they are achieving their objective. Thus, we have a moral imperative to measure the effects of our triage protocol and ensure it's being implemented in a transparent and equitable manner.

The protocol itself is considered a "green" document, which can be updated based on new data and feedback. There is a need to provide real-time access to the latest, most updated version of the protocol to physicians at the bedside. Moreover, there is a need for a system to collect data on real patients affected by the triage system, to allow for near real-time feedback to Critical Care leads about how the protocol is being used. In addition, because the expected major surge in demand may be some weeks or months in the future, we can collect information about the outcomes of real patients admitted in non-triage periods to develop predictive models to inform us about how the protocol might function in a future surge and help to improve it using objective, data-driven metrics. This project will convert the triage algorithm into a user-friendly digital tool that doctors across Canada can use during surge and non-surge periods.

The objective of this project is to mobilize research knowledge into action and develop a digital tool based on the most recent iteration of the 'Clinical Triage Protocol for Major Surge in the COVID-19 Pandemic' to aid health-care workers in deciding which patients to admit to the ICU and to record a final decision. Two main development challenges will be addressed during this project:

1) Development of a mobile app and backend server enabling immediate system wide update of the

[1] *March 28, 2020. Ontario Health. https://caep.ca/wp-content/uploads/2020/04/Clinical-Triage-Protocol-for-Major-Surge-in-COVID-Pandemic-March-28-202.pdf*

triage algorithm including data input, triage algorithm and information display.

2) Development of a user interface and user experience (UI/UX) that is intuitive, simple to use under high stress conditions and is compatible with a wide range of digital devices and the user personal protective equipment (PPE).

The goal of the partnership is to bring together the strengths of the University of Ottawa and the Ottawa Department of Medicine (Ottawa DOM) to help in the implementation of the Triage protocol. The system will enable access to all the relevant information within the app for convenience and workflow efficiency; a key aspect to enabling adoption by frontline medical staff. The system will inform appropriate utilization of ICU bed capacity for COVID-19 and possibly future pandemics towards optimal societal benefit (survivors) in a fair and equitable fashion based on the triage algorithm.

University of Ottawa researchers have been involved with the development of the triage protocol and will continue to be involved with the modification and improvement of the protocol. Through this project they will ensure that physicians across Ontario and other provinces have access to the latest iteration of the protocol. The information collected through the proposed tool will help to improve the protocol while helping to inform future decisions on resource allocation and treatment.

Ottawa DOM will lead the training of ICU physicians and other healthcare professionals in the collection and analysis of the data collected from the use of this tool. The data collected will be used to validate and improve treatment choices, improving the care provided in future surges by effectively using augmented intelligence (predictive modeling to help bedside decision-making).

The protocol has already been adopted by Ontario, Quebec, British Columbia and Newfoundland (to be used only in the event of a major surge) and can be easily adapted to be used in other provinces and countries that are facing a major surge due to the COVID-19 pandemic. The tool can be modified to collect and share insights amongst healthcare professionals and manage future global health crises. It can be adopted for future epidemic preparedness. To enhance applicability, it can also be used in non-triage situations.

Partnership

The University of Ottawa Faculty has approximately 300 basic and clinical researchers spanning a wide range of areas in medicine. As one of Canada's leading research-intensive institutions, the uOttawa Faculty of Medicine has a long history of conducting the highest quality basic and clinical research, many of which are conducted in partnership with affiliated teaching hospitals and research institutes. These partnerships lead to biomedical discoveries that have a significant impact on health care across Canada and around the world.

Ottawa DOM is a registered Not-For-Profit organization created by the Department of Medicine. It supports physicians, researchers and its partners in developing and executing innovative, practice-changing programs. It provides business strategy, healthcare insights, marketing services and external relationship management to help translate research discoveries into clinically applied medical solutions. Ottawa DOM is actively engaging faculty to address the healthcare challenges arising from the COVID-19 pandemic.

Partner Organization Information:
Sandra Yuk-Sim Wu, MBA, PMP, Executive Director
Ottawa's Department of Medicine @ www.OttawaDOM.ca / E-mail: sawu@toh.ca

The Faculty members will bring the clinical and data-analysis expertise, and Ottawa DOM will provide technical expertise and resources needed for software development and dissemination of the tool. Ottawa DOM will lead the project implementation of converting the triage protocol into a digital tool and subsequently ensuring the roll-out of the tool across the province. This will include the training of physicians and the collection and analysis of the data collected from the use of this tool. The data collected will be used to validate and improve the protocol, leading to better clinical decisions through the use of augmented intelligence technology (improving decision-making through predictive modeling). Ottawa DOM will leverage its network in both public and private sectors to enable timely access to the right technology and the talent of highly skilled professionals to build the pilot protocol of the system and test the assumptions to

prove an assessment of the impact of using the tool on the overall health outcomes. Ottawa DOM has established a collaborative partnership with Microsoft Corp. for infrastructure support to the project. They will provide access to use of all the necessary technologies, technical support and advisory services from them to aid in building the solution. Ottawa DOM has a knowledgeable Board of Directors that provides advice in technology, financial, and legal to protect the liability, accountability of the project and ensure the success of the project.

University of Ottawa researchers have been involved with the development of the triage protocol and will continue to be involved with the modification and improvement of the protocol. They would provide the clinical knowledge and expertise to make sure the tool reflects the updated triage protocol and reflects the requirements of clinicians. The partnership with Ottawa DOM enables the clinical researcher to remain engaged in the clinical aspects of the COVID-19 pandemic and protocol design, while Ottawa DOM develops the technical tools and manages their dissemination.

Proposal

The objective of this project is to develop a digital tool to ensure that physicians have access to the updated clinical triage protocol from Ontario Health for managing major surges in demand of healthcare resources due to the COVID-19 pandemic, while collecting data about the use and effect of the triage protocol that will inform revisions and improvements of the protocol itself.

The application will provide the frontline teams with the latest and updated information on the clinical triage protocol, the triage process, inclusion criteria and exclusion criteria for levels 1, 2 and 3 triage scenarios. Various tools for calculating clinical scores and scales from the criteria that are in the triage protocol will be integrated in to the application. This functionality will be regularly updated from a backend system by the central command team. The triage indicator is intended as a guide to clinicians based on the most current data, but the clinicians ultimately decided on patient management.

The add-on functionality of the application (data collection to allow surveillance) will have input fields to obtain information about the patients who are being excluded, admitted, and/or discharged (e.g., identifiers, sex, age, COVID-19 status, why they were excluded or discharged, and whether they survived to ICU or hospital discharge). This data will be stored in a secure server at the Ottawa Hospital Research Institute (pending transfer to a provincial/national server) with built-in functionalities for analysis and reporting. The data obtained will allow the tracking of patients with critical illness, their risk factors, prognosis and decision to admit to the ICU. The data will be cross analyzed with *ICU and ventilator occupancy status indicators* (Ministry of Colleges and Universities COVID-19 Rapid Research Fund Application under review entitled "Surveillance of Critical Care Outcomes during implementation of Ontario's ICU Triage Recommendations during the COVID-19 Pandemic", PI: J. Downar, $458K) to analyze protocol adherence, resource utilization and outcomes. This critical feedback will enable a nimble triage protocol that responds to changing clinical practices and observed patient outcomes, and benefit healthcare providers by providing transparent and real-time feedback about their ICU's practices and outcomes, and allow learning from the practices of other ICUs. Finally, this information will benefit patients by ensuring that triage decisions are transparent, equitable, and efficient, and in turn improve the quality of care for patients.

Resources & Activities

The project includes developing a system comprised of two communicating software components:

- Mobile Application - For easy accessibility and quick adoption of the tool by physicians working in the frontlines, the tool will be deployed as a mobile application and accessed from a tablet, smartphone or a computer. The application will be cross-platform compatible and can be accessed from an Android, iOS or Windows device. The primary activity of the project is to develop the application to accurately represent the latest triage protocol in a digital format. The application will feature an easy to use UI/UX to allow data collection, communication to a backend server and provide feedback to the user on algorithm recommended patient management. The design will accommodate ICU triage team members working

under stressful conditions while wearing personal protective equipment (PPE).

- Backend server – The backend system will communicate with mobile devices to receive input data, combine it with other data sources (i.e. *ICU and ventilator occupancy status indicators*) and generate a recommendation according the most current algorithm and archive the data for future analysis. This objective requires the development of secured cloud-based databases to store and process all collected data and interface other relevant databases.

Timelines: The project will be developed in two phases:

→ **Phase 1** – will involve the development and deployment of a digital tool for use by individual doctors on Tablets. The initial implementation will reflect the up-to-date triage level for each facility and enable the calculations of the inclusion / exclusion criteria with the use of embedded formulae and calculators. The system would have the option to connect with the web-based surveillance system that is being deployed for collection of basic information through a daily tracking of *ICU and ventilator occupancy status indicators*. The database will be on a platform that enables data-mining, including the development of artificial intelligence (AI) for future applications. **Deliverable**: The main deliverable for this phase will be a cross-platform mobile app capable of communicating the latest triage level to the frontline physicians and will be capable of data collection for tracking use of the triage protocol. This tool will be deployed across all critical care facilities across the province.

→ **Phase 2** – will involve the creation of a Learning Health System (LHS) by collecting data that validates and improves the protocol. In the event of a major surge, the tool would enhance decision-making by triage physicians (augmented intelligence). The proposed system will also allow linkage to provincial healthcare databases like ICES to allow us to assess long-term morbidity, health care utilization outcomes, and equity by determining how the protocol was applied across socioeconomic and geographic groups**.** This will help in improving the triage protocol for future surges by examining the survival of admitted ICU patients. **Deliverable**: The main deliverable for this phase will be the app feature to collect data that would allow revisions of the protocol. Second deliverable will be connectivity to other databases and development of data-mining and AI technologies to enhance the triage algorithm.

High-level Gantt Chart for milestones and deliverables (July 2020 to June 2021 - 1 year)

	2020		**2021**		**Ongoing**
	Q3	**Q4**	**Q1**	**Q2**	
1. Resource Identification	x				
2. Document Review / Systematic Review	x				
3. Develop End-user Segments and Relationship	x				
4. Knowledge Assessment / Pre-market Assessment	x	x			
5. Design and Develop Prototype		x			
6. Test and Evaluate Prototype		x			
7. Adapt Knowledge to Local Context		x			
8. Assess Barriers and Implement Interventions		x			
Deliverable 1 - Digital Tool		x			
9. Data collection		x	x		
10. Development of augmented intelligence component		x	x		
Deliverable 2 - Enhanced Digital Tool				x	
Knowledge Translation and Dissemination					x

Note: Considering the urgent nature of the COVID-19 pandemic situation, timelines have been condensed. These may be impacted due to any exigencies caused due to uncertainties of the pandemic and the software development cycle.

Team

The team is comprised of experts in complimentary fields, specifically selected to ensure successful implementation of this project:

Principal Investigator and Project Coordinator

Dr. Ran Klein, PhD Electrical Engineering (Assistant Professor, Department of Medicine, uOttawa) leads a research program into quantitative imaging, quality assurance, and AI for image segmentation and tumor detection (NSERC Discovery Grant 2020-2025). He is also Imaging Physicist in the Department of Nuclear Medicine and has over 15 years developing information systems in a clinical setting. He has developed commercially successful clinical software in-house and in collaboration with industry partners. His role will be to manage the software development and liaison between the clinical team and software developers to ensure that the products meet clinical needs.

Co-Principal Investigators:

Dr. James Downar, MDMC MHSc FRCPC (Associate Professor, Department of Medicine, uOttawa) led the development of Ontario Health's Clinical Triage Protocol for Major Surge in COVID Pandemic. His research interests include communication and decision-making for seriously ill patients and their families; Palliative Care for the Critically Ill; and Palliative Care for Noncancer Illnesses. He has comprehensive expertise in clinical research and health care delivery, including an extensive experience in palliative care delivery which is critical for the research, development and implementation phases of the current project.

Dr. Peter Tanuseputro, MD MHSc CCFP FRCPC (Assistant Professor, Department of Medicine, uOttawa. Scientist, Ottawa Hospital Research Institute. Investigator, Bruyère Research Institute) has research interests including health services research to improve care delivery, palliative and end-of-life care, and in building tools informed by "big data" to improve the ability of health care practitioners, patients, and caregivers to identify meaningful outcomes such as death and transitions between care settings.

Collaborators:

Sandra Wu, MBA, PMP, Executive Director is the primary contact for Ottawa DOM, the partnering organization for the current project proposal. Her background includes strategic planning, project management, advisory services as well as finance and administration. Sandra Wu will facilitate collaboration between the involved TOH departments, divisions, and stakeholders outside of TOH. She will work closely with the project coordinator and the team to work on the mobile app development efforts, project management and platform integration strategies.

Dr. Carrington, Post-doctoral fellow, Machine Learning for health care, will be supporting and guiding the team as the AI Expert consultant. His areas of research include various machine learning models and their use for equitable AI.

Support staff:

Darshdeep Dhillon, MBA and **Abhilash Menon, MBA**, Business Strategists, Ottawa DOM will assist in project management, dissemination, and project implementation.

TBD through Ottawa DOM, Research methodologist, Ottawa DOM will perform mobile app quality assurance (Phase II), data gathering and real-time data analysis (Phase I and Phase II). An integrative knowledge translation approach will be implemented from the early phases of project development. This will ensure timely feedback on app implementation as well as development of a knowledge dissemination strategy to communicate on the project goals, success and feedback to a wider audience (i.e. clinicians, patients, collaborators).

Software Developer:

TBD we have a pool of candidate software developers to draw from the University network, including recent graduates from Ran Klein's laboratory, but if a suitable candidate is not available, we will recruit externally.

Personal identification no. (PIN)	Family name of applicant
Valid 282850	Klein

PROPOSED EXPENDITURES

	Cash				
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1) Salaries and benefits					
a) Students	0	0	0	0	0
b) Postdoctoral fellows	0	0	0	0	0
c) Technical/professional assistants	50,000	0	0	0	0
d)	0	0	0	0	0
2) Equipment or facility					
a) Purchase or rental	0	0	0	0	0
b) Operation and maintenance costs	0	0	0	0	0
c) User fees	0	0	0	0	0
d)	0	0	0	0	0
3) Materials and supplies					
a)	0	0	0	0	0
b)	0	0	0	0	0
c)	0	0	0	0	0
4) Travel					
a) Conferences	0	0	0	0	0
b) Field work	0	0	0	0	0
c) Project-related travel	0	0	0	0	0
d)	0	0	0	0	0
5) Dissemination					
a) Publication costs	0	0	0	0	0
b)	0	0	0	0	0
6) Technology transfer activities					
a)	0	0	0	0	0
b)	0	0	0	0	0
c)	0	0	0	0	0
Total Proposed Expenditures	50,000	0	0	0	0
Partner organization recognized for cost-sharing					
Partner organization not recognized for cost-sharing	0	0	0	0	0
Other funder (not involved in the research)					
Postsecondary institution					
Amount requested from NSERC	50,000	0	0	0	0

PROTECTED B WHEN COMPLETED

Salaries and Benefits

The entirety of the requested budget ($50,000) is allocated for employment of technical/professional assistants. These will be drawn upon from the pool of available staff and students at the University or recruited externally if needed. Salaries have been calculated according the table below:

Expense	**No. of positions**	**No. of months**	**No. of hours / week**	**No. of Hours / year**	**Hourly Rate**	**Total in CAD**
Software Developer	1	8	20	640	60	$38,400
Data Analyst	1	3	20	240	50	$12,000
Total						$50,400
Requested from NSERC						**$50,000**

Equipment and Facility

No funds are requested from NSERC for facilities or equipment.

Computing resources (Azure storage and software development tools) are provided in-kind by Microsoft Canada through collaboration with DOM-NFP to combat the COVID-19 pandemic (agreement in progress). The value of this contribution is estimated at $250,000 and includes:

- Software development tools and technical assistance
- Cloud based application servers
- Data storage

Other

No additional funds are requested for materials and supplies, travel, dissemination or technology transfer activities.

Personal identification no. (PIN)	Family name of applicant
Valid 282850	Klein

Organization Category

Partner organization not recognized for cost-sharing

Partner organization

Ottawa Department of Medicine

Partner department

Not Applicable

Contact family name, contact given name

Wu, Sandra

Contact email address

sawu@toh.ca

CONTRIBUTIONS FROM PARTNER ORGANIZATION

	Year 1	Year 2	Year 3	Year 4	Year 5
Cash contributions to direct costs of research	0	0	0	0	0
In-kind contributions					
1) Salaries for scientific and technical staff	31,680	0	0	0	0
2) Donation of equipment, software	250,000	0	0	0	0
3) Donation of material	0	0	0	0	0
4) Field work logistics	0	0	0	0	0
5) Provision of services	0	0	0	0	0
6) Use of organization's facilities	0	0	0	0	0
7) Salaries of managerial and administrative staff	89,280	0	0	0	0
8)	0	0	0	0	0
Total In-kind contributions	370,960	0	0	0	0
Contribution to postsecondary institution overhead	0	0	0	0	0

The Ottawa Department of Medicine (Ottawa DOM, NFP), the partner, actively engaging in this project and is that making available technical, administrative and managerial staff in-kind. Furthermore, Ottawa DOM is leveraging computing infrastructure and industry collaboration towards the success of this project.

Salaries for Scientific and Technical Staff

Expense	No. of positions	No. of months	No. of hours / week	No. of Hours / year	Hourly Rate	Total in CAD
Postdoc Fellow (Andre. C)	1	6	8	192	165	$31,680
Total						$31,680
Portion paid by partner						$31,680
Requested from NSERC						**$0**

Salaries of Managerial and Administrative Staff

Expense	No. of positions	No. of months	No. of hours / week	No. of Hours / year	Hourly Rate	Total in CAD
Executive Director	1	6	30	720	74	$53,280
Business Strategists (D. Dhillon and A Menon)	2	3	30	720	50	$36,000
Total						$89,280
Portion paid by partner						$89,280
Requested from NSERC						**$0**

Equipment and Facility

No funds are requested from NSERC for facilities or equipment.

Computing resources (Azure storage and software development tools) are provided in-kind by Microsoft Canada through collaboration with DOM-NFP to combat the COVID-19 pandemic (agreement in progress). The value of this contribution is estimated at $250,000 and includes:

- Software development tools and technical assistance
- Cloud based application servers
- Data storage

Other

No additional funds are requested for materials and supplies, travel, dissemination or technology transfer activities.

Ontario Health

Clinical Triage Protocol for Major Surge in COVID Pandemic

March 28, 2020

A. Overview

The need to undertake triage in a developed health care system in and of itself is uncharted territory without an evidence base upon which to specifically guide management. In extraordinary circumstances best efforts are required drawing upon evidence from clinical practice and ethical principles.

Triage is an option of last resort, to be used once all existing local resources have been used, and all reasonable attempts have been made to move patients to or resources from areas with greater availability. The overall purpose of a triage system is to minimize mortality and morbidity for a population overall, as opposed to individual mortality and morbidity risk.

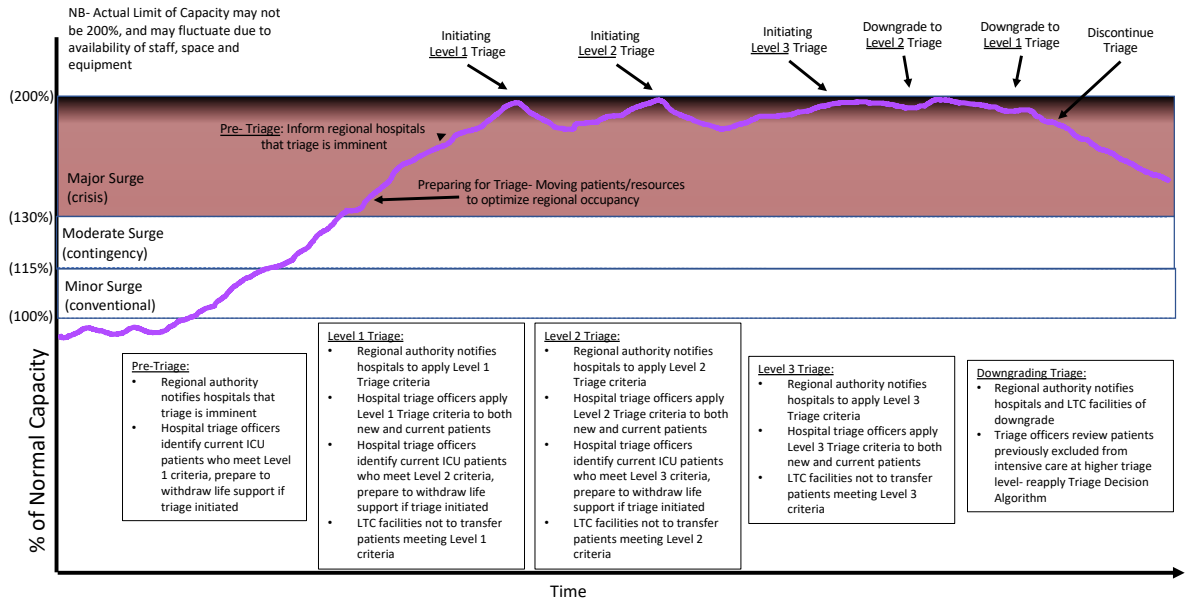
Clinical triage for major surge should be guided by ethical principles. Relevant ethical principles are: utility, proportionality, and fairness.

The decision to initiate clinical triage for major surge should be predictable and apply to an entire region rather than just individual hospitals. This decision falls under the authority of the Provincial and Regional Critical Care Command Centres with full situational awareness of the existing resources and the demands on those resources. The ongoing need for triage (and at which level) should be frequently reviewed.

There are three levels of triage, and as system pressures increase, triage criteria will become proportionately more strict (see Figure). The degree of triage will be prompted by the degree of demand, in order to limit the possibility that anyone will be denied critical care resources unnecessarily.

Patients who are denied critical care resources due to triage should not necessarily have other medical treatments discontinued. They should receive the highest priority for palliative resources, including comfort medications and a consultation by a palliative care provider if necessary and available. All patients must be cared for.

Surge and Levels of Triage in a Pandemic



B. Guiding Principles

The overall purpose of a triage system is to minimize mortality and morbidity for a population overall, as opposed to individual mortality and morbidity risk. There are published frameworks that outline the ethical principles that guide triage systems. Recent publications of surveys and stakeholder engagement indicate a preference for a consequentialist approach based on maximizing the number of lives saved[4], followed by the application of a first-come, first-served or random allocation system for prioritization of people with similar likelihood of benefit[5]. The ethical principles involved in a triage process overall have been published previously. For this protocol, the following ethical principles are foremost:

1. ***Utility-*** Aiming to derive the maximum benefit by allocating resources preferentially to those who derive the greatest incremental benefit. People who are very likely to die from their critical illness, and people who are very likely to die in the near future even if they recovered from their critical illness would have a lower priority.
2. ***Proportionality***- The number of individuals who are negatively affected by the triage system should not exceed what would be required to accommodate the surge in demand, understanding that capacity and demand can be fluid. In other words, the response should not adversely affect more people than would have been affected if we had used a "first come, first served" approach. Triage systems necessarily have a disproportionate effect on people from vulnerable groups- proportionality is the best way to minimize this effect.
3. ***Fairness***- Clinically-relevant criteria should be used first and foremost to allocate resources. In the event that clinically-relevant considerations cannot be used to prioritize one patient over another, patients should not be removed from intensive care in favour of another patient with a similar chance of benefit. Priority should not be given to anyone on the basis of socioeconomic privilege, or political rank.

C. Clinical Triage Criteria

In order to be admitted to an ICU bed, a patient must meet one of the inclusion criteria, and must not meet any of the exclusion criteria.

Inclusion Criteria[1]:

Variable	Inclusion Criteria for Critical Care Admission
Requirement for invasive ventilatory support	Refractory hypoxemia (Spo_2 < 90% on nonrebreather mask Fio_2 > 0.85) Respiratory acidosis with pH < 7.2 Clinical evidence of respiratory failure Inability to protect or maintain airway
Hypotension	SBP < 90 mm Hg for adults (see BP parameters for all age-groups in Table 3) or relative hypotension with clinical evidence of shock for all ages (altered level of consciousness, decreased urine output, other end-organ failure) refractory to volume resuscitation requiring vasopressor/inotrope support that cannot be managed on the ward

SBP = systolic BP; Spo_2 = oxygen saturation as measured by pulse oximetry.

Exclusion Criteria:
These have traditionally fallen under 2 categories- (1) criteria that indicate a low probability of surviving an acute illness, and (2) criteria that indicate a low probability of surviving more than a few months regardless of the acute episode of critical illness[1]. These categories are not mutually exclusive, as life-limiting illnesses affect prognosis from acute illness, and acute illness affects the trajectory of chronic illness. These criteria reflect the principles of *utility* and *fairness* (see below) because they would exclude people who are very likely to die from their critical illness, and people who are very likely to die in the near future even if they recovered from their critical illness. Note these criteria are not comprehensive- they are meant to reflect known evidence or experience-based prognostic indicators. **Clinical judgment should supplement these criteria**, as some conditions not listed may also denote a poor prognosis, and such patients should be triaged appropriately. The tools listed in this table can be found in Appendix A.

Level 1 Triage Scenario (Aiming to exclude people with >~80% predicted mortality)	**Level 2 Triage Scenario (Aiming to exclude people with >~50% predicted mortality)**	**Level 3 Triage Scenario (Aiming to exclude people with ~>30% predicted mortality)**
A. Severe Trauma with predicted mortality >80% based on TRISS score	A. Severe Trauma with predicted mortality >50% based on TRISS score	A. Trauma with predicted mortality >30% based on TRISS score
B. Severe burns with any 2 of: • Age >60 • >40% total body surface area affected • Inhalation injury	B. Severe burns with any 2 of: • Age >60 • >40% total body surface area affected • Inhalation injury	B. Severe burns with any 2 of: • Age >60 • >40% total body surface area affected • Inhalation injury
C. Cardiac arrest • Unwitnessed cardiac arrest • Witnessed cardiac arrest with non-shockable rhythm • Recurrent cardiac arrest	C. Cardiac arrest • Unwitnessed cardiac arrest • Witnessed cardiac arrest with non-shockable rhythm • Recurrent cardiac arrest	C. Cardiac arrest
D. Severe baseline cognitive impairment (unable to perform activities of daily living independently due to cognitive impairment) due to a progressive illness	D. Severe baseline cognitive impairment (unable to perform activities of daily living independently due to cognitive impairment) due to a progressive illness	D. Severe and moderate baseline cognitive impairment (significant impairment in high-order ADLs (e.g. finances. Medications, transportation)) due to a progressive illness
E. Advanced irreversible neurodegenerative disease (e.g. Parkinson Disease, Amyotrophic Lateral Sclerosis)	E. Advanced irreversible neurodegenerative disease (e.g. Parkinson Disease, Amyotrophic Lateral Sclerosis)	E. Advanced and moderate irreversible neurodegenerative neuromuscular disease (e.g. Parkinson Disease, Amyotrophic Lateral Sclerosis)
F. Metastatic malignant disease with any of the following: • ECOG class >=2 • Disease progressing or stable on treatment • Active treatment plan with >80% mortality risk at 1 year • Unproven (experimental) treatment plan • Treatment plan that would only be started if the patient recovers from critical illness	F. Metastatic malignant disease with any of the following: • ECOG class >=2 • Disease progressing or stable on treatment • **Active treatment plan with >50% mortality risk at 1 year** • Unproven (experimental) treatment plan • Treatment plan that would only be started if the patient recovers from critical illness	F. Metastatic malignant disease
G. Advanced and irreversible immunocompromise	G. Advanced and irreversible immunocompromise	G. Advanced and irreversible immunocompromise

Level 1 Triage Scenario (Aiming to exclude people with >~80% predicted mortality)	**Level 2 Triage Scenario (Aiming to exclude people with >~50% predicted mortality)**	**Level 3 Triage Scenario (Aiming to exclude people with ~>30% predicted mortality)**
H. Severe and irreversible neurologic event with >80% risk of death or poor outcome based on: • For Intracerebral Hemorrhage a modified ICH score of 4-7 • For Subarachnoid Hemorrhage, a WFNS grade 5 (GCS 3-6) • For Traumatic Brain Injury, the IMPACT score • Acute ischemic stroke alone would not be excluded at this level	H. Severe and irreversible neurologic event with >50% risk of death or poor outcome based on: • For Intracerebral Hemorrhage a modified ICH score of **3-7** • For Subarachnoid Hemorrhage, a WFNS grade 3-5 (GCS 3-12 OR GCS 13-14 AND focal neurological deficits) • For Traumatic Brain Injury, the IMPACT score • For acute ischemic stroke, an NIHSS of **22-42.**	H. Irreversible neurologic event/condition with >30% risk of death or poor outcome based on: • For Intracerebral Hemorrhage a modified ICH score of **2-7** • For Subarachnoid Hemorrhage, a WFNS grade 2-5 (GCS <15) • For Traumatic Brain Injury, the IMPACT score • For acute ischemic stroke, an NIHSS of **14-42.**
I. End-stage organ failure meeting the following criteria: *Heart* • Chronic End-stage Heart Failure with NYHA Class 4 symptoms, ineligible for advanced therapies (mechanical support, transplant) *Lung* • COPD with FEV_1 <30% predicted, baseline PaO_2 < 55 mmHg • Cystic Fibrosis with postbronchodilator FEV_1 <30% or baseline PaO_2 <55 mmHg • Pulmonary fibrosis with VC or TLC <60% predicted, baseline PaO2 <55 mmHg, or secondary pulmonary hypertension • For pulmonary hypertension, anyone with ESC/ERS high risk criteria (see below) *Liver* • Chronic Liver Disease with failure of 2 or more organ systems (ACLF Grades 2-3) • MELD score >=25 Note that patients who meet these criteria may be eligible for ICU admission if they are currently on an organ donation waiting list and would be given highest priority if admitted to ICU (e.g. status 4/4F for liver transplantation). This does not include people who have been referred to a transplant service but not yet listed for a transplantation. <u>This also would not apply if organ donation processes are halted due to triage conditions precluding organ procurement.</u>	I. End-stage organ failure meeting the following criteria: *Heart* • Chronic End-stage Heart Failure with NYHA Class 3 or 4 symptoms, ineligible for advanced therapies (mechanical support, transplant) PLUS any of: ○ High/increasing BNP ○ Cardiorenal syndrome ○ Recent discharge (<30d) or multiple admissions for CHF in past 6 months *Lung* • COPD with FEV_1 <50% predicted, baseline PaO_2 < 55 mmHg • Cystic Fibrosis with postbronchodilator FEV_1 <30% or baseline PaO_2 <55 mmHg • Pulmonary fibrosis with VC or TLC <60% predicted, baseline PaO2 <55 mmHg, or secondary pulmonary hypertension • For pulmonary hypertension, anyone with ESC/ERS high risk criteria (see below) *Liver* • Chronic Liver Disease with failure of 1 or more organ systems (ACLF Grades 1-3) • MELD score >=15 Note that patients who meet these criteria may be eligible for ICU admission if they are currently on an organ donation waiting list and would be given highest priority if admitted to ICU (e.g. status 4/4F for liver transplantation). This does not include people who have been referred to a	I. End-stage organ failure (any diagnosis) or previous organ transplant with evidence of chronic rejection or chronic organ dysfunction in the transplanted organ.

Level 1 Triage Scenario (Aiming to exclude people with >~80% predicted mortality)	Level 2 Triage Scenario (Aiming to exclude people with >~50% predicted mortality)	Level 3 Triage Scenario (Aiming to exclude people with ~>30% predicted mortality)
	transplant service but not yet listed for a transplantation. This also would not apply if organ donation processes are halted due to triage conditions precluding organ procurement.	
J. Anyone with a Clinical Frailty Score of >=7 due to a progressive illness or condition	**J. Anyone with a Clinical Frailty Score of >=5** due to a progressive illness or condition	**J. Anyone with a Clinical Frailty Score of >=3** due to a progressive illness or condition
K. Elective palliative surgery	K. Elective palliative surgery	K. Elective or emergency palliative surgery
L. Anyone receiving mechanical ventilation for >=14 days with a ProVent score of 4-5.	**L. Anyone receiving mechanical ventilation for >=14 days with a ProVent score of 2-5.**	**L. Anyone receiving mechanical ventilation for >=14 days who is not improving**
M. A clinical judgment that this patient has a >80% chance of mortality due to their critical illness, or in the near future regardless of their critical illness	M. A clinical judgment that this patient has a >50% chance of mortality due to their critical illness, or in the near future regardless of their critical illness	M. A clinical judgment that this patient has a >30% chance of mortality due to their critical illness, or in the near future regardless of their critical illness

Supplemental Criteria at Level 3:

Once a Level 3 triage is initiated, only people with the lowest risk of death or poor outcome in the near future would receive intensive care. At this point, should the demand continue to exceed the capacity of the intensive care services there would be little evidence to guide our triage on the basis of *utility*.

- The use of an acute illness score (e.g. SOFA) would be difficult to justify, given that even people with the highest scores have a roughly 50% chance of surviving an acute viral respiratory illness, and if you only look at those who do not meet any of the exclusion criteria at levels 1-3, the survival rate would likely be even higher.
- We do not know whether the prognosis of COVID-19 illness is similar to other vital illnesses. Early data suggests that the admission SOFA scores for nonsurvivors was low, and thus unhelpful for distinguishing them from survivors[2,3]
- Mortality risk from acute illness does not easily translate into utility. It is not clear whether the greatest benefit would be seen in those with mild, moderate, or severe illness.

Focusing on the principles underlying this triage protocol, the demand for intensive care from new patients who don't meet exclusion criteria does not justify withdrawing life-sustaining measures from someone else with a similar prospect of benefitting from them. Decisions to withdraw life-sustaining measures from someone already admitted to intensive care should be primarily driven by clinical considerations. In practice, this would involve a frequent reassessment of admitted patients for any indication that they are no longer responding to treatment, or their clinical trajectory suggests that their chances of recovery have substantially worsened from when they were admitted. To be clear, this is a decision that should be based on clinical considerations, integrating all relevant information, and not solely on any demographic or socioeconomic factor. As with all triage decisions, they should be referred for a second opinion to confirm the assessment that the person's chance of recovery have substantially worsened from when they were admitted.

D. Clinical Triage Protocol:

Overall Approach

The initiation of a tertiary critical care triage process should be a well-coordinated and predictable decision made at a regional level. Ideally, transportation resources should be used to move patients to or resources from areas/hospitals with lower occupancy as the surge in demand increases, in order to ensure that all resources are maximally used prior to the initiation of a triage protocol. This will reduce the chances that some people will be denied critical care resources that they would have received had they been in another hospital. Of course, transportation resources will become stretched in a pandemic and this will not always be possible. Ideally, triage protocols should be applied consistently across a large region, and reviewed frequently to determine whether the surge in demand is still large enough to justify triaging. Each hospital should be aware of the precise number of critically ill and mechanically-ventilated patients they can accommodate with their resources (including consumables), staff and space. The timing and degree of the surge in demand is likely to be variable in different areas, so as one site approaches their maximum capacity, regional authorities should make significant efforts to transfer patients to or equipment from hospitals with lower occupancy. When all hospitals in a region are near their capacity, or when transportation resources are no longer able to reallocate patients to hospitals with lower occupancy, Provincial and Regional Critical Care Command Centres should clearly inform these hospitals that a triage scenario is impending. Surges in demand may be intermittent requiring a regular review (e.g. every 12 hours) of occupancy to determine whether the triage protocol is still required, or whether hospitals can decrease the level of triage.

Scale-up of Clinical Triage in Major Surge

In Major Surge, all patients who are currently receiving critical care resources should be reviewed, and those who would be excluded under a level 1 triage scenario identified in advance and they (or their substitute decision-makers) informed of the situation if possible. Each hospital should communicate the number of patients who would no longer receive critical care in a level 1 scenario to their regional authority, to assist with planning. When the level 1 triage scenario is initiated, these patients should be removed from critical care resources and transferred to non-critical care beds, with appropriate palliative measures initiated. All patients who develop critical illness after a level 1 triage scenario should be evaluated against the level 1 criteria before receiving critical care resources.

Once a level 1 triage scenario is initiated, this should prompt each hospital to review and identify all patients in their critical care beds who would be excluded from critical care resources under a level 2 triage scenario, informing the patients (or their substitute decision-makers) and the regional authority. The regional authority should continue to coordinate transportation of patients to optimize the utilization of all critical care resources before initiating a level 2 triage. If a level 2 triage scenario is initiated, hospitals should remove these patients from critical care resources and transfer them to non-critical care beds and initiate palliative care measures. All patients who develop critical illness after a level 2 triage scenario should be evaluated against the level 2 criteria before receiving critical care resources.

The hospitals should then prepare for a level 3 triage scenario, similar to the previous steps.
The initiation of a tertiary triage process should also prompt the initiation of primary and secondary triage processes. Patients with exclusion criteria who have impending respiratory failure should not be transferred to acute care facilities if we know in advance that they would not receive critical care

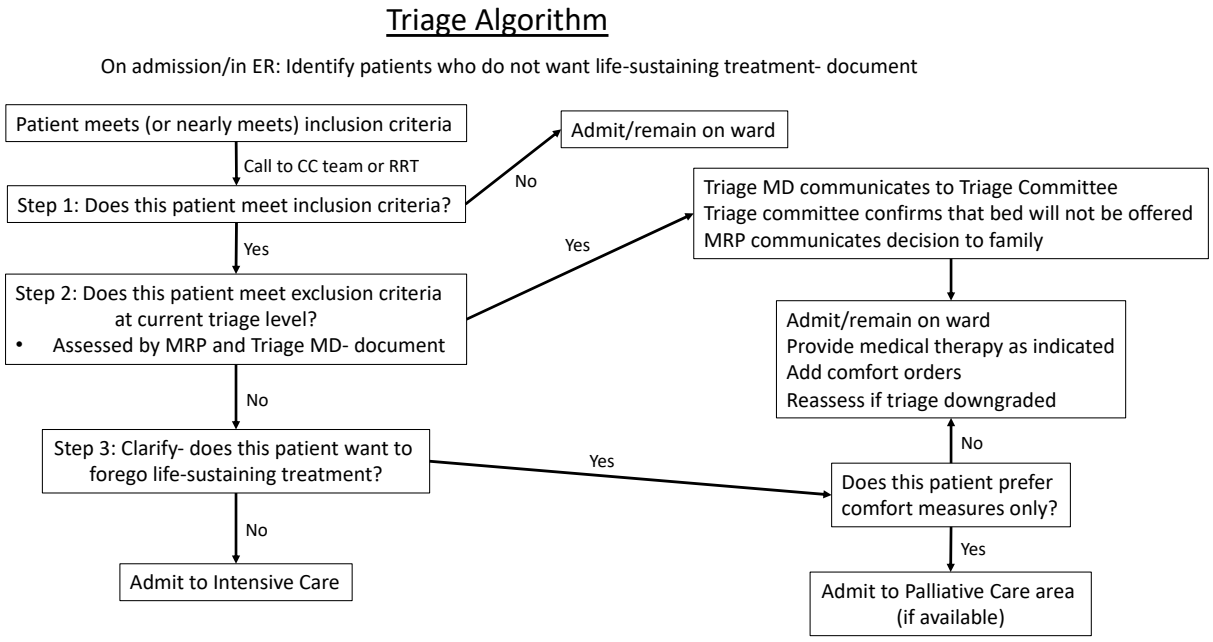
resources. All efforts should be made to treat them supportively, including palliative treatments, in their current location or a nonacute setting.

Triage Process in Hospital

The process of triage involves at least 3 separate individuals or groups:

- The Most Responsible Physician (MRP)
- The consulting physician from the Critical Care (CC) team or Rapid Response Team (RRT)
- The triage physician, who could be a designated triage physician or the consulting physician from the CC team or RRT
- The hospital triage committee, which should at least include a physician, an ethicist, and a representative from the hospital administration responsible for allocating beds

Regardless of whether or not the triage protocol has been implemented, when a patient is admitted to hospital or assessed in the Emergency Department, if the most responsible physician (MRP) identifies any chronic or incurable illness or condition that implies a shortened life expectancy, they will explore the patient's goals and aim to develop a plan of care that reflects those goals and respects the limitations of medical care. If the patient indicates a preference to receive life-sustaining measures in the event of a deterioration, but the MRP feels that this is not appropriate given the patient's medical condition, they should attempt to resolve this discordance as they normally would. If a person expresses a desire not to receive life-sustaining treatment in the event of a deterioration, this should be recorded in the chart and the patient should not be referred for intensive care.



Once the triage protocol has been implemented, if an in-patient meets (or is close to meeting) the inclusion criteria, provided that there is no order withholding life sustaining measures, the MRP should consult with the CC team or RRT, as they normally would in such a situation. At the time of the assessment of by the CC team or RRT, the MRP and a triage physician (who could be either the CC physician, RRT physician, or a designated triage physician with acute care expertise) should assess the

patient to determine whether they meet the inclusion criteria, and whether they meet any of the exclusion criteria. If both the MRP and the triage physician agree that the patient meets the exclusion criteria in place at the time of the assessment, then they will document this in the medical record. Disagreements should be resolved by consensus among those at the bedside if possible.

Following this assessment, the triage physician will communicate the assessments to the hospital triage committee, who will review the decision. The triage committee may also help to resolve any disagreement about whether the patient meets exclusion criteria. If appropriate, the triage committee will confirm that under the triage protocol, they will not offer admission to intensive care. The MRP will communicate this decision to the patient or substitute decision maker and their next-of-kin (See Appendix B for suggested language to disclose a triage decision). The MRP should continue to offer all other indicated medical treatments, and write comfort orders to ensure that the patient does not suffer (see Appendix C for suggested comfort medication orders). For clarity, the MRP and triage physicians take responsibility for determining that the patient meets the exclusion criteria. The healthcare system, through the implementation of the triage protocol, takes responsibility for determining that they cannot offer admission to intensive care.

E. Paediatric Considerations

Given the very low mortality of most conditions with which children are admitted to intensive care (<5%), patients <18 years who meet the mortality criteria associated with the adult triage levels will be very rare, such that the adoption of the same triage system in pediatrics is unlikely to mobilize further resources[14,15]. An entirely different medical criteria table or algorithm that is pediatric specific would be necessary in considering pediatric specific triage policy, since pediatric life-limiting conditions are diverse and do not lend themselves to scoring nor have such scales been developed or validated in any practically applicable way. Some centres have modeled situations where a certain mortality rate or predicted ventilator-days could exclude some children from initiating invasive ventilator support at a time of significantly increased short-term ventilator needs [16], but there is a paucity of pediatric-specific data to guide such triage. The same task force that assessed adult triage criteria did not adopt an equivalent for pediatrics [17]. Medical specificities aside, the guiding ethical principles remain the same for pediatric triage and should still be applied to pediatric triaging. It is important to recognize that the initiation of adult triage levels does not itself imply initiation of pediatric triage (or vice versa). However, dependent on the level of impact within the pediatric system, pediatric hospitals may need to consider lower level triage initiation at a point when adult systems have reached level 3 triage, in order to respect the principles of utility and fairness population-wide.

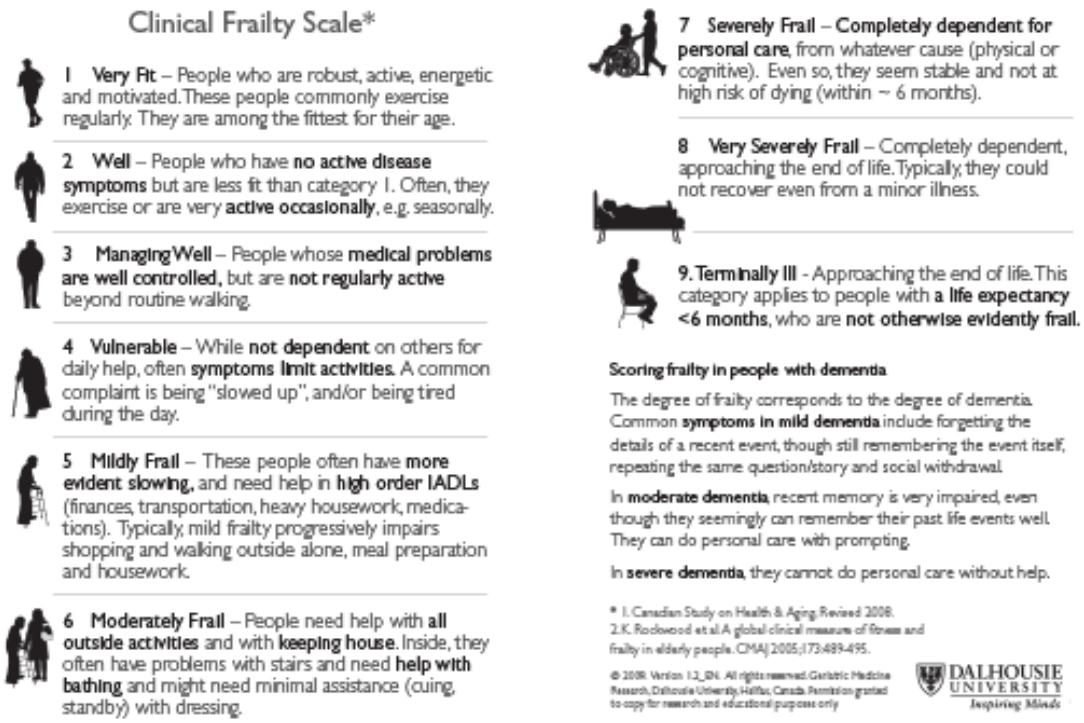
Pediatric centres should regionally activate a Pediatric Level 1 triage when shared pediatric resources (accounting for transportation capacity) are exhausted, with mortality predictions subject to expert opinion which should be agreed upon and documented by at least two members of the treating team where possible (Pediatric disease-specific triage algorithm/table to be developed). Prior to movement to a Level 2 or 3 Triage, especially in light of such steps being unlikely to mobilize resources, discussions should be held regarding movement of ventilators back to the pediatric centres from adult sites. Lastly, additional considerations for pediatrics include the moral distress inherent in removing a *child* from life support, or denying its application.

Additional information on the background of the document (Appendix D).

Appendix A. Triage Criteria Tools

TRISS Score Calculator
https://www.mdapp.co/trauma-injury-severity-score-triss-calculator-277/

Clinical Frailty Scale (Rockwood et al)



Clinical Frailty Scale*

1 **Very Fit** – People who are robust, active, energetic and motivated. These people commonly exercise regularly. They are among the fittest for their age.

2 **Well** – People who have **no active disease symptoms** but are less fit than category 1. Often, they exercise or are very **active occasionally**, e.g. seasonally.

3 **Managing Well** – People whose **medical problems are well controlled,** but are **not regularly active** beyond routine walking.

4 **Vulnerable** – While **not dependent** on others for daily help, often **symptoms limit activities**. A common complaint is being "slowed up", and/or being tired during the day.

5 **Mildly Frail** – These people often have **more evident slowing,** and need help in **high order IADLs** (finances, transportation, heavy housework, medications). Typically, mild frailty progressively impairs shopping and walking outside alone, meal preparation and housework.

6 **Moderately Frail** – People need help with **all outside activities** and with **keeping house**. Inside, they often have problems with stairs and need **help with bathing** and might need minimal assistance (cuing, standby) with dressing.

7 **Severely Frail** – **Completely dependent for personal care**, from whatever cause (physical or cognitive). Even so, they seem stable and not at high risk of dying (within ~ 6 months).

8 **Very Severely Frail** – Completely dependent, approaching the end of life. Typically, they could not recover even from a minor illness.

9. **Terminally Ill** - Approaching the end of life. This category applies to people with **a life expectancy <6 months**, who are **not otherwise evidently frail.**

Scoring frailty in people with dementia

The degree of frailty corresponds to the degree of dementia. Common **symptoms in mild dementia** include forgetting the details of a recent event, though still remembering the event itself, repeating the same question/story and social withdrawal.

In **moderate dementia**, recent memory is very impaired, even though they seemingly can remember their past life events well. They can do personal care with prompting.

In **severe dementia**, they cannot do personal care without help.

* 1. Canadian Study on Health & Aging. Revised 2008.
2. K. Rockwood et al. A global clinical measure of fitness and frailty in elderly people. CMAJ 2005;173:489-495.

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Provent Score- calculated at 14 days:
One point for each of Age >50, platelet count <150, requiring hemodialysis, and requiring vasopressors. An additional point is given for age >=65, for a maximum score of 5. Scores of 4-5 at 14 days suggest a mortality rate of ~90% at 1 year. Scores of 2-3 at 14 days suggest a mortality rate of 56-80% at 1 year[31].

Modified ICH Score[23]:
One point each for age >80, infratentorial origin, volume >30mL, intraventricular extension, use of oral anticoagulants, and Glasgow Coma Score of 5-12. Two points for a GCS of 3-4. Scores of 4-7 suggest a 30-day mortality rate of >80%. Scores of 3-7 suggest a mortality rate of >60%.

The World Federation of Neurological Surgeons grading system:
A combination of Glasgow Coma Score (GCS) and the presence or absence of focal neurological deficits[32]. A WFNS grade 5 (GCS 3-6) is associated with a >90% probability of a poor outcome. Grades 3-4 (GCS 7-12 or GCS 13-14 AND focal neurological deficits) are associated with a >50% probability of a poor outcome. Grade 2 (GCS 14 with no neurological deficits) is associated with a ~30% probability of a poor outcome.

National Institue of Health Stroke Scale (NIHSS): score 0-7 is associated with a 30-day mortality of 4.2%; 8-13 with a 30d mortality of 13.9%; 14-21 with a 30d mortality of 31.6%; and 22-42 with a 30d mortality of 53.5%[24]:.

The IMPACT Score[25] predicts outcome at 6-months based on multiple demographic, clinical and radiographical factors using the calculator found at http://www.tbi-impact.org/?p=impact/calc

The ACLF grading system is based on the number of organ systems failing at the time of admission in a patient with chronic liver disease. Patients with more than 2 organ systems failing on presentation (ACLF Grades 2 and 3) have an >=80% risk of mortality at 6 months[33]. Those with ACLF Grade 1 have an approximately 50% mortality at 6 months[33]; ACLF grade 1 is defined as having chronic liver failure plus ONE of the following:

- Creatinine >177 umol/L (2.0 mg/dL)
- Creatinine >132 umol/L (1.5 mg/dL) AND Hepatic encephalopathy grade 3-4
- Creatinine >132 umol/L (1.5 mg/dL) OR Hepatic encephalopathy grade 1-2 AND ONE OF:
    - Bilirbin >200umol/L (12mg/dL)
    - INR >2.5
    - pressor support required
    - PaO2/FiO2 <200

For pulmonary hypertension**, the ECS/ERS High Risk Criteria** are[22]:

- WHO Class 4 symptoms
- 6MWT <165m
- NT pro-BNP >1400 ng/L
- RA area >26 cm^2
- RAP >14 mmHg
- CI <2.0 L/min/m^2
- SvO_2 <60%

Appendix B. Suggested language for physicians providing support to a patient or family member who is denied intensive care due to resource scarcity

Template 1.
Normally, when somebody develops critical illness, the medical team would offer them intensive care (a combination of medications and machines to support their vital organs), provided that the medical team felt that they had a reasonable chance of survival. However, because of the COVID outbreak, we are currently unable to offer intensive care to everyone who is critically ill. As a result, our hospital is working under triage guidelines, which means that we are only offering intensive care to those who are most likely to be able to survive and recover from their critical illness. You probably have heard about this in the news – all hospitals in the region are working under these guidelines.

I regret to inform you that we are unable to offer you intensive care treatments at this time, as a result of the triage guidelines. Because of your medical condition, the likelihood that you would survive even with intensive care is considered to be too low for us to offer intensive care. The team has made this decision based on the following information:_____.

I have also asked for a second opinion from a colleague, Dr. _____, who has concurred with my assessment. You may speak with him/her if you wish.

I am deeply sorry about this situation. This is not the way we ordinarily make these decisions, and I can only imagine how you must feel right now. I want you to know that even though we cannot offer intensive care, we will do everything else that could conceivably give you a chance of recovering, including: _____.

And I promise you that, no matter what, we will also use medication to treat any discomfort, such as pain or shortness of breath. We know that when we treat discomfort appropriately, this is not harmful and may actually help improve your condition.

Template 2.
As you know, you/your loved one has been receiving treatment in our Intensive Care Unit. Normally, when somebody is admitted to our Intensive Care Unit, the medical team continues to offer them intensive care until they recover, or it becomes apparent that there is no reasonable chance that they could recover even with continued intensive care. However, because of the COVID outbreak, we are currently unable to offer intensive care to everyone who is critically ill. As a result, our hospital is working under triage guidelines, which means that we are only offering to provide or continue intensive care for those who are most likely to be able to survive and recover from their critical illness. You probably have heard about this in the news – all hospitals in the region are working under these guidelines.

I regret to inform you that we are unable to continue giving you/your loved one intensive care treatments at this time, as a result of the triage guidelines. Because of your medical condition, the

likelihood that you would survive and recover even with continued intensive care is too low for us to offer intensive care. I have made this decision based on the following information:

[Either document the specific exclusion criterion met by the patient, or a brief explanation for concluding that this person's chances of survival fall below the threshold indicated in the triage document]

I have also asked for a second opinion from a colleague, Dr. _____, who has concurred with my assessment. You may speak with him/her if you wish.

I am deeply sorry about this situation. This is not the way we ordinarily make these decisions, and I can only imagine how you must feel right now. I want you to know that even though we cannot continue intensive care, we will continue other therapies, including:

And I promise you that, no matter what, we will also use medication to treat any discomfort, such as pain or shortness of breath. We know that when we treat discomfort appropriately, this is not harmful and may actually help improve your condition. We have guidelines for how to keep people comfortable when we discontinue life-sustaining measures, and we will use those guidelines.

Appendix C. Suggested order set for symptom management for COVID-19 patients (adapted with permission from Champlain Palliative Symptom Management Medication Order Form - Long Term Care)

Symptom	Medications	Recommended starting dose
Pain/Dyspnea	Hydromorphone 2mg/ml	0.5-1.0 mg SC q30min PRN*
Nausea/Delirium	Haloperidol 5mg/ml	1 mg subcut q2hourly PRN **
Sedation	Midazolam 5 mg/ml	1-2 mg subcut q15 minutes PRN ***
Secretions	Scopolamine 0.4 mg/ml	0.4 mg subcut q4hourly PRN
Fever	Acetaminophen 650 mg suppositories	Administer q6hourly PR PRN
Urinary retention	Foley catheter 16 Fr	Insert catheter PRN
Dry mouth	Mouth swabs	Mouth care QID and PRN

Please call MD if patient receives more than 2 PRN of hydromorphone in 4 hours.

* may start at 0.25mg in a patient who is opioid naive, frail, or elderly
** relative contraindication in Parkinson's disease
*** can use higher doses for refractory dyspnea

Appendix D. Backgrounder

A. Context

The current pandemic of COVID-19 is likely to lead to a substantial increase in the demands on acute and critical care services in Ontario. Given that these services operate near or even above capacity at baseline, even the lowest estimates of incidence would exceed our capacity at an early stage. A minor or moderate surge could potentially be accommodated by adapting existing resources (e.g. transport and OR ventilators, operative settings and non-ICU staff with appropriate training). However, there is a compelling need to prepare a triage system to allocate critical care resources in the event of a severe surge in demand, to be used only as a last resort when critically ill people are unable to access any critical care resources. This triage system would be applied to current and new patients with critical illness, whether or not they are presenting with COVID acute respiratory illness or another illness. In order to enact this triage plan, we require a triage decision support protocol, infrastructure, processes, legal/regulatory protections and training[1], all of which are currently lacking in Ontario. We also need to ensure that patients who are denied critical care resources are still cared for appropriately, ensuring that they are given an opportunity to survive, while also receiving appropriate symptom management. The consequences of failing to prepare for this eventuality are potentially serious, as has been seen in Italy, a country with similar ICU resource levels to Canada.

B. Purpose & Methods

Purpose of this Document

This document is intended to outline criteria to be used for the allocation of critical care resources (especially mechanical ventilators) in a scenario where the need for ventilatory support is greater than the existing resources. The use of a triage protocol should be considered a last resort, to be used only when all potential resources (e.g. operating room ventilators, transport ventilators) and staff have been deployed, all reasonable efforts have been made to move patients to available resources at other locations, and there is still demand. The triage protocol is a green document within the overall 2020 COVID pandemic response in Ontario.

Methods

Development of the protocol was led by Dr. James Downar (The Ottawa Hospital) under the auspices of the Ethics Table of the Ontario COVID Command Structure. It builds on earlier work in Ontario by Christian et al[1] (see also Appendix 1) and is informed by a consultative process with Ontario critical care and other physicians and members of the Ethics Table in March 2020. Consultation will continue over the coming days. Legal opinion is being sought to ascertain legal implications of its use in the 2020 COVID pandemic.

Evolution and Key Considerations of Triage Criteria

Existing critical care triage plans have generally described a set of inclusion criteria, a set of exclusion criteria, and a timeframe for reassessment of improvement[1,18].

i) Inclusion Criteria (Christian et al.[1]):

Variable	Inclusion Criteria for Critical Care Admission
Requirement for invasive ventilatory support	Refractory hypoxemia ($Spo_2 < 90\%$ on nonrebreather mask $Fio_2 > 0.85$) Respiratory acidosis with $pH < 7.2$ Clinical evidence of respiratory failure Inability to protect or maintain airway
Hypotension	SBP < 90 mm Hg for adults (see BP parameters for all age-groups in Table 3) or relative hypotension with clinical evidence of shock for all ages (altered level of consciousness, decreased urine output, other end-organ failure) refractory to volume resuscitation requiring vasopressor/inotrope support that cannot be managed on the ward

SBP = systolic BP; Spo_2 = oxygen saturation as measured by pulse oximetry.

ii) Exclusion Criteria:

These have traditionally fallen under 2 categories- (1) criteria that indicate a low probability of surviving an acute illness, and (2) criteria that indicate a low probability of surviving more than a few months regardless of the acute illness[1]. These categories are not mutually exclusive. A detailed list of these criteria appear in Ontario's pandemic plan, published in 2006[18]:

Exclusion critiera

The patient is excluded from admission or transfer to critical care if *any* of the following is present:

A. Severe trauma
B. Severe burns of patient with any 2 of the following:
   - Age > 60 yr
   - > 40% of total body surface area affected
   - Inhalation injury
C. Cardiac arrest
   - Unwitnessed cardiac arrest
   - Witnessed cardiac arrest, not responsive to electrical therapy (defibrillation or pacing)
   - Recurrent cardiac arrest
D. Severe baseline cognitive impairment
E. Advanced untreatable neuromuscular disease
F. Metastatic malignant disease
G. Advanced and irreversible immunocompromise
H. Severe and irreversible neurologic event or condition
I. End-stage organ failure meeting the following criteria:
   Heart
   - NYHA class III or IV heart failure

   Lungs
   - COPD with FEV_1 < 25% predicted, baseline PaO_2 < 55 mm Hg, or secondary pulmonary hypertension
   - Cystic fibrosis with postbronchodilator FEV_1 < 30% or baseline PaO_2 < 55 mm Hg
   - Pulmonary fibrosis with VC or TLC < 60% predicted, baseline PaO_2 < 55 mm Hg, or secondary pulmonary hypertension
   - Primary pulmonary hypertension with NYHA class III or IV heart failure, right atrial pressure > 10 mm Hg, or mean pulmonary arterial pressure > 50 mm Hg

   Liver
   - Child-Pugh score ≥ 7
J. Age > 85 yr
K. Elective palliative surgery

In addition, this pandemic plan identified those with Sequential Organ Failure Assessment (SOFA) scores of 7-11 for the highest priority, with those <7 as lower priority, and those with scores of 0 or >11 being excluded from critical care resources. The aim was to prioritize those with intermediate levels of acute illness to receive intensive care.

Considerations to establish current criteria

- With greater experience, most experts no longer recommend the use of SOFA scores to prioritize patients, because the correlation with outcomes is not as strong as was previously believed. Many young patients are admitted with severe illness but ultimately survive, and the severity of acute illness does not imply greater or lower utility of treatment.
- Some selected individuals with metastatic cancer have a reasonable expectation of surviving an ICU admission and living for years[19,20].

- We are able to better prognosticate for patients with some types of chronic organ disease who develop critical illness, such as people with chronic liver disease using the Acute on Chronic Liver Failure (ACLF) grading system[21]
- Organ donation has become more common, and may offer substantial life prolongation for people with organ failure. Selected patients who are admitted to the ICU and assigned the highest priority for organ transplantation have a reasonably high expectation of receiving an organ and surviving to discharge. This would mean that anyone who is immediately postoperative from an organ transplant should not be denied ICU admission. However, patients who are being referred for ICU admission while awaiting an organ should only be admitted if organ transplantation is still proceeding (and this may not be the case if people who would be eligible for organ donation after neurological or circulatory death are not being admitted to the ICU) and they are assigned the highest priority for an organ transplant
- We have better prognostication tools for neurological injury, including:
    - For subarachnoid hemorrhage, the WFNS system[22].
    - For intracerebral hemorrhage, the ICH score[23].
    - For acute ischemic stroke, the NIH Stroke Scale[24].
    - For moderate or severe traumatic brain injury, the IMPACT score[25].
- Specific age limits may also seem arbitrary, and perhaps less rationally connected to mortality than frailty[26-28]. The Clinical Frailty Score is currently in widespread use throughout the healthcare system.
- There is also a greater appreciation of the concept of chronic critical illness, and the ability to identify ICU patients who have survived their acute illness but who are still requiring mechanical ventilation after 2 weeks and very unlikely to survive to a year using the ProVent score[29-31].

With this in mind, we propose a staged triage protocol that allows for the use of continuous data at different thresholds depending on the degree of surge.

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Reviewer Suggestions
(Form 101)

Date
2020/06/01

Family name of applicant	Given name	Initial(s) of all given names	Personal identification no. (PIN)
Klein	Ran	R	**Valid** 282850

Title of proposal

Clinical Triage Protocol for Major Surge in COVID-19 Pandemic - Aiding and Recording Patient Management Decisions

1		Area(s) of expertise	PIN	Lang.
2		Area(s) of expertise	PIN	Lang.
3		Area(s) of expertise	PIN	Lang.
4		Area(s) of expertise	PIN	Lang.
5		Area(s) of expertise	PIN	Lang.

PROTECTED B WHEN COMPLETED

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7		Area(s) of expertise	PIN	Lang.
8		Area(s) of expertise	PIN	Lang.
9		Area(s) of expertise	PIN	Lang.
10		Area(s) of expertise	PIN	Lang.

PROTECTED B WHEN COMPLETED

Personal identification no. (PIN)	Family name of applicant
Valid 282850	Klein

REVIEWER EXCLUSIONS

Sandra Wu, MBA, PMP, Executive Director

Sandra is the primary contact for the Ottawa DOM, the partnering organization for the current project proposal. Her background includes strategic planning, project management, advisory services as well as finance and administration. Sandra Wu will facilitate collaboration between the involved TOH departments, divisions, and stakeholders outside of TOH. She will work closely with the project coordinator and the team to work on the mobile app development efforts, project management and platform integration strategies.

Darshdeep Dhillon, MBA, Business Strategist, Ottawa DOM

Darshdeep brings with her years of healthcare management experience in building businesses across sectors, including medical devices, pharmaceutical, diagnostics and over-the-counter consumer goods. She is a Biomedical Engineer and an MBA from the University of Ottawa. She has held various positions of responsibility across marketing, strategy, business development and sales leadership across international markets and is currently working as a Business Strategist with the Ottawa DOM. Her project management skills along with the understanding of health systems will help successful dissemination and implementation of the project.

Abhilash Menon, MBA, Business Strategist, Ottawa DOM

Abhilash Menon is an electronics-engineer and holds an MBA from the University of Ottawa. He is experienced in software development, digital marketing, business development, and entrepreneurship and works as a Business Development Strategist at the Ottawa DOM. Abhilash will be part of the project management and integrated knowledge translation teams and will assist in prospecting for partners and users of the application, and dissemination of knowledge through digital marketing channels.

André Carrington, PhD, MMath, PEng, CISSP, Post-doctoral fellow, Machine Learning for Health Care

André is a postdoctoral fellow in artificial intelligence (AI) at the Ottawa Hospital Research Institute with affiliations to the Institute for Clinical Evaluative Sciences, L'Institut du Savoir Montfort and the Ottawa Department of Medicine. His publications and research focus on methods and measures for optimal, equitable, explainable and personalized AI; the nature of real and synthetic data in learning, dimensionality and autoencoding; and variations of recurrent and convolutional neural networks (deep learning). He also has a strong background in software development and health informatics from over a decade in industry. He will be supporting and guiding the team as the AI expert consultant.