

OurPractice

General Medicine

*A hospital-level report for quality care
in General Medicine*

Background and Indicator Details

JUNE 30, 2024



Ontario
General Medicine
Quality Improvement
Network



Ontario
Health

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Introduction

The [Ontario General Medicine Quality Improvement Network \(GeMQIN\)](#)¹ is a provincial program delivered by Ontario Health, in partnership with the [GEMINI](#) data collaborative.² GeMQIN is a data-driven community of practice focused on improving the quality of inpatient general medicine care.

GeMQIN uses data from GEMINI to create practice reports at the individual physician level ([MyPractice: General Medicine Report](#)³), and the hospital level ([OurPractice: General Medicine Report](#)⁴). These personalized, confidential reports inform physicians and hospitals about their clinical care patterns and patient outcomes. Quality indicators focus on length of stay, readmission, in-hospital mortality, routine bloodwork, advanced imaging, appropriate blood transfusion, and ordering of sedative-hypnotic medications. Hospital-level reports provide risk-adjusted comparisons across the network.

This document provides background information regarding the data sources used, inclusion criteria, indicator selection, contextual interpretation, and specific details for each indicator presented in the [OurPractice: General Medicine Report](#).

Data Collection and Management

The data for this report were collected by GEMINI. Established in 2015, GEMINI is one of Canada's largest hospital data and analytics resources. GEMINI is a hospital research collaborative based out of Unity Health Toronto and currently holds data on over 2.1 million admissions from more than 30 Ontario hospitals.² With data for all medical (including general medicine, cardiology, oncology, etc.) and intensive care hospitalizations, GEMINI data covers approximately 60% of all adult medical and intensive care beds across Ontario.

Both administrative and clinical data from hospital information systems are extracted and shared with GEMINI directly from hospitals participating in GeMQIN. Administrative data include defined variables, such as patient demographics, admission and discharge dates, and diagnosis codes standardized for reporting to the Canadian Institute for Health Information (CIHI). Clinical data include variables such as patient vital signs, laboratory test results, imaging, interventions, and medication orders. GEMINI receives hospital data every 3 months and has established analytical processes to handle the volume and range of data collected, along with workflows for de-identification, quality control, standardization, and validation. The methodology for ensuring data quality has been rigorously validated, demonstrating 98% to 100% accuracy across key data elements compared to the gold-standard chart review.⁵ GEMINI data are collected through research ethics board-approved protocols and are governed by the GEMINI data governance policies.

Inclusion Criteria

OurPractice reports include hospitalizations that meet the following criteria:

1. Discharged during the reporting period
2. Admitted to or discharged from the general medicine department or hospitalist service at a participating hospital

Strategies to attribute patients to General Medicine are tailored and developed in collaboration with each hospital based on their specific model of clinical care.

Patient Diagnoses

The OurPractice: General Medicine reports present indicators stratified by patient diagnosis groups. We use the [Clinical Classifications Software Refined](#) (CCSR)⁶ to group Canadian [ICD-10-CA](#)⁷ codes into clinically meaningful diagnosis groups. These diagnosis groups are based on the most responsible ICD-10-CA discharge diagnosis, as reported in the CIHI [Discharge Abstract Database](#) (DAD).⁸ The CCSR approach allows us to aggregate more than 70,000 unique ICD-10-CA diagnosis codes into ~540 mutually exclusive categories across 22 body systems. Some diagnosis codes are cross-classified into more than 1 category because individual ICD-10-CA codes can describe multiple conditions, or a condition and a common symptom/manifestation. We define patient diagnosis based on the default CCSR code. When a proxy most responsible discharge diagnosis is present (diagnosis type 6), that code is used in place of the most responsible discharge diagnosis (diagnosis type M).

CCSR codes are designed for ICD-10-CM codes. GEMINI has developed an algorithm to reliably map CCSR categories to Canadian ICD-10-CA codes. The algorithm is an open source resource freely available to the public⁹ and has been validated by clinical experts.¹⁰

Indicator Selection

The OurPractice: General Medicine report includes 10 indicators that were selected by the GeMQIN Report Development Committee (comprising the program's provincial clinical leads, physicians and interdisciplinary health professionals, hospital administrators, quality improvement experts, and researchers). A focus of GeMQIN in the coming years will be to further develop quality indicators that are relevant to hospital medicine through consultation with an expert indicator committee. Feedback and/or participation in future indicator selection is welcome at GeMQIN@OntarioHealth.ca.

Contextual Interpretation

These data are intended to help hospitals understand the quality of general medicine care and inform quality improvement efforts. There are sometimes large differences in quality indicator performance between hospitals. These differences may be due to differences in processes and quality of care, case mix, and/or patient characteristics. Risk-adjusted estimates standardize for (i.e., hold constant) differences in case mix and patient severity. This allows remaining differences between hospitals to be attributed to a hospital's processes and quality of care.

While our risk adjustment is robust, it is unable to consider factors that are not included in hospital or administrative health data (e.g., primary care data, outpatient clinic data). Furthermore, risk adjustment is based on electronic health record data, which reflect not only the health of a patient but also their interactions with a given hospital.¹¹ Thus, we encourage these data to be interpreted with local context in mind. This context-driven interpretation is especially important given that the COVID-19 pandemic impacted hospitals in different ways and to varying degrees.

Hospitals in This Report

This OurPractice report includes data from the following hospitals. GeMQIN includes additional hospitals not included in this report because they do not participate in the data collection portion of the program.

- Brampton Civic Hospital – William Osler Health System
- Cortelluci Vaughan Hospital – Mackenzie Health
- Etobicoke General Hospital – William Osler Health System
- Grand River Hospital
- Greater Niagara General Site – Niagara Health
- Oakville Trafalgar Hospital – Halton Healthcare
- Humber River Hospital
- Kingston General Hospital – Kingston Health Sciences Centre
- Mackenzie Richmond Hill Hospital – Mackenzie Health
- Mount Sinai Hospital – Sinai Health
- Michael Garron Hospital – Toronto East Health Network
- North York General Hospital
- Sault Area Hospital
- St. Catharines Site – Niagara Health
- St. Joseph's Health Centre – Unity Health Toronto
- St. Mary's General Hospital
- St. Michael's Hospital – Unity Health Toronto
- Sunnybrook Health Sciences Centre
- Thunder Bay Regional Health Sciences Centre
- University Hospital – London Health Science Centre
- Victoria Hospital – London Health Science Centre
- Welland Hospital Site – Niagara Health

OurPractice Report versions from different years should not be directly compared to one another. This is because the specific hospitals in the OurPractice Report vary slightly from year to year. Sometimes, a hospital is unable to extract and validate data for the most recent reporting period due to technical barriers (e.g., transition to a different electronic medical record). This is particularly important for risk-adjusted values, which use information from all other hospitals in the report. Two hospitals included in the previous report are not included in this report. One hospital not included in the previous report is included in this report.

Indicator Details

Table 1: Total Length of Stay

Indicator Name	Total length of stay
Description	The number of days from admission to discharge
Unit of Analysis	Hospitalization
Calculation	<p>Median number of days</p> <ol style="list-style-type: none">1. Identify all hospitalizations discharged during the reporting period2. Apply exclusions defined below3. Calculate total length of stay as the difference between date/time of admission and date/time of discharge, in days4. Sort total length of stay values5. Select the middle value, representing the 50th percentile total length of stay
Exclusions	<p>Hospitalizations that were transferred in from or out to another acute care institution</p> <ul style="list-style-type: none">• Coded transfers are based on the DAD fields “Institution From” and “Institution To” <p>Hospitalizations with total length of stay longer than 365 days</p>
Source	Hospital data standardized for reporting to the CIHI DAD
Risk Adjustment	Yes (see Risk Adjustment, below, for details)
Desired Value	No clear desired direction. A shorter length of stay may reflect more efficient use of resources, while a longer length of stay may reflect more thorough care. Interpret in the context of your hospital’s processes of care, case load, and other local clinical context
Comments	This indicator includes alternate level of care days

Table 2: Acute Length of Stay

Indicator Name	Acute length of stay
Description	The number of days from admission to discharge, excluding alternate level of care days
Unit of Analysis	Hospitalization
Calculation	<p>Median number of days</p> <ol style="list-style-type: none">1. Identify all hospitalizations discharged during the reporting period2. Apply exclusions defined below3. Calculate total length of stay as the difference between date/time of admission and date/time of discharge, in days4. Subtract alternate level of care days from total length of stay5. Sort acute length of stay values6. Select the middle value, representing the 50th percentile acute length of stay
Exclusions	<p>Hospitalizations that were transferred in from or out to another acute care institution</p> <ul style="list-style-type: none">• Coded transfers are based on the DAD fields “Institution From” and “Institution To” <p>Hospitalizations with total length of stay longer than 365 days</p> <p>Hospitalizations where entire length of stay is in an alternate level of care service</p>
Source	Hospital data standardized for reporting to the CIHI DAD
Risk Adjustment	Yes (see Risk Adjustment, below, for details)
Desired Value	No clear desired direction. A shorter acute length of stay may reflect more efficient use of resources, while a longer acute length of stay may reflect more thorough care. Interpret in the context of your hospital’s processes of care, case load, and other local clinical context
Comments	This indicator excludes alternate level of care days. Alternate level of care days are coded as integers. As a result, all hospitalizations involving alternate level of care will have at least one coded alternate level of care day. In the rare situation where a hospitalization involves ALC and has total length of stay less than 1 day, this hospitalization is assigned no acute inpatient days and is excluded from acute length of stay calculations

Table 3: Alternate Level of Care Days

Indicator Name	Alternate level of care days (ALC days)
Description	<p>ALC days ÷ total days: the percentage of total inpatient days that were spent on an alternate level of care service</p> <p>ALC days per ALC patient: the median number of days spent on an alternate level of care service, among patients with at least 1 alternate level of care day</p>
Unit of Analysis	Hospitalization
Calculation	<p>ALC days ÷ total days</p> <ol style="list-style-type: none">1. Identify all hospitalizations discharged during the reporting period2. Apply exclusion defined below3. Calculate total length of stay as the difference between date/time of admission and date/time of discharge, in days4. Calculate the total number of ALC days (sum)5. Calculate the total number inpatient days (sum)6. Divide the total number of ALC days by the total number of inpatient days <p>ALC days per ALC patient</p> <ol style="list-style-type: none">1. Identify all hospitalizations discharged during the reporting period2. Apply exclusion defined below3. Exclude patients with no ALC days4. Sort number of ALC days5. Select the middle value, representing the 50th percentile number of ALC days
Exclusion	Hospitalizations with total length of stay longer than 365 days
Data Source	Hospital data standardized for reporting to the CIHI DAD
Risk Adjustment	None
Desired Value	Fewer ALC days is desirable
Comments	<p>This indicator requires 2 separate calculations:</p> <ol style="list-style-type: none">1. ALC days ÷ total days describes the percentage of total inpatient days that were designated as ALC2. ALC days per ALC patient describes the median number of days that patients remain in ALC among patients with at least 1 ALC day <p>ALC days are coded as integers</p>

Table 4: 7-Day Readmission

Indicator Name	7-day readmission
Description	Readmission to any medical or intensive care service at a GeMQIN hospital within 7 days of discharge
Unit of Analysis	<p>Episode of Care</p> <p>An episode of care includes all contiguous inpatient hospitalizations admitted to any medical or intensive care service within GeMQIN. Episodes involving interfacility transfers are linked regardless of diagnosis. An acute care transfer is assumed to have occurred if either of the following criteria are met:</p> <ul style="list-style-type: none">• An admission to a medical or intensive care service at a GeMQIN hospital occurs within 7 hours after discharge from another GeMQIN hospital, regardless of whether the transfer is coded• An admission to a medical or intensive care service at a GeMQIN hospital occurs 7–12 hours after discharge from another GeMQIN hospital, and at least 1 hospital has coded the transfer<ul style="list-style-type: none">○ Coded transfers are based on the DAD fields “Institution From” and “Institution To” <p>For episodes of care involving acute care transfers, readmissions are attributed to the last hospital from which the patient was discharged before readmission</p>
Calculation	Rate: numerator ÷ denominator (calculation equivalent to arithmetic mean)
Exclusion	Episodes with an invalid health card number
Denominator	<p>Total number of episodes of care discharged during the reporting period</p> <p>Exclusions from the denominator:</p> <ul style="list-style-type: none">• Episodes with discharge as death<ul style="list-style-type: none">○ DAD discharge disposition codes: 07, 72, 73, 74• Episodes with at least 1 record for palliative care<ul style="list-style-type: none">○ ICD-10-CA code Z51.5 as diagnosis type M• Episodes with at least 1 record for mental health<ul style="list-style-type: none">○ CIHI major clinical category 17 as diagnosis type M• Episodes where the last record is a self sign-out<ul style="list-style-type: none">○ DAD discharge disposition codes: 06, 61, 62, 65, 66, 67• Episodes where the last hospital has coded a transfer out to a non-GeMQIN acute care institution<ul style="list-style-type: none">○ This indicates that the patient was transferred to a hospital outside of GeMQIN; in which case, readmission cannot be attributed to a GeMQIN hospital○ Coded transfers out are based on the DAD field “Institution To”

Numerator	<p>Total number of episodes of care that were followed by readmission to any medical or intensive care service at a GeMQIN hospital within 7 days of discharge during the reporting period</p> <p>Exclusions from the numerator:</p> <ul style="list-style-type: none"> • Episodes where the first record is elective admission <ul style="list-style-type: none"> • DAD admission category code L • Episodes with at least 1 record for chemotherapy for neoplasm <ul style="list-style-type: none"> • ICD-10-CA code Z51.1 as diagnosis types M, 1, W, X, Y • Episodes with at least 1 record for palliative care <ul style="list-style-type: none"> • ICD-10-CA code Z51.5 as diagnosis type M • Episodes with at least 1 record for mental health <ul style="list-style-type: none"> • CIHI major clinical category 17 as diagnosis type M • Episodes with at least 1 record for obstetric delivery <ul style="list-style-type: none"> • ICD-10-CA codes O10–O16, O21–O29, O30–O37, O40–O46, O48, O60–O69, O70–O75, O85–O89, O90–O92, O95, O98, O99 with a sixth digit of 1 or 2, or Z37 recorded in any diagnosis field • Medical assistance in dying <ul style="list-style-type: none"> • After April 2018: DAD discharge disposition code 73 • Before April 2018: discharge disposition code 7 and all three Canadian Classification of Health Intervention codes: 1.ZZ.35.HA-P7, 1.ZZ.35.HA-P1, 1.ZZ.35.HA-N3
Data Source	Hospital data standardized for reporting to CIHI DAD
Risk Adjustment	Yes (see Risk Adjustment, below, for details)
Desired Value	Lower 7-day readmission rates are desirable
Comments	<p>This indicator does not capture readmissions to hospitals outside of GeMQIN.</p> <p>In rare cases, an episode of care may be mistakenly identified as 2 separate episodes when a patient is transferred from a GeMQIN hospital to a non-GeMQIN hospital and then back to a GeMQIN hospital</p> <p>The following scenario applies only to hospitals where the data provided to GEMINI does not go beyond the reporting period of the OurPractice report at the time of the development:</p> <p>GEMINI receives data after the inpatient has been discharged from hospital. If a patient is still hospitalized at the time of data extraction, that information will not be provided to GEMINI until the hospitalization has ended. If this particular hospitalization is a readmission, this would result in an underestimation of readmission rates because this hospitalization has not yet been counted by GEMINI. To minimize this bias, 7-day readmission rates exclude the most recent 37 days collected from each hospital. The rationale is as follows:</p> <ul style="list-style-type: none"> • 7 days must have passed to allow for 7-day readmission to occur

- > 95% of hospital admissions will be discharged within 30 days based on analyses of GEMINI data

Sources: Discharge Abstract Database,⁸ GEMINI data,² MyPractice: General Medicine,³ ICD-10-CA codes and classifications.⁷

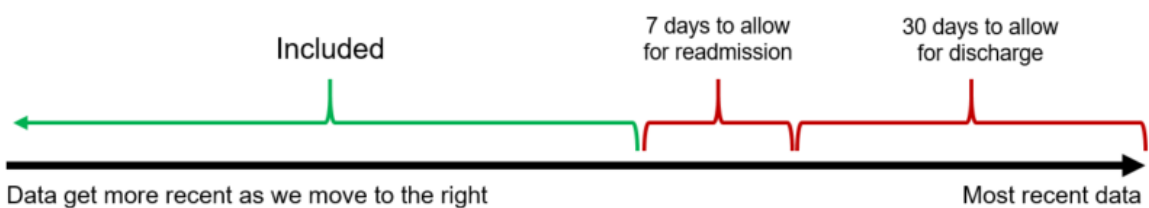


Table 5: 30-Day Readmission

Indicator Name	30-day readmission
Description	Readmission to any medical or intensive care service at a GeMQIN hospital within 30 days of discharge
Unit of Analysis	<p>Episode of Care</p> <p>An episode of care includes all contiguous inpatient hospitalizations admitted to any medical or intensive care service within GeMQIN. Episodes involving interfacility transfers are linked regardless of diagnosis. An acute care transfer is assumed to have occurred if either of the following criteria are met:</p> <ul style="list-style-type: none">• An admission to a medical or intensive care service at a GeMQIN hospital occurs within 7 hours after discharge from another GeMQIN hospital, regardless of whether the transfer is coded• An admission to a medical or intensive care service at a GeMQIN hospital occurs 7–12 hours after discharge from another GeMQIN hospital, and at least 1 hospital has coded the transfer<ul style="list-style-type: none">○ Coded transfers are based on the DAD fields “Institution From” and “Institution To” <p>For episodes of care involving acute care transfers, readmissions are attributed to the last hospital from which the patient was discharged before readmission.</p>
Calculation	Rate: numerator ÷ denominator (calculation equivalent to arithmetic mean)
Exclusion	Episodes with an invalid health card number
Denominator	<p>Total number of episodes of care discharged during the reporting period</p> <p>Exclusions from the denominator:</p> <ul style="list-style-type: none">• Episodes with discharge as death<ul style="list-style-type: none">○ DAD discharge disposition codes: 07, 72, 73, 74• Episodes with at least 1 record for palliative care<ul style="list-style-type: none">○ ICD-10-CA code Z51.5 as diagnosis type M• Episodes with at least 1 record for mental health<ul style="list-style-type: none">○ CIHI major clinical category 17 as diagnosis type M• Episodes where the last record is a self sign-out<ul style="list-style-type: none">○ DAD discharge disposition codes: 06, 61, 62, 65, 66, 67• Episodes where the last hospital has coded a transfer out to a non-GeMQIN acute care institution<ul style="list-style-type: none">○ This indicates that the patient was transferred to a hospital outside of GeMQIN; in which case, readmission cannot be attributed to a GeMQIN hospital○ Coded transfers out are based on the DAD field “Institution To”

Numerator	<p>Total number of episodes of care that were followed by readmission to any medical or intensive care service at a GeMQIN hospital within 30 days of discharge during the reporting period</p> <p>Exclusions from the numerator:</p> <ul style="list-style-type: none"> • Episodes where the first record is elective admission <ul style="list-style-type: none"> • DAD admission category code L • Episodes with at least 1 record for chemotherapy for neoplasm <ul style="list-style-type: none"> • ICD-10-CA code Z51.1 as diagnosis type M, 1, W, X, Y • Episodes with at least 1 record for palliative care <ul style="list-style-type: none"> • ICD-10-CA code Z51.5 as diagnosis type M • Episodes with at least 1 record for mental health <ul style="list-style-type: none"> • CIHI major clinical category 17 as diagnosis type M • Episodes with at least 1 record for obstetric delivery <ul style="list-style-type: none"> • ICD-10-CA codes O10–O16, O21–O29, O30–O37, O40–O46, O48, O60–O69, O70–O75, O85–O89, O90–O92, O95, O98, O99 with a sixth digit of 1 or 2, or Z37 recorded in any diagnosis field • Medical assistance in dying <ul style="list-style-type: none"> • After April 2018: DAD discharge disposition code 73 • Before April 2018: discharge disposition code 7 and all 3 Canadian Classification of Health Intervention codes: 1.ZZ.35.HA-P7, 1.ZZ.35.HA-P1, 1.ZZ.35.HA-N3
Data Source	Hospital data standardized for reporting to CIHI DAD
Risk Adjustment	Yes, see Risk Adjustment, below, for details
Desired Value	Lower 30-day readmission rates desirable.
Comments	<p>This indicator does not capture readmissions to hospitals outside of GeMQIN.</p> <p>In rare cases, an episode of care may be mistakenly identified as 2 separate episodes when a patient is transferred from a GeMQIN hospital to a non-GeMQIN hospital and then back to a GeMQIN hospital.</p> <p>The following scenario applies only to hospitals where the data provided to GEMINI does not go beyond the reporting period of the OurPractice report at the time of the development:</p> <p>GEMINI receives data after the inpatient has been discharged from hospital. If a patient is still hospitalized at the time of data extraction, that information will not be provided to GEMINI until the hospitalization has ended. If this particular hospitalization is a readmission, this would result in an underestimation of readmission rates because this hospitalization has not yet been counted by GEMINI. To minimize this bias, 30-day readmission rates exclude the most recent 60 days collected from each hospital. The rationale is as follows:</p> <ul style="list-style-type: none"> • 30 days must have passed to allow for 30-day readmission to occur

- > 95% of hospital admissions will be discharged within 30 days based on analyses of GEMINI data

Sources: Discharge Abstract Database,⁸ GEMINI data,⁹ MyPractice: General Medicine,³ ICD-10-CA codes and classifications.⁷

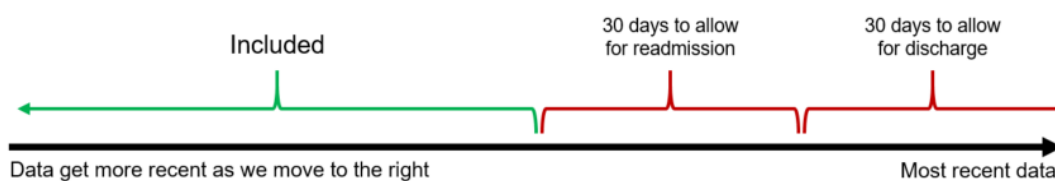


Table 6: In-Hospital Mortality

Indicator Name	In-hospital mortality
Description	Death occurring in hospital
Unit of Analysis	Hospitalization
Calculation	Rate: numerator ÷ denominator (calculation equivalent to arithmetic mean)
Exclusions	<p>Hospitalizations with total length of stay longer than 365 days</p> <p>Age greater than 120 years</p> <p>Hospitalizations with palliative care as the most responsible discharge diagnosis</p> <ul style="list-style-type: none">• ICD-10-CA code Z51.5 as diagnosis type M <p>Medical assistance in dying</p> <ul style="list-style-type: none">• After April 2018: DAD discharge disposition code 73• Before April 2018: discharge disposition code 7 and all 3 Canadian Classification of Health Intervention codes: 1.ZZ.35.HA-P7, 1.ZZ.35.HA-P1, 1.ZZ.35.HA-N3
Denominator	Total number of hospitalizations discharged during the reporting period
Numerator	Total number of deaths in hospitalizations discharged during the reporting period. Death defined by DAD discharge disposition code 7, 72, 73, or 74
Data Source	Hospital data standardized for reporting to CIHI DAD
Risk Adjustment	Yes (see Risk Adjustment, below, for details)
Desired Value	Lower in-hospital mortality rates are desirable
Comments	Consistent with CIHI's Hospital Standardized Mortality Ratio calculation, risk-adjusted quality indicator performance for mortality is limited to diagnosis groups accounting for 80% of in-hospital deaths in GeMQIN-participating hospitals. The default setting of the in-hospital mortality indicator page is to exclude hospitalizations with palliative care as the most responsible discharge diagnosis when determining these diagnosis groups. To include palliative care as a most responsible discharge diagnosis, set the "Exclude" filter on the top left of the indicator page to "Nothing"

Table 7: Advanced Imaging Tests

Indicator Name	Advanced imaging tests
Description	The number of advanced imaging tests per hospitalization. Advanced imaging tests include computed tomography, magnetic resonance imaging, and ultrasound. Interventional radiology is not included
Unit of Analysis	Hospitalization
Calculation	Rate: numerator ÷ denominator (calculation equivalent to arithmetic mean)
Exclusion	Hospitalizations with total length of stay longer than 365 days
Denominator	Total number of hospitalizations discharged during the reporting period
Numerator	Total number of advanced imaging tests in hospitalizations discharged during the reporting period
Data Source	Data extracted from hospital electronic patient records and standardized by subject matter experts
Risk Adjustment	Yes (see Risk Adjustment, below, for details)
Desired Value	No clear desired value. Fewer advanced imaging tests may reflect more efficient use of resources, while more advanced imaging tests may reflect more thorough care. Interpret in the context of your hospital's processes of care, case load, and other local clinical context
Comments	<p>Images of multiple body parts that are grouped together in the same imaging order (e.g., CT abdomen and pelvis) are treated as a single imaging test</p> <p>The advanced imaging indicator page has a filter in the top-left to view results for individual imaging modalities. There are separate tabs for computed tomography, magnetic resonance imaging, and ultrasound. Risk-adjustment on these tabs is modality-specific</p> <p>A small minority of hospitals in the network do magnetic resonance imaging at a partner hospital because they do not have a machine on-site. Thus, magnetic resonance imaging orders are not captured in radiology data at these hospitals. We use Canadian Classification of Health Intervention codes (with the form 3XX40XX) as reported by hospitals to the CIHI Discharge Abstract Database and National Ambulatory Care Reporting System to identify a magnetic resonance imaging order in these cases.</p>

Table 8: Routine Bloodwork Tests

Indicator Name	Routine bloodwork tests
Description	The number of routine bloodwork tests per hospitalization. Routine bloodwork tests are defined as electrolyte tests and complete blood count tests
Unit of Analysis	Hospitalization
Calculation	Rate: numerator ÷ denominator (calculation equivalent to arithmetic mean)
Exclusion	Hospitalizations with total length of stay longer than 365 days
Denominator	Total number of hospitalizations discharged during the reporting period
Numerator	Total number of routine bloodwork tests in hospitalizations discharged during the reporting period
Data Source	Data extracted from hospital electronic patient records and standardized by subject matter experts
Risk Adjustment	Yes (see Risk Adjustment, below, for details)
Desired Value	No clear desired value. Fewer routine blood tests may reflect more efficient use of resources, while more routine blood tests may reflect more thorough care. Interpret in the context of your hospital's processes of care, case load, and other local clinical context
Comments	None

Table 9: Appropriate Red Blood Cell Transfusion

Indicator Name	Appropriate red blood cell transfusion
Description	The rate of appropriate red blood cell transfusion among all red blood cell transfusions in hospitalizations during the reporting period
Unit of Analysis	Blood transfusion
Calculation	Rate: numerator ÷ denominator (calculation equivalent to arithmetic mean)
Exclusion	Red blood cell transfusions with no hemoglobin measurement within 48 hours prior to the transfusion are excluded from the numerator and denominator. These scenarios are rare, occurring in approximately 2% of blood transfusions based on analyses of GEMINI data
Denominator	Total number of red blood cell transfusions in hospitalizations discharged during the reporting period
Numerator	The total number of appropriate ^a red blood cell transfusions in hospitalizations discharged during the reporting period
Data Source	Data extracted from hospital electronic patient records and standardized by subject matter experts
Risk Adjustment	None
Desired Value	A higher rate of appropriate red blood cell transfusion is desirable
Comments	None

^aAppropriate blood transfusions are defined by the most recent pre-transfusion hemoglobin value < 80 g/L within 48 hours prior to transfusion. We use the date/time of when the red blood cell product was issued from the blood bank instead of the date/time when the transfusion was administered because the latter value is not widely available in electronic health record data. We make the assumption that blood products will be transfused shortly after leaving the blood bank.

Table 10: Sedative-Hypnotic Orders

Indicator Name	Sedative-hypnotic orders
Description	<p>The proportion of hospitalizations that received at least 1 order for a sedative-hypnotic drug</p> <p>Note: Ideally, we would exclude patients who were prescribed sedative-hypnotic medications prior to hospital admission from the indicator; however, GEMINI does not currently hold data about pre-hospital medications. Therefore, we report a “main indicator” and a “secondary indicator” to address this</p>
Unit of Analysis	Hospitalization
Calculation	Rate: numerator ÷ denominator (calculation equivalent to arithmetic mean)
Exclusions	<p>Hospitalizations with an appropriate indication for sedative-hypnotics are excluded. Indications for sedative-hypnotics are based on Choosing Wisely Canada’s toolkit to reduce inappropriate inpatient use of sedative-hypnotics.¹² We supplemented the Choosing Wisely list with Lexicomp’s “Benzodiazepines General Statement” to include additional evidence-based indications. Lexicomp is a subscription-based resource that provides evidence-based drug referential content¹³</p> <p>The following are considered indications for sedative-hypnotics when they are present as most responsible discharge diagnosis, proxy most responsible discharge diagnosis, or post-admission comorbidity (diagnosis types M, 6, 2):</p> <ul style="list-style-type: none">• Panic attacks (ICD-10-CA code F41.0)• Anxiety (CCSR category: MBD005; anxiety and fear-related disorders)• Seizures (CCSR category NVS009: epilepsy; convulsions)• Catatonia (ICD-10-CA codes F06.1, F20.2)• Alcohol withdrawal (ICD-10-CA codes F10.3, F10.4)• Benzodiazepine withdrawal (ICD-10-CA codes F13.3, F13.4)• Neuroleptic malignant syndrome (ICD-10-CA code G21.0)• Serotonin syndrome (ICD-10-CA codes T43, T44, F19)• Intoxication: cocaine and other stimulants (ICD-10-CA codes F14.0, F15.0)• Palliative care (ICD-10-CA code Z51.5)
Denominator	<p>Main indicator: number of hospitalizations that did not have a sedative-hypnotic order within 24 hours of admission</p> <p>Note: the main indicator excludes patients who had a sedative-hypnotic order placed in the first 24 hours of hospital admission. This is an imperfect proxy to exclude patients who were taking sedative-</p>

	<p>hypnotic medications before hospital admission (because they would be continued at the time of admission)</p> <p>Secondary indicator: number of hospitalizations, regardless of whether a sedative-hypnotic was ordered in the first 24 hours after admission</p> <p>Note: because orders placed in the first 24 hours do not always reflect pre-hospital medications (for example, a new order could be part of an admission order set), we also report “All orders” in a tab at the top left of the indicator page</p>
Numerator	<p>Main indicator: number of hospitalizations with a new sedative-hypnotic order after 24 hours post-admission in a ward-based setting</p> <p>Secondary indicator: when the “All orders” tab is selected, the numerator includes sedative-hypnotic orders entered at any time after admission</p> <p>Note: sedative-hypnotic orders initiated in the intensive care unit (ICU) are excluded. Step-down units are not considered ICU for this exclusion because patients requiring sedation are typically not admitted to step-down units</p>
Data Source	Data extracted from hospital pharmacy systems, processed by the GEMINI-RxNorm system, ^a and standardized/validated by subject matter experts
Risk Adjustment	None
Desired Value	A lower rate of sedative-hypnotic orders is desirable
Comments	<p>The list of sedative-hypnotic drugs is based on Choosing Wisely Canada’s toolkit for reducing inappropriate use of benzodiazepines and sedative-hypnotics among older adults in hospitals.¹² This list is supplemented with medications listed by the Ontario Ministry of Health’s Narcotics Monitoring System¹⁴ and Trazodone is added as a commonly used sleep medication. We did not include quetiapine or olanzapine because these antipsychotics have other indications</p> <p>The following drugs are considered sedative hypnotics:</p> <ul style="list-style-type: none"> • Alprazolam • Bromazepam • Chlordiazepoxide • Clobazam • Clonazepam • Clorazepate • Diazepam • Flurazepam • Lorazepam • Midazolam • Nitrazepam • Oxazepam

- Temazepam
- Trazodone
- Triazolam
- Zolpidem
- Zopiclone

Handling “as needed” (pro re nata, or PRN) orders for medication:

Because not all hospitals have electronic medication administration records, GEMINI collects data on ordered medications rather than administered medications. PRN orders are included in the calculation of the numerator and are treated like standing scheduled orders for the purposes of all inclusion/exclusion criteria and calculations of the indicator

The indicator cards on the left of the indicator page include detail on the percentage of hospitalizations where the only sedative-hypnotic order is a PRN order

The main bar plot in the center of the indicator page can filter for patients at elevated risk of harms from sedative-hypnotic medications. Options include patients aged > 65 years and patients at risk of frailty, defined as having at least 6 deficits per CIHI’s Hospital Frailty Risk Measure¹⁵

^aThe GEMINI-RxNorm system is a highly accurate automated pipeline for medication data standardization in multisite patient data repositories.¹⁶ The GEMINI-RxNorm system uses a combination of RxNorm tools and external datasets to permit querying of unstandardized medication data to enable research.

Sources: Choosing Wisely Canada,¹⁷ Wolters Kluwer (Lexicomp),¹³ Ontario Ministry of Health.¹⁴

Risk Adjustment

Risk-Adjusted Quality Indicators

It is difficult to assess hospital performance in a fair manner. Certain hospitals may appear to perform worse despite delivering high quality care because they treat sicker patients. Risk adjustment aims to address differences in patient characteristics by comparing what we observed during the reporting period to what we should expect based on a hospital's case mix and patient severity.

We base our expectation on regression models trained on historical data at all hospitals during the 4 years immediately prior to the reporting period. These regression models are developed using methodology from CIHI and Kaiser Permanente, and consider a patient's age, sex, diagnosis group, Charlson comorbidity index score¹⁸ at admission, a modified laboratory-based acute physiology score (mLAPS) based on 11 biochemical parameters at admission,¹⁹⁻²¹ and whether the admission was elective or urgent. Separate regression models are fit for each diagnosis group, allowing each group to have its own associations between risk-adjustment variables and quality indicators. These models are trained on all hospitals in GEMINI regardless of whether that hospital was able to contribute data to the current reporting period.

Variables Used in Risk-Adjustment Models

Table 11 provides a summary of the variables used in risk-adjustment models for each indicator. Regression models are fit with these variables for each diagnosis group.

Table 11: Summary of Variables in Risk-Adjustment Models

	In-hospital mortality	7-day readmissions	30-day readmissions	Total LOS	Acute LOS	Routine bloodwork	Advanced imaging
Age	X	X	X	X	X	X	X
Sex	X	X	X	X	X	X	X
Charlson comorbidity index score	X	X	X	X	X	X	X
Elective admission	X	X	X	X	X	X	X
mLAPS	X	X	X	X	X	X	X
Number of acute care hospitalizations in the past 6 months		X	X	X	X	X	X
Total LOS	X						
Transfer in from acute care	X						
COVID-19 as a risk factor	X						

Abbreviations: LOS, length of stay; mLAPS, modified laboratory-based acute physiology score.

Age

Age is recorded at the time of hospital admission. It is coded as an integer value and is modeled as a restricted cubic spline. Age is included in risk-adjustment models for all indicators.

Sex

Sex is defined by two categories: female and non-female. Data for males and other sexes are combined into "non-female" as the data on other sexes are too limited to model as separate categories. Sex is included in risk-adjustment models for all indicators.

Charlson Comorbidity Index Score

The Charlson Comorbidity Index (CCI) score is based on ICD-10-CA diagnosis codes that were present at admission. The CCI score includes emergency department diagnoses as well as inpatient diagnoses that are classified as pre-admit comorbidities or transfer diagnoses (diagnosis type 1, W, X, Y). The [CIHI Hospital Standardized Mortality Ratio](#) (HSMR) outlines specific circumstances where secondary diagnoses (diagnosis type 3) and most responsible diagnoses (diagnosis type M) are included (pages 18–22).²² Encounters with no emergency department diagnosis codes and no eligible inpatient diagnosis codes are assigned a value of zero. The CCI score is modeled as a linear term and is included in risk-adjustment models for all indicators.

Elective Admission

There are two categories of admission: elective and not-elective, determined based on DAD admit category L. This variable is included in risk adjustment models for all indicators.

Modified Laboratory-Based Acute Physiology Score

The laboratory-based acute physiology score (LAPS) is a measure of illness severity based on 14 laboratory parameters. It is a validated predictor of in-hospital mortality when combined with patient characteristics listed above.^{19,20} The LAPS score is not disease-specific and has been validated in hospitalized patients irrespective of their disease condition, including in Ontario hospitals.²⁰ The LAPS score considers serum albumin, anion gap, serum bicarbonate, arterial pH, arterial PaCO₂, arterial PaO₂, total serum bilirubin, blood urea nitrogen, serum creatinine, serum glucose, serum sodium, serum troponin, hematocrit, and total white blood cell count. We apply a modified LAPS score (mLAPS) that excludes troponin, anion gap, and serum bicarbonate. We exclude troponin because there is no way to reconcile high-sensitivity troponin tests when calculating the score. We exclude anion gap and serum bicarbonate because their use is limited to a preliminary imputation step for missing arterial pH and white blood cell count, and this imputation step is not implemented in the mLAPS score. GEMINI has validated the mLAPS score in 28 Ontario hospitals.²¹ We consider only laboratory tests performed before admission to ensure that post-treatment values are not considered. We assume that laboratory tests that were not performed would be normal. The mLAPS score is modeled as a linear term and is included in risk-adjustment models for all indicators.

Number of Acute Care Hospitalizations in the Past 6 Months

The number of acute care hospitalizations in the past 6 months is defined by three categories: 0, 1, and 2+, representing the number of times a person has been discharged from acute care during the 6 months prior to the admission date. The number of acute care hospitalizations in the past 6 months is included in all risk-adjustment models except mortality (mortality is excluded based on [CIHI's HSMR](#)).²²

Total Length of Stay

Total length of stay is defined as the number of days between admission and discharge. This variable is modeled as a linear term and is included only in risk-adjustment models for mortality (length of stay is included as a variable in mortality models based on [CIHI's HSMR](#)).²² Note that HSMR models 6 categories of total length of stay, while we model it as a linear term. This is due to singular model fits when applying the categorical approach.

Transfer in From Acute Care

There are 2 categories of transfer in from an acute care institution: transferred in and not transferred in, determined based on the DAD field "Institution From," and is augmented using the Ontario Ministry of Health's [Master Numbering System](#).²³ We include transfer in from an acute care institution as a variable in mortality models based on [CIHI's HSMR](#).²²

COVID-19 as a Risk Factor for Mortality

Hospitalizations where COVID-19 is the most responsible discharge diagnosis are treated as a separate diagnosis group for risk adjustment of all indicators. Where it is not the most responsible discharge diagnosis, COVID-19 has been added as a risk factor to mortality indicator models for all diagnosis groups. There are two categories of COVID-19 as a risk factor for mortality: COVID-19 present and COVID-19 not present. As a risk factor, it is determined by inpatient diagnosis code U07.1, or U07.2 as a pre-admit diagnosis, post-admit comorbidity, or service transfer diagnosis (diagnosis type 1, 2, W, X, Y). We include COVID-19 as a risk factor in mortality models for all diagnosis groups, consistent with [CIHI's HSMR](#).²²

Interaction Terms

All risk-adjustment models include 2-way restricted interaction terms between CCI score, mLAPS, and age.

Diagnosis Group

Risk-adjustment models are fit separately within each diagnosis group to allow for diagnosis-specific intercepts and associations between risk-adjustment variables and quality indicators. Diagnoses are grouped using the [Clinical Classifications Software Refined](#) (see Patient Diagnoses, above, for details).⁶ Diagnosis groups with fewer than 200 hospitalizations (150 events for binary indicators) in the training data are grouped into an "Other" catch-all diagnosis group. The "Other" group is then broken down into three subgroups based on

observed values of the quality indicator in the training data. These subgroups are based on event rates for binary indicators and geometric mean for numeric indicators.

Consistent with [CIHI's HSMR](#),²² risk adjustment for mortality is limited to diagnosis groups accounting for 80% of in-hospital deaths in GeMQIN-participating hospitals (based on training data—the 4 years of data immediately prior to the reporting period). Risk-adjusted values for all other indicators consider all diagnosis groups. The default setting for the in-hospital mortality indicator page excludes hospitalizations with palliative care as the most responsible discharge diagnosis when determining these diagnosis groups. To include hospitalizations with palliative care as the most responsible discharge diagnosis, set the “Exclude” filter on the top left of the indicator page to “Nothing.” Separate risk adjustment is performed with and without palliative care.

Missing Data

Patients with no Ontario Health Insurance Plan (OHIP) card number cannot be tracked between admissions, resulting in missing values for the number of acute care hospitalizations in the past 6 months. For our modelling, these missing values are assumed to be 0. Patients without an OHIP card number represent approximately 2% of all hospitalizations at each hospital.

Risk-Adjustment Models for Binary Quality Indicators

We used logistic regression models to risk-adjust binary quality indicators (7-day readmission, 30-day readmission, and in-hospital mortality). All analyses were performed in R²⁴ and models were fit using the `lrm` function from the `rms` package.²⁵

We evaluated models using Harrell's bias correction and 1,000 bootstrap iterations.²⁶⁻²⁹ Evaluation metrics include the Brier (skill) score, c-statistic, Nagelkerke's R², calibration slope, calibration intercept, integrated calibration index, 50th/90th/99th percentile absolute difference between smoothed calibration curves and the diagonal line of best fit, and visual inspection of bootstrapped calibration curves. All variables were retained in the models regardless of statistical significance, and models were not altered based on results of model evaluation. We assumed that observations from the same patient are conditionally independent in all risk-adjustment models.

All risk-adjustment variables for 7- and 30-day readmissions were taken from the last encounter of the index episode of care from which the patient was discharged.

Risk-Adjustment Models for Numeric Quality Indicators

We used semiparametric ordinal regression models to risk-adjust numeric quality indicators (i.e., total and acute length of stay, routine bloodwork, advanced imaging).³⁰ Semiparametric ordinal models were chosen for several reasons: they do not require a distributional assumption for the outcome given covariates, the coefficient estimates are completely robust to extreme outcome values, they require no assumption of equal

variance, and they can handle arbitrary clumping at zero (particularly relevant for advanced imaging). All analyses were performed in R²⁴ and models were fit using the `orm` function from the `rms` package.²⁵

We evaluated models using Harrell's bias correction and 1,000 bootstrap iterations.²⁶⁻²⁹ Evaluation metrics include spearman's Rho, Nagelkerke's R², calibration slope, visual inspection of agreement between observed and estimated mean values, and visual inspection for parallelism of the link function transformed inverse cumulative probability function of one minus the empirical distribution function stratified by fitted values from ordinary least squares regression.³¹ All variables were retained in the models regardless of statistical significance and models were not altered based on results of model evaluation. We assumed observations from the same patient are conditionally independent in all risk-adjustment models.

We compared model fit for each numeric indicator using logit, probit, and loglog link functions in 3 of the 5 largest diagnosis groups, chosen at random. Parallelism was inspected for each link function and the transformed outcome was regressed on fitted values from ordinary least squares regression to assess consistency of slopes across arbitrary cutpoints. All models use a logit link and are equivalent to proportional odds models.

Total and acute length of stay values were rounded to 1 decimal point when fitting risk-adjustment models. Separate risk adjustment is performed for computed tomography, magnetic resonance imaging, ultrasound, and aggregated advanced imaging.

Institutional Assessment for Binary Quality Indicators

Hospital assessments for binary quality indicators (i.e., in-hospital mortality, 7-day readmission, 30-day readmission) use an observed-to-expected ratio framework consistent with [CIHI's HSMR](#) in which the observed number of events during the reporting period is compared to the expected number of events. The expected number of events is the sum of predicted probabilities (from risk-adjustment models) for all encounters at that hospital during the reporting period. A ratio above 1 means that observed values were higher than expected; a value below 1 means that observed values were lower than expected. A 95% confidence interval (95% CI) is calculated using Byar's approximation (below). The ratio is multiplied by the combined event rate at all hospitals during the reporting period so that results can be interpreted as rates on a more meaningful scale. For example, if a hospital had 1.2× more deaths than expected and the combined network-wide in-hospital mortality rate was 6%, the risk adjusted mortality rate at that hospital would be 1.2 × 6% = 7.2%. We do not apply corrections for multiple testing.

Byar's Approximation

Where CI is the confidence interval, E is the expected number of events, O is the observed number, L is the lower bound, U is the upper, and Z is 1.96:

$$95\% \text{ CIL} = O/E \times \{1 - 1/(9 \times O) - Z/[3 \times \sqrt{O}]\}^3$$

$$95\% \text{ CIU} = (O + 1)/E \times \{1 - \{1/[9 \times (O + 1)]\} + Z/[3 \times \sqrt{O + 1}]\}^3$$

Institutional Assessment for Numeric Quality Indicators

Hospital assessments for numeric quality indicators (i.e., total and acute length of stay, routine bloodwork, advanced imaging) use a random intercept regression framework.³²⁻³⁴ A negative binomial regression is fit with expected values as a fixed effect and with hospitals as random intercepts. Expected values are centered encounter-level estimated means (from risk-adjustment models) for all encounters at all hospitals during the reporting period.³⁵ The hospital-level random intercepts represent hospital-specific deviations from the average intercept, holding expected values constant.

An empirical Bayes estimate of each hospital's random intercept is calculated along with its standard error and 95% CIs are constructed around these estimates. The overall model intercept is added so all estimates and confidence intervals are in units of log(estimated mean) and the antilog is taken so that results can be interpreted as estimated means. Hospital effects are assumed to be normally distributed. Models were tested for zero-inflation using scaled residuals from simulating the fitted model and no zero-inflation was present. All analyses were performed in R.²⁴ Models were fit using the glmmTMB function from the glmmTMB package,³⁴ and zero-inflation was tested using the DHARMA package.³⁶

Unadjusted Numbers May Be Different From Risk-Adjusted Numbers

Unadjusted numbers are raw data, summary statistics describing what was observed during the reporting period. They do not take into account differences in case mix or patient severity. Risk-adjusted numbers compare what was observed during the reporting period against what would be expected based on the case mix and patient severity at a given hospital.

Unadjusted numbers will be notably different from risk-adjusted numbers for total length of stay, acute length of stay, and in-hospital mortality due to calculation methods. Length of stay values differ because unadjusted values are medians, while risk-adjusted values are estimated means. Mortality values differ because risk-adjustment only considers diagnosis groups accounting for 80% of mortality, consistent with [CIHI's HSMR](#)²² (i.e., risk-adjusted mortality estimates are based on a subgroup of patients from high-mortality diagnosis groups).

How to Interpret Risk-Adjusted Institutional Assessments

Risk-adjusted values should be interpreted in the context of their 95% CIs. These intervals reflect uncertainty in the hospital's risk-adjusted values. A hospital whose entire interval is below the expected value will be classified as below average and colored blue. A hospital whose entire interval is above the expected value will be classified as above average and colored magenta. A hospital whose interval contains the expected value will be classified as average and colored gray. Note that above and below average describe the direction of the effect and should not be interpreted as good or bad.

Each hospital's risk-adjusted value should be interpreted based on its position relative to the expected value (solid vertical black line). Risk-adjusted values are not designed for direct comparison between individual hospitals, and risk-adjusted values are not designed to rank hospitals relative to one another.

Considerations Regarding COVID-19

The COVID-19 pandemic has evolved substantially over time. Ontario's population has become increasingly vaccinated, the demographics of people infected with COVID-19 have shifted, new treatments have become available for both mild and severe COVID-19, and the virulence of dominant COVID-19 variants has reduced. The time-varying nature of the COVID-19 pandemic makes it difficult to estimate the baseline risk of patients hospitalized with COVID-19 using historical data, leading to overestimation of baseline risk during the reporting period.

Patients with a most responsible discharge diagnosis of COVID-19 are excluded from risk-adjusted reporting. This pertains to caterpillar plots and diagnosis-specific plots on risk-adjusted indicator pages. Patients with COVID-19 are included in all unadjusted reporting.

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