GEMINI Project Proposal Form

INSTRUCTIONS: There are two parts to this form. Part A is to be completed and submitted for review by the GEMINI Project and Publications Committee. Part B is to be completed once your project proposal has been approved AND if your project requires GEMINI Data Analyst support.

Part A: PROJECT DESCRIPTION

Please provide a brief (1-2 pages) description of your proposed project. Provide just enough detail for the GEMINI Project and Publications Committee (non-specialist investigators) to determine whether the study is feasible.

Project Title
Using machine learning to estimate delirium prevalence in hospitalized adults during the Covid-19 pandemic in Ontario

Project Acronym/Nickname/Short Title
GEMINI-Pandemic Delirium

Project Members and Institution	
Name, Institution	
Lead Investigator:	[Lead researcher at the institution]
GEMINI Lead Investigator:	[Amol Verma/Fahad Razak or any GEMINI Investigator]
Team Members:	[All team members]
Main contact and email: (for kickoff meeting and communication)	[Who to contact regarding this proposal + email]

Study Question/Objective
1. What was the prevalence of delirium among adult medical inpatients during the Covid-19 pandemic?
2. How did the prevalence of delirium during the Covid-19 pandemic compare to pre-pandemic prevalence?
3. How did delirium prevalence vary across patient subgroups: with/without Covid-19, with/without critical illness (defined as being cared for in an ICU)
4. How did delirium prevalence vary over time in association with changing hospital visitation policies?
5. Before and during the pandemic, what was the association between delirium and in-hospital mortality, hospital length-of-stay, and 30-day readmission rates?

Please select the GEMINI research objective(s) that apply to	☐ Develop methods to de-identify, standardize, assess and improve the quality of data for research across multiple hospitals ☒ Characterize populations of hospitalized patients, examine variations and associations related to sociodemographic data, clinical characteristics and conditions, processes of care, resource use, and clinical outcomes for COVID and non-COVID illnesses

your proposal:	☐ Predict and model clinical outcomes and resource use for patients with COVID and non-COVID illness ☒ Study the effects of the COVID-19 pandemic and corresponding changes made to health systems on the demographic and clinical characteristics, processes of care, resource use, and clinical outcomes of patients with non-COVID illness in hospital ☒ Quantify the association between organizational aspects of hospital care (e.g. staff scheduling, ward organization, infection control practices, etc.) and resource use and clinical outcomes for patients with COVID and non-COVID illness ☐ None of the above

Background/Rationale
Provide background, rationale and how the selected GEMINI research objective(s) apply to the proposal

Delirium affects approximately 1 in 3 patients hospitalized[1,2] with Covid-19 and more than half of those who required intensive care.[3] Furthermore, visitor restrictions[4] during the pandemic have been associated with increased risk of delirium in specific patient populations, such as those hospitalized to a stroke unit.[5] Our previous GEMINI research (publication in process) showed that delirium affects up to 25-30% of general internal medicine patients. It is not known how delirium rates changed in adult medical inpatients during the pandemic in Ontario.

In the GEMINI-Delirium project, we have developed a machine learning tool that is able to measure the occurrence of delirium using GEMINI data with 90% accuracy and 75-80% sensitivity and positive predictive value. We have recently validated this tool in data during the pandemic at Sunnybrook, and it performs similarly (further validation at other sites is ongoing).

In this study, we propose to use the GEMINI-Delirium machine learning tool to measure the rates of delirium among all adult medical inpatients, including those with and without Covid-19 during and before the pandemic, to address the questions laid out above.

We hypothesize that the prevalence of delirium among Covid-19 and non-Covid-19 patients will increase during the pandemic, will be greater in periods/hospitals of greater Covid-19 burden, and will be greater during periods of greater hospital visitation restrictions.

Shao SC, Lai CC, Chen YH, Chen YC, Hung MJ, Liao SC. Prevalence, incidence and mortality of delirium in patients with COVID-19: A systematic review and meta-analysis. *Age Ageing*. 2021;50(5):1445-1453. doi:10.1093/ageing/afab103

Kennedy M, Helfand BKI, Gou RY, et al. Delirium in Older Patients with COVID-19 Presenting to the Emergency Department. *JAMA Netw Open*. 2020;3(11):1-12. doi:10.1001/jamanetworkopen.2020.29540

Pun BT, Badenes R, Heras La Calle G, et al. Prevalence and risk factors for delirium in critically ill patients with COVID-19 (COVID-D): a multicentre cohort study. *Lancet Respir Med*. 2021;9(3):239-250. doi:10.1016/S2213-2600(20)30552-X

Munshi L, Evans G, Razak F. The case for relaxing no-visitor policies in hospitals during the ongoing COVID-19 pandemic. *Cmaj*. 2021;193(4):E135-E137. doi:10.1503/cmaj.202636

5.	Hahn M, Gröschel S, Gröschel K, Uphaus T. Association of Delirium Incidence with Visitation Restrictions due to COVID-19 Pandemic in Patients with Acute Cerebrovascular Disease in a Stroke-Unit Setting: A Retrospective Cohort Study. *Gerontology*. Published online 2022. doi:10.1159/000526165

Study Overview	
Study Design (E.g. cohort, case-control, etc.)	Serial cross-sectional study
Patient Population	All adult medical and ICU inpatients (i.e. admitted to any medical specialty or ICU)
GEMINI data date range (E.g. Apr 2015-Mar 2020)	April 1, 2018 – Most recent

Inclusions (in order)* Add more rows if needed	Step	Description
	1	Adult > =18 years old
	2	Admitted to medical specialty ICU
	3	

Exclusions (in order)* Add more rows if needed	Step	Description
	1	
	2	
	3	

*Please be specific with your inclusion and exclusion criteria. These will be treated as step-by-step instructions when creating your GEMINI data cut. For instance, if your GEMINI cohort is based on ICD codes, please provide the specific ICD codes and CIHI diagnosis types that define your cohort.

Include details on primary outcome, explanatory variables, and high-level description of analyses:

Primary Outcome: Delirium as determined by GEMINI machine learning tool

Secondary Outcomes: Delirium as determined by ICD-10 codes, in-patient mortality, hospital length-of-stay, 30-day readmission to any GEMINI hospital

Main Exposure:
Analysis 1: Pandemic vs. pre-pandemic. We will define the pandemic period as beginning March 17, 2020 (when lockdown policies were implemented). We will analyze data up to June 30, 2021. Pre-pandemic period will be April 1, 2018 to March 16, 2020.

Analysis 2: Pre-pandemic period vs. different waves of the pandemic, defined by "lockdown periods" as described by the CIHI COVID19 Intervention Tool (https://www.cihi.ca/en/canadian-covid-19-intervention-timeline)
Pre-pandemic period defined as: April 1 2018 to Mar 16 2020
Lockdown periods:
Mar 17, 2020 to Jul 24, 2020
Jan 14, 2021 to Feb 19, 2021
Apr 8, 2021 to Jun 9, 2021
Covariates: patient baseline characteristics such as age, sex, comorbidity, residence in nursing home, LAPS, etc. along with calendar month, study month, season, and hospital.

Subgroup analyses:
- Male vs female patients (to assess for any sex-related differences, in keeping with best practices of sex-gender based analysis as required by CIHR)
- Patients with/without Covid-19 (defined using ICD-10 codes)
- Patients with/without ICU use (defined using CIHI special care unit data)

High-level analysis description:

We will use multivariable regression modeling to assess the association of delirium with being hospitalized during the exposure time period(s) compared with the pre-pandemic period, adjusting for patient and other situational factors. We will examine effects in pre-specified subgroups. Then, we will examine the association between delirium and patient outcomes (mortality, LOS, 30-day readmission) compared to patients without delirium, using multivariable regression accounting for covariates described above, stratifying the analyses by pre-pandemic and pandemic exposure time periods. We will qualitatively compare the association between delirium and outcomes in the different time periods and determine if formal statistical testing is needed to compare whether the association between delirium and outcomes changed during the pandemic compared to pre-pandemic.

Requested Data Elements
Which **GEMINI Hospital sites** will be **excluded** (if all sites included, leave blank):
Click or tap here to enter text.
What **Data Tables** will be used in the analysis (check all that apply):
GEMINI Data Dictionary can be downloaded here
[In this order please]
☒IP Administrative
☒ED Administrative
☒IP Diagnosis
☒ED Diagnosis
☐IP Intervention
☐ED Intervention
☒IP Special Care Unit
☒Room Transfer
☐Radiology Test Occurrence (date/time of whether tests occurred)
☐Radiologist Reports (narrative text) - <mark>If requested, please justify for this:</mark>
☒Laboratory
☒Blood Transfusion
☒Pharmacy
☒Derived Variables (renamed to match dictionary)
☒Locality Variables
☐Other:
Please note that data available for research is subject to change. For the most up-to-date details, please review the latest GEMINI Data Repository Dictionary available here.

What is the timeline for this project?	6 months
Are there any upcoming deadlines?	[No/Yes (if yes please explain)]

Will a GEMINI data analyst conduct the analytic component of this project?	☒Yes ☐No
If **No**, list the researcher(s) who require access to HPC4Health to conduct the analytic component of this project (name and email)	

Please check the box below to confirm that the researcher(s) accessing HPC4Health and conducting the analytic component of this project are:

- Comfortable with basic Unix commands
- Familiar with R and/or Python

Please note: the following tools are available: RStudio Workbench, GitLab and slurm. There is no internet access or use of Microsoft software on HPC4Health.

☐ **I confirm**

Grants/Funding

Is this proposal related to a grant submission [pre-award stage]? ☐Yes ☒No

Has the grant been successfully funded? ☐Yes ☐No

If yes, please list the name of the grant competition and the main aims:

1.
2.
3.

If not, please inform the GEMINI team when the grant has been successfully funded.

Conflict of Interest

Is this project industry-sponsored, have any industry ties or commercial component? ☐Yes ☒No

If yes, please describe:

Do you have any perceived or actual conflicts of interest and/or industry ties, which the Projects and Publications Committee should be aware of? ☐Yes ☒No

If yes, please describe:

As per GEMINI's data Governance Policy, the use of GEMINI Data is strictly restricted to the purpose of conducting REB-approved scientific research. GEMINI Data or the output of analyses using GEMINI Data is not be used for commercial purposes or interest, nor to be shared with any third parties for such purposes.

Prior to Submission

Has a GEMINI Investigator reviewed your project proposal? If not, please contact a GEMINI Investigator to review before submitting your project proposal to GEMINI.Research@unityhealth.to

☒Yes   ☐No

Name of Investigator who reviewed project proposal: [Amol Verma/Fahad Razak or any other GEMINI Investigator]

Is your project related to any of the following specialty areas?
☐ Specialized methods (e.g., AI/machine learning)
☐ Specialized patient population (e.g., paediatrics)
☐ Specialized dataset (e.g. cancer/ONCO)