SUSQI PROJECT REPORT

Project Title: Use of Serial Cycle Threshold Values for SARS-CoV-2 to Assist in Early De-Isolation of COVID-19 Positive Patients on a Medical/Surgical unit
Start date of Project: April 25, 2025
Date of Report: July 10, 2025
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Background:

In acute care hospitals across Alberta current guidance for isolation of immunocompetent Coronavirus Disease 2019 (COVID-19) positive patients, is that patients, regardless of their symptoms, are maintained on contact and droplet isolation precautions for 11 days after initial onset of symptoms or initial test positive date, if symptom onset date is not available (1).

For patients on contact and droplet precautions, staff are required to wear the following Personal Protective Equipment (PPE): gown, gloves, eye protection, and a procedure mask. Staff may choose to wear an N95 respirator instead of a procedure mask at any time based on their own infection control risk assessment. However, the use of an N95 respirator is required when caring for patients undergoing an aerosol-generating medical procedure (AGMP), to protect against the transmission of infectious aerosols generated during such procedures.

Clinically indicated patient isolation is a cornerstone of infection control and an indispensable tool for preventing disease transmission (2). However, despite its vital role, maintaining patient isolation imposes considerable financial costs, time demands, environmental impact, clinical challenges and significant social and psychological burdens for both individuals and the healthcare system (Figure 1.) (3,4,13–15,5–12)

Figure 1. The Multifaceted costs of isolation

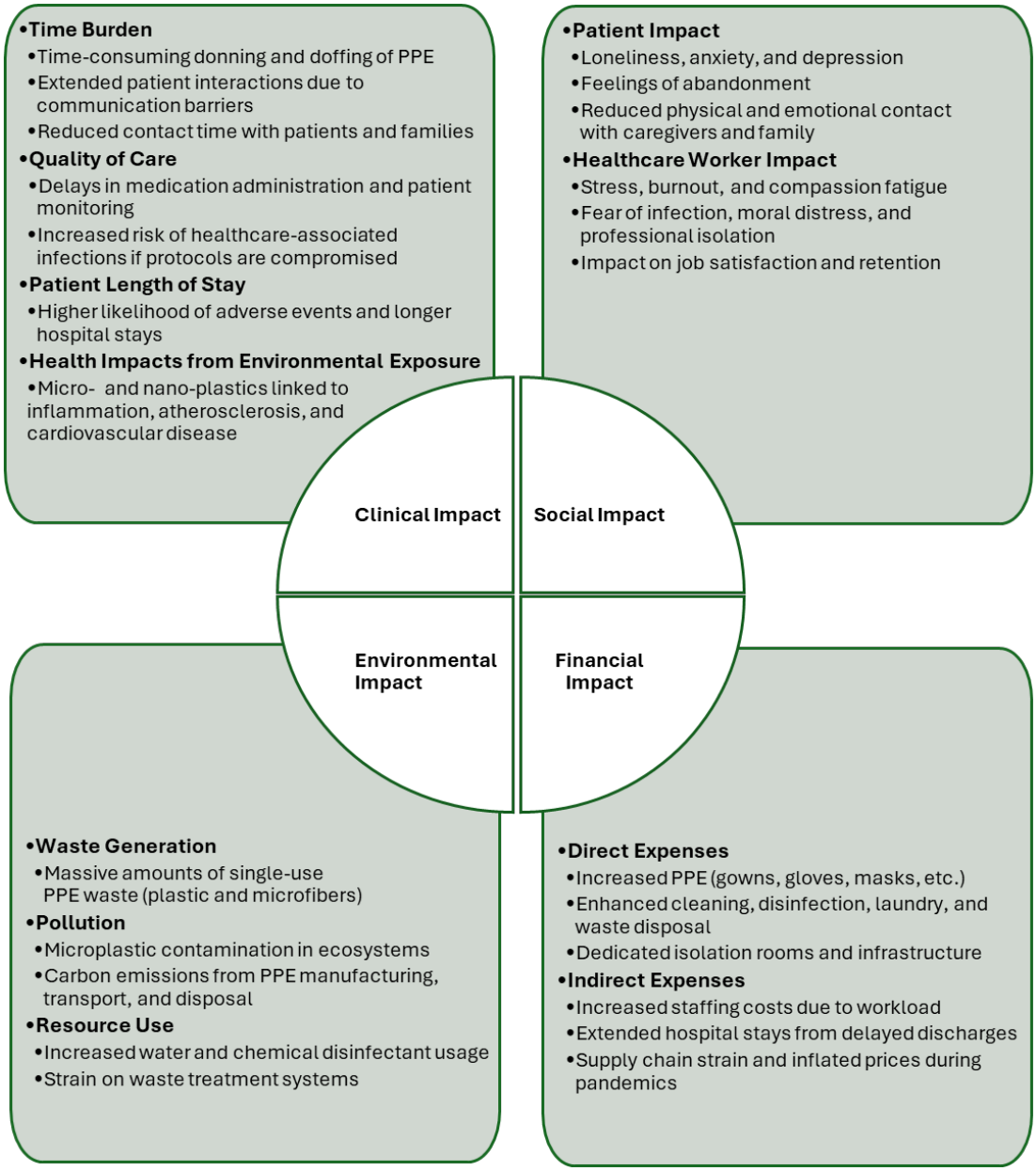


Figure 1 illustrates many of the multifaceted costs associated with patient isolation. However, it is not an exhaustive representation. It does not include all micro costs—such as itemized clinical resources—and indirect costs, including loss of livelihood, travel expenses for family visitation, patient-incurred costs for new medications, and mental health-related expenses such as counselling for unintended consequences of isolation.

Although COVID-19 test results are reported as either positive or negative, the lab also provides an output called a cycle threshold (Ct) value. This value represents the number of polymerase chain reaction (PCR) cycles required to amplify viral genetic material to a detectable level - usually within a range 1 to 40. A lower Ct value means fewer cycles were needed, suggesting a higher viral load, while a higher Ct value indicates a

lower amount of virus present in the sample. Although the PCR platforms used are not strictly quantifiable assays, Ct values greater than 30 consistently correlated with non-cultivatable and hence non-infectious virus, across multiple testing platforms for Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) – the virus responsible for COVID-19 disease (16–20). Therefore, the magnitude of the Ct value and the trending in immunocompetent patients (21), can facilitate confidence in clinical decision-making regarding transmission events, isolation, and treatment plans. A recent retrospective case series carried out by Infection Prevention and Control (IPC) in 2025 identified 12 patients who, in the absence of progressive COVID-19 symptoms, underwent follow-up COVID-19 swab testing. This facilitated clinical decision-making, enabling patient de-isolation within 1–4 days—compared to the standard 11-day isolation period outlined in the Alberta Health Services (AHS) guidance document—resulting in estimated savings of up to $3,482.96 per patient based on PPE costs and healthcare worker time spent donning and doffing PPE (22).

This current quality improvement (QI) initiative is being conducted in the Pulmonary Medicine and Thoracic Surgery Unit, Unit 61, at the Foothills Medical Centre (FMC) in Calgary, Alberta, the province's largest tertiary care facility. Unit 61 admits patients with complex medical conditions and sees high patient turnover, making efficient use of limited isolation rooms and staff resources particularly critical. As the primary respirology unit, our team is uniquely positioned to lead this QI initiative due to its diverse expertise and direct experience with COVID-19 management. Furthermore, our IPC partners bring a strong research background, ensuring an evidence-based approach is included and rigorously evaluated. This combination of clinical insight, operational experience, and research acumen makes us the ideal team to effectively assess and refine current COVID-19 isolation practices.

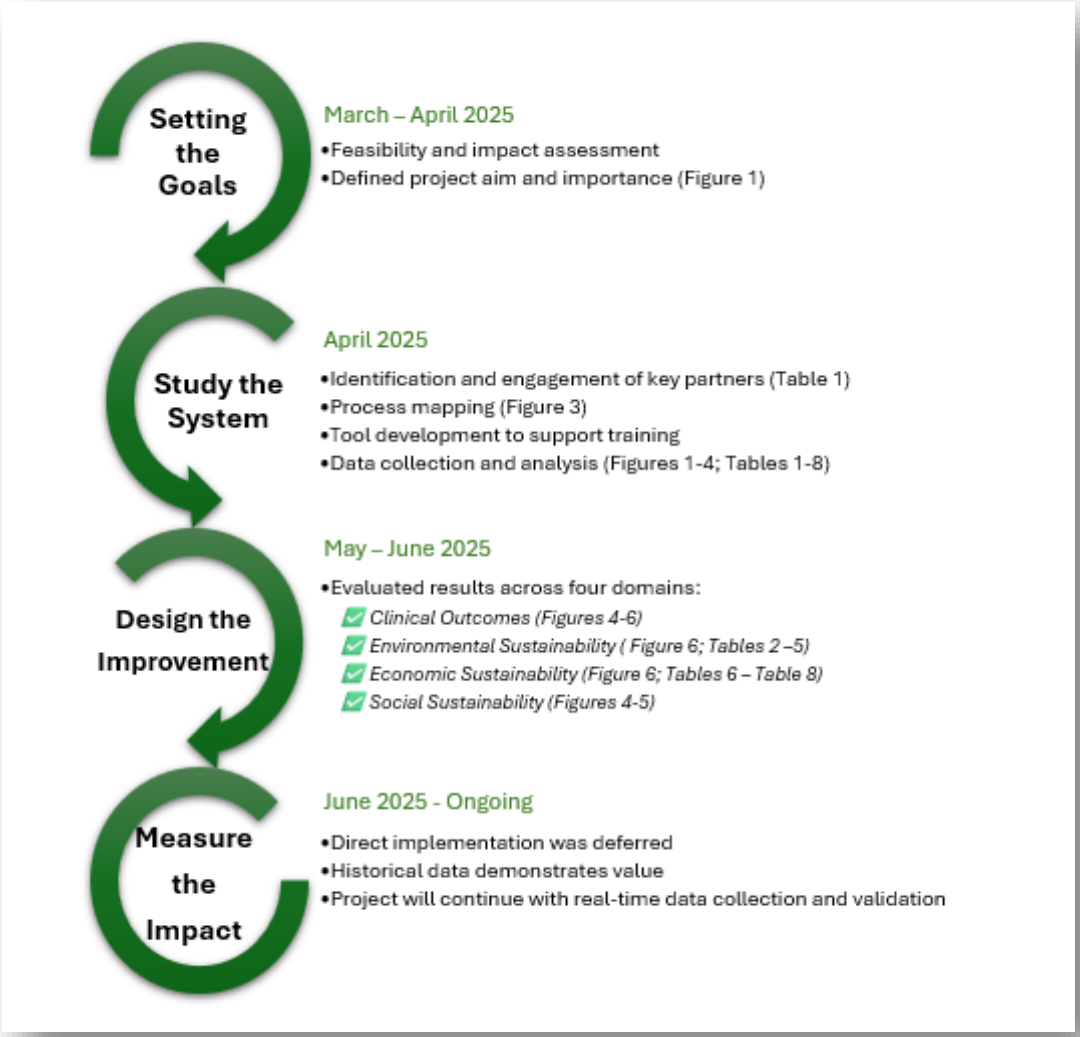
Specific Aims:

To reduce healthcare costs, enhance patient care, and promote sustainability by applying Ct values in real-time clinical decision-making—alongside judicious clinical and epidemiologic assessment—on a single patient care unit, to minimize the impact of prolonged isolation on patients, staff, the healthcare system, and the environment.

Methods:

This QI initiative employed the SusQI framework to evaluate the feasibility and impact of a targeted intervention within a specific inpatient unit. This report represents the first of what may be multiple PDSA (Plan, Do, Study, Act) cycles aimed at reducing unnecessary time spent on isolation and medication for COVID-19 positive patients on Unit 61. The PDSA methodology is a foundational approach to QI that allows for small iterative testing of change ideas. In accordance with the SusQI framework and in conjunction with the PDSA model, we focused on assessing the current state and setting tangible goals, defining our desired future state, identifying opportunities for impactful change, and implementing an initial intervention.

Figure 2. Implementation of the SusQI framework



Identification of key partners

Early identification of partners (Table 1) is critical to the successful development and implementation of any QI initiative. Engaging all relevant disciplines from the outset ensures alignment, fosters collaboration and supports the effective rollout of a new process.

Partner engagement was achieved through the following approaches:

- presenting data demonstrating the potential cost savings and benefits to patients and healthcare workers when Ct values are incorporated into clinical decision making.
- highlighting how the project aligns with AHS strategic goals (23) of achieving a balanced budget, improving emergency department and acute care flow, and improving the patient experience.
- highlighting the multifaceted and significant cost of unnecessary or over-isolation of patients

Partner	Impact Assessment
Unit 61 Nursing Staff/ Healthcare Aides	Nursing staff and healthcare aids were informed of the trial for awareness; they will be actively treating patients on Unit 61.

Unit 61 Nurse Clinicians	Directly involved in the planning and implementation of this quality improvement initiative. Championed the project and were integral to developing pathways, liaising with physicians, monitoring Ct values, ordering swabs and manual tracking.
Attending Providers: Pulmonary Medicine Physicians, Thoracic Surgeons, Hospital Medicine Physicians, MTU Physicians, and Nurse Practitioners	End user – awareness required regarding repeat COVID-19 swabbing and the use of Ct values alongside clinical assessment to discontinue isolation.
Patients on isolation	Patients are central partners within this project, uniquely positioned to influence and benefit from the outcomes. Patient insight was captured from Engagement and Patient Experience team.
IPC	Awareness that Ct values can be used to aid in clinical decision making and not all patients will need to be isolated for 11 days. Responsible for the removal of IPC alerts in patient's electronic chart. Serve as subject matter experts on IPC guidelines and emerging evidence, including interpretation of Ct values and their implications for transmission risk to ensure a safe and effective project design.
Alberta Precision Labs (APL)	Awareness that Ct values can be used to aid in clinical decisions and the willingness to run additional COVID-19 tests, that have Ct values as outputs, on swabs for Unit 61 patients. Share the cost of COVID-19 lab testing for cost analysis. Facilitate access to Ct values for clinical team.
Quality Improvement Consultants	Supported the initiative by facilitating process mapping. Completing patient chart reviews and data extraction and analysis and provided expertise in calculating carbon emissions and assessing environmental impact.
Leadership	Leadership was made aware of the project and the primary objectives. Leadership sponsored the work completed.

Table 1. Partner Impact Assessment

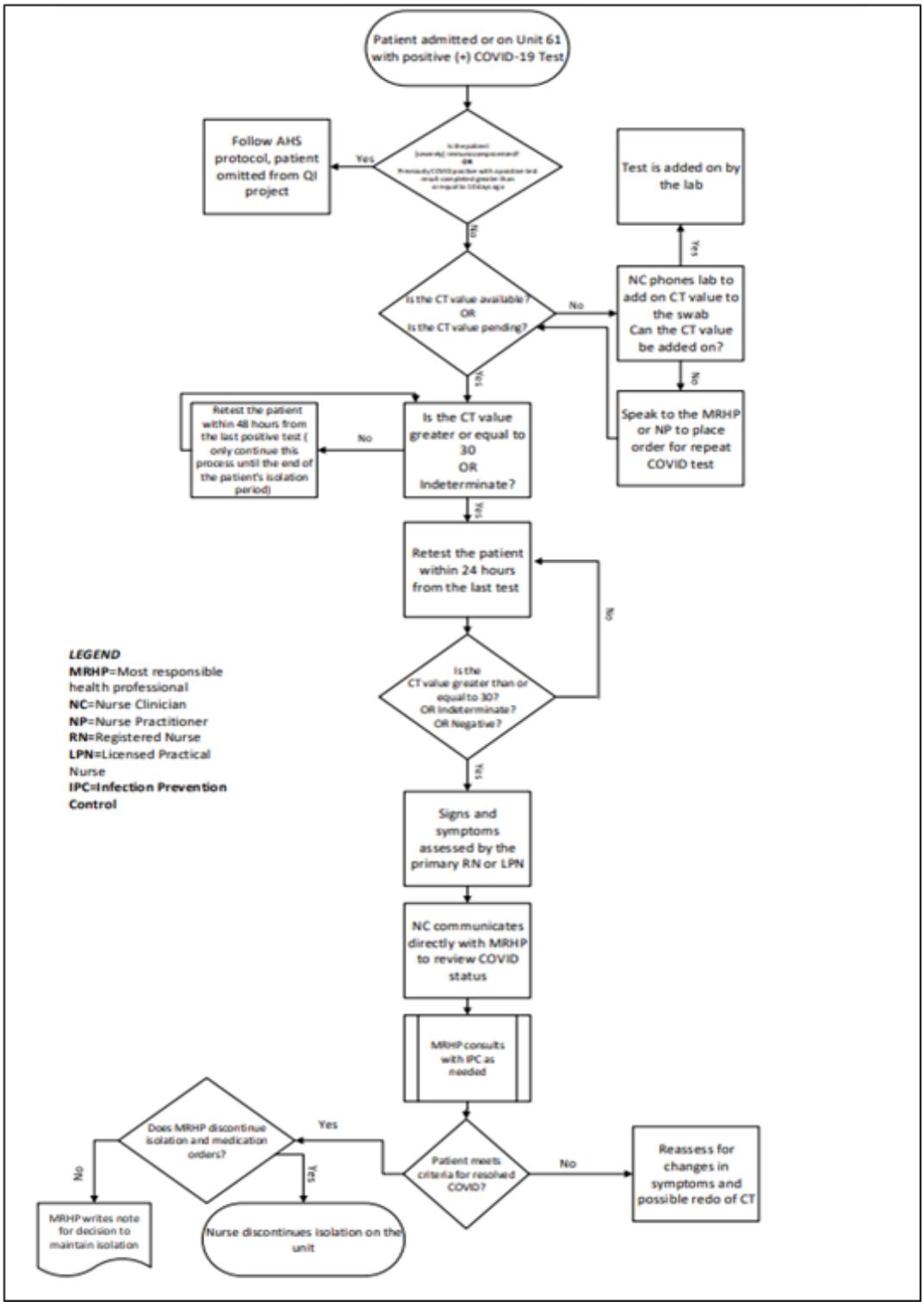
Initial Considerations

The Alberta Research Ethics Community Consensus Initiative (ARECCI) (24) scoring tool was used to understand and mitigate potential risk. The ARECCI scoring tool had a score of 1 indicating the project fit with a QI initiative, rather than formal research and that it poses minimal risk to participants. To help identify any potential transmission, patients will be actively monitored for unusual or increased COVID-19 illness as part of routine clinical assessments and surveillance. In accordance with workplace illness protocols, any potential staff exposure or transmission event will be reported to workplace health and safety.

Process mapping

To begin the project, the Unit 61 Management Team, Nurse Clinicians, Infection Control Professional, and IPC Physician conducted a process mapping exercise with the Quality Improvement Consultants. The current process was assessed and then a new process was developed to outline the new workflow for identification of eligible patients, ordering additional swabs and accessing Ct values when a patient on Unit 61 had a positive COVID-19 result (Figure 3).

Figure 3. Updated Process for Isolation Discontinuation Incorporating Ct Values into Clinical Decision Making.



Process overview

As part of the revised and new process, Nurse Clinicians and Infection Control Professionals complete a daily review for any new SARS-CoV-2 positive patients on Unit 61 and their corresponding Ct values. If a Ct value is not available, the Nurse Clinician orders a repeat swab. If the initial Ct value is greater than or equal to 30 (or indeterminate), and the patient is clinically stable, a repeat swab will be performed 24-48 hours following the

initial swab. If the patient is deemed non-transmissible after at least two COVID-19 swabs with Ct values ≥ 30, and following detailed clinical and epidemiological assessment, isolation and medication orders are discontinued by the most responsible health practitioner (MRHP). Patients who are immunocompromised or severely immunocompromised are excluded from the criteria for using Ct values to discontinue isolation precautions.

As per the new process a nasopharyngeal (NP) swab will be ordered on any eligible patient with a clearly specified reason for testing that ensure swabs are run on a lab testing platform that has reportable Ct values as some platforms are only capable of reporting positive, negative or indeterminate*
**Notes on lab testing process*

- At the time of the study the platform used was the SARS-CoV-2 Assay (Panther Fusion™ System).
- A positive or negative result is automatically determined by the system based on the test results for samples and controls and their interpretation (25)
- An indeterminate result is reported if a sample had a Ct> 38, was repeated, and tested negative on repeat. As such, for our purposes, indeterminate is used as a proxy for a Ct value >30 (*B. Berenger Personal Communication).*

Supporting Materials for Process Implementation and Patient Tracking:

- An education package (Appendix A) was developed and disseminated on June 06, 2025, to assist physicians and other healthcare professionals within Connect Care. This package included guidance on proper swab ordering and standardized documentation practices for cases where isolation was not discontinued, to enable easy tracking of these decisions.
- A shared Excel document was created to track COVID-19 positive patients on Unit 61. This document captured key data elements, including the patient's medical record number (MRN), dates of isolation initiation and discontinuation, Ct values, and where applicable, reasons for being excluded from the project.
- Access to laboratory data specifically for COVID test results including Ct values, was requested for and granted to Unit 61 clinical team members to allow for more timely clinical decision making. Prior to this, access to this dataset was limited to IPC.

Measurement

To evaluate the success of this initiative, multiple data sources were utilized to identify potential patient and population outcomes, environmental, economic, and social sustainability. Data was collected from patient feedback, staff surveys, the Alberta Blue Cross Drug price list (26), Contracting, Procurement and Supply Management (CPSM) team, Alberta Precision Lab (APL), electronic health records and AHS COVID-19 operational data.

The environmental and economic cost of PPE was calculated by comparing the requirements for isolation versus non-isolation patients. For isolation patients, each room entry involved the use of one reusable gown, one pair of gloves, one procedure mask (or N95 respirator), one face shield, and five pumps of hand sanitizer—one prior to donning of PPE and room entry, three during the doffing process, and one on exit. In contrast, non-isolation patients did not require PPE or the additional three hand hygiene steps associated with doffing. Only two pumps of hand sanitizer were used per entry for non-isolation patients: one on entry and one on exit.

The average number of room entries per hour was sourced from Sharma et al. (2022) (3), a systematic analysis study which calculated the average of the mean number of entries into patient rooms from 6 independent studies, reporting 4.42 entries per hour for isolation patients and 6.59 for non-isolation patients. The estimates

calculated represent the minimum cost difference between isolation and non-isolation rooms. They do not account for variations in PPE use based on staff preferences, infection control risk assessments, specific tasks performed, or additional hand hygiene moments.

Patient Outcomes

We anticipate improvements in the quality of care delivered to patients. The primary anticipated patient centred outcome is a decrease in the average duration of isolation, aiming to minimizing unnecessary isolation while preventing onward transmission. As supported by the literature this approach will enhance both the timeliness and safety of care, while also improving patient experiences (3–6,9,12–14). Data on isolation and length of stay will be obtained from the electronic health system.

A secondary anticipated outcome is reducing the unnecessary administration of antiviral (Remdesivir) and corticosteroid (Dexamethasone) therapies in cases where patients are clinically assessed as no longer having active COVID-19 infections. The aim is to support more targeted therapy and promote responsible resource utilization. Data on medication orders will be collected via patient chart review and pharmacy utilization reports, as appropriate.

Population Outcomes

Earlier discontinuation of isolation precautions, in addition to benefits to individual patients, is also anticipated to improve the flow of patients out of the emergency department (ED) by freeing up private rooms or reducing blocked beds for isolation, due to the lack of private rooms.

Environmental sustainability

An assessment of environmental sustainability was conducted with the support of the Centre for Sustainable Healthcare, UK. Green House Gas (GHG) emissions associated with PPE, medications, and lab testing were estimated using a hybrid approach. For single-use PPE – including face masks, face shields, and non-sterile gloves, carbon footprints were sourced directly from a published study (27) that employed a process-based life cycle assessment (LCA). It was assumed that the PPE items analyzed in the study were comparable to those used in this project. No adjustments were made to reflect the Canadian context.

For reusable gowns, a more detailed environmental impact assessment was conducted. Material weights and types were converted into greenhouse gas (GHG) emissions using emission factors from the Inventory of Carbon and Energy (ICE) database (28), supplemented with Canadian-specific reference values (27). The assessment accounted for emissions across the gown's life cycle, including raw material production, packaging, laundering, transportation, and disposal. Laundering emissions were calculated using raw data on hospital laundry utilities (27). including energy, water, and detergent use. Due to the lack of Alberta-specific data, UK-based resource use was assumed to be comparable and converted into GHG emissions using 2025 Canadian emission factors (29) to reflect the local context (30), accounting for travel to and from the laundry facility (22.3 km) and to landfill (11.5 km). The carbon footprint methodology for reusable gowns was informed by a previous Centre for Sustainable Healthcare (CSH) Green Team Competition study, which used a process-based bottom-up approach. While most emissions data were taken directly from the original study, disposal emissions were adapted using Alberta Health Services (AHS) landfill emission factors to reflect local waste practices. Emissions associated with international transport from the country of manufacture to the hospital were excluded. Based on manufacturer data, it was assumed that each gown could be reused 75 times before disposal.

The GHG emissions associated with medication use were estimated using an Environmentally Extended Input-Output Analysis (EEIOA). The financial cost of each medication was adjusted using the Bank of Canada's inflation rate (31) and then converted into GHG emissions using the 2022 UK Government Standard Industrial

Classification (SIC) emission factor for "*pharmaceuticals"* (32). As the SIC factor is based on British pounds, it was converted to Canadian dollars using the average 2025 exchange rate of £1 = 1.8299 CAD. The calculation reflects cradle-to-gate emissions only, encompassing the emissions from raw material extraction through to the point of manufacture. Emissions associated with the disposal of pharmaceuticals were excluded from this estimate, as they are considered minimal compared to those generated during manufacturing.

Emissions associated with hand sanitizer use were estimated by calculating the carbon cost per hand pump and applying an EEIOA. The same methodology used for medications was followed, with the exception that the SIC emission factor for "*soap and detergents"* was used in place of that for "*pharmaceuticals"*.

For COVID-19 swabs, the carbon footprint was sourced directly from Courdier et al. 2025 (33). The swab and PCR assay used in the Courdier study (33) was assumed to be sufficiently comparable to those employed within AHS, as available information indicated it was the best available match. No adjustments were made to account for the Canadian context and testing is done on site, so no travel costs were included.

Economic sustainability

Economic sustainability was assessed by subtracting the cost of additional SARS-CoV-2 testing from the savings from reduced PPE usage and unnecessary medication administration. PPE costs were estimated using item cost data from the FMC CPSM team, while the cost of additional swab testing was provided by APL. Medication costs were sourced from Alberta Blue Cross Drug Price List (26)

Reducing isolation days is expected to decrease the use of PPE, including gloves, surgical masks, face shields, gowns, and N95 respirators. Each day saved in isolation corresponds to fewer PPE sets used per patient interaction, contributing to cost savings and improved operational efficiency. Additionally, reduced time spent donning and doffing PPE may enhance staff workflow and productivity.

Social sustainability

Leveraging Ct values to support earlier de-isolation offers meaningful social sustainability benefits by reducing the emotional, psychological, and relational burdens associated with prolonged isolation for both patients and healthcare workers (Figure 1). Data to support the impact of isolation precautions on patients was collected through a survey conducted by the Engagement and Patient Experience team during the COVID-19 pandemic. A focused survey was distributed to Unit 61 staff on June 6, 2025, via REDCap, to capture their experiences and challenges when caring for patients under COVID-19 isolation precautions. The survey explored perceptions of current practices and their effects on workflow, time management, and emotional well-being.

Results:

This prospective quality improvement project aimed to use real-time Ct values to guide clinical decisions, reducing both isolation duration and COVID-19 treatment length, along with the associated costs. A total of 3 COVID-19 positive patients were admitted to Unit 61 between June 2 to July 11, 2025. However, these 3 patients were not eligible for inclusion in the study; two were excluded based on their immunocompromised status and the third was excluded as they were COVID-19 positive ≥10 days ago. Thus, a major limitation of this study was that within the designated 12-week project timeframe no eligible COVID-19 positive patients were admitted to the unit. As the initiative was part of a time-sensitive competition, we adapted our approach by retrospectively analysing patient data from 2024 to simulate the impact of our proposed intervention. This allowed us to estimate potential cost savings and operational improvements using credible real-world data that would have occurred had the intervention been implemented during that period. While real-time evaluation will continue beyond the competition timeline, this preliminary analysis provided meaningful insights into the feasibility and projected value of the intervention.

Patient Outcomes

Between January 1 and December 31, 2024 a total of 56.6% of patients placed under isolation on Unit 61 were included in this project. Patients were excluded based on either their immune status or the duration of their isolation. The median isolation period was 7.5 days, with an interquartile range (IQR) of 4 to 10.25 days. Notably, many patients were discharged prior to completing the full 11-day isolation protocol, resulting in an average isolation duration of 7.09 days per patient. If isolation had instead been discontinued on day 4 rather than day 7—based on a conservative and reasonable estimate informed by the 2024 data and typical turnaround time for Ct values (approximately 24 hours)—the average isolation duration would have been reduced by 3.09 days per patient. This estimated reduction forms the basis for calculating potential cost and carbon footprint savings associated with earlier de-isolation, including reduced PPE usage.

Population Outcomes

Due to the absence of patient recruitment during the initial 12-week period, outcome data related to emergency department flow and isolation discontinuation is not available. However, research supports that earlier discontinuation of isolation precautions can improve emergency department flow, reduce wait times, and enhance overall system efficiency by freeing up private rooms and reducing bed blockages (12)

Environmental Outcomes

1. *PPE*

Environmental outcomes for patients that were in isolation was determined by using an average of 4.42 room entries for isolation patients and 6.59 for non-isolation patients per hour to calculate greenhouse gas emissions (GHG) per day (3). The environmental impact was assessed by considering a mask, a face shield, an isolation gown, and 3 additional pumps of hand sanitizer that would be used in the donning and doffing process for isolation patients. A total of 0.2 kgCO2e was calculated to launder a gown which factored in the laundering process and transportation to and from the hospital. For other single-use PPE carbon footprints were sourced directly from Rizan et al (2021) (27).

Acknowledging that patient demographics, unit workflows, and admission patterns vary significantly across units and institutions, which may influence the applicability and outcomes of this type of predictive analysis, the following results are intended to illustrate a proof of concept. Further validation would be required to ensure accuracy and relevance.

Site-level and provincial-level estimates were extrapolated from Unit 61 data. This extrapolation was used to estimate potential cost savings. Using Alberta Health Services (AHS) operational data from January 1 to December 31, 2024, in conjunction with the 56% eligibility rate and an average reduction of 3.09 isolation days per patient, the total number of reduced isolation days was calculated to estimate potential environmental cost savings at all levels (Table 2). The estimated annual reduction in greenhouse gas emissions—resulting from decreased isolation time and reduced PPE use for contact and droplet precautions with a procedure mask—is 7,714 $kgCO_2e$ at a unit level, 109,330 $kgCO_2e$ at the site level and 1,164,524 $kgCO_2e$ at the provincial level.

Population	Estimated total reduction in GHG emissions (kgCO2e)
Unit Level (PCU61)	7,714
Site Level (FMC)	109,330

Provincial (AB)	1,164,524

Table 2. Extrapolated annual reduction in GHG Emissions (U61-Based Estimates) to Inform Site and Provincial-Level Estimated Savings for PPE.

2. *Medications*

Environmental impact of the medications, Remdesivir and Dexamethasone, for the treatment of COVID-19 patients, were calculated based on the greenhouse gas emissions saved if treatment days were reduced by 2 days. This estimate was selected as a conservative midpoint, informed by clinical discussions within the project team.

The Remdesivir treatment protocol for COVID-19 patients consists of a loading dose of 200mg on day 1 and subsequent doses of 100mg per day on day 2 to 5 of treatment. For this analysis, it was assumed that a COVID-19 positive patient would receive the initial dose on day 1—prior to the availability of Ct values used to guide clinical decision-making. Since Ct values are typically available within 24 hours, we assumed treatment could reasonably be discontinued prior to a dose on day 4, allowing time for two swabs with Ct values ≥30 to support clinical decision making and support the discontinuation of antiviral and steroid therapies. Therefore, cost (environmental and economic) calculations were based on the per-day cost of 100 mg of remdesivir, representing treatment on days 4 and 5.

Using the 2024 historical Unit 61 data, chart reviews were conducted to determine a percentage of how many patients were prescribed Remdesivir and Dexamethasone. At the unit level, a reduction of 4,839 $kgCO_2e$ is estimated by shortening treatment duration to two days. Site-level and provincial estimates were extrapolated from Unit 61 data. The projected annual reduction in medication days and associated carbon emissions—resulting from a 2-day reduction in treatment duration—is 68,548 kgCO2e and 730,483 $kgCO_2e$ at the FMC site and provincial levels, respectively (Table 3). For comparison, a more conservative 1-day reduction would result in estimated carbon savings of 2,419 $kgCO_2e$ (unit), 34,274 $kgCO_2e$ (site), and 365,241 $kgCO_2e$ (provincial). A 3-day reduction—considered achievable by some clinicians—would yield reductions of 7,258 $kgCO_2e$ (unit), 102,822 $kgCO_2e$ (site), and 1,095,724 $kgCO_2e$ (provincial).

	Estimated total reduction in GHG emissions (kgCO2e)
Unit Level (PCU61)	4,839
Site Level (FMC)	68,548
Provincial (AB)	730,483

Table 3. Extrapolated annual reduction in GHG Emissions (U61-Based Estimates) to Inform Site and Provincial-Level Estimated Savings for COVID-19 treatment.

3. *Additional lab tests*

This project required a minimum of one additional PCR test. The use of an additional PCR test would result in an added GHG emission of 31 kgCO2e, 448 kg CO2e, and 4777 kgCo2e from the unit level, site level, and provincial level respectively (Table 4).

Population	Additional test environmental impact (kgCO2e)	Additional test total economic cost (CAD$)
Unit Level (PCU61)	31	1,314.51
Site Level (FMC)	448	18,769.98

Provincial (AB)	4777	200,050.08

Table 4. Estimation of Greenhouse Gas (GHG) Emissions and CAD cost of additional COVID-19 swab.

Overall Environmental Savings per year

Total reduction in GHG emissions were determined by adding together the decrease in emissions from PPE and medications for COVID-19 positive patients and subtracting the cost of additional lab testing for COVID-19. The estimated reduction in greenhouse gas emissions resulting from the use of Ct values to support earlier de-isolation and treatment of COVID-19 positive patients—if implemented at a provincial scale—exceeds the equivalent of 1.8 million $kgCO_2e$ per year (Table 5).

Population	Estimated total reduction in GHG emissions for PPE (kgCO2e)	Estimated total reduction in GHG emissions for medications (kgCO2e)	Additional Test Environmental Impact (kgCO2e)	Estimated overall reduction in GHG emissions (kgCO2e)
Unit Level (PCU61)	7,714	4,839	31	12,522
Site Level (FMC)	109,330	68,548	448	177,634
Provincial (AB)	1,164,524	730,483	4777	1,892,234

Table 5. Overall Projected Annual Environmental Cost Savings.

Economic Outcomes

Total economic cost savings were determined by subtracting the expenses associated with the additional COVID-19 swabs from the projected savings gained through reduced PPE usage from reduced isolation days and decreased medication usage.

1. *PPE*

The cost of PPE was calculated as the difference between the daily PPE costs for isolation versus non-isolation patients. The contact precaution cost—which includes gown and gloves, as well as 85 seconds of staff time to don and doff—was based on a rate of $8.95 per day from Sharma et al., 2022 (3) and inflation adjusted to a 2025 amount of $9.18 using the Bank of Canada inflation calculator (31). Droplet precaution costs (mask and eye protection) were estimated using staff preferences for mask and eyewear on Unit 61 and pricing data from CPSM. The total daily PPE cost for isolation included a reusable gown, gloves, a procedure mask or N95 respirator, a face shield, and the hand sanitizer required for proper doffing, as per AHS IPC guidance. This estimate conservatively assumes staff use a procedure mask rather than an N95 respirator, resulting in a projected PPE cost savings.

Based on an average reduction of 3.09 isolation days there is an estimated total cost savings of $39,018.21 in a year for Unit 61 (Table 6). The extrapolation of Unit 61 historical data was conducted to estimate potential cost savings at hospital and provincial levels and shows an estimated total savings of associated PPE cost savings of $553,002.45 at an FMC site level and a total estimated saving of associated PPE cost savings of over $5.8M, across the province in 2024 (Table 6).

Population	PPE Estimated total cost savings (CAD$)
Unit Level (PCU61)	39,018.21
Site Level (FMC)	553,002.45
Provincial (AB)	5,890,282.86

Table 6. Extrapolated Annual PPE Economic Costs (U61-Based Estimates) to Inform Site and Provincial-Level Estimated Savings per year

2. *Medication*

A proportion of patients eligible for inclusion received treatment with Remdesivir and Dexamethasone for active COVID-19 infection on Unit 61 in 2024. This proportion was subsequently extrapolated to estimate treatment rates at both the site and provincial levels. Based on this, an estimated total savings of $39,903.60 at a unit level, $565,301.00 at a site level, and $6,024,113.48 provincially were calculated for COVID-19 medications in the 2024 data (Table 7). This 2-day reduction was selected as a conservative midpoint, informed by clinical input. For comparison, a more cautious 1-day reduction would yield savings of $19,951.80 (unit), $282,650.50 (site), and $3,012,056.74 (provincial), while a 3-day reduction—considered achievable by some clinicians—would result in $59,855.40 (unit), $847,951.50 (site), and $9,036,170.22 (provincial).

	Estimated total reduction in medication savings (CAD$)
Unit Level (PCU61)	39,903.60
Site Level (FMC)	565,301.00
Provincial (AB)	6,024,113.48

Table 7. Extrapolated medication economic costs (U61-Based Estimates) to Inform Site and Provincial-Level Estimated Savings for COVID-19 treatment

3. *Additional lab test*

Each enrolled patient will require an additional COVID-19 PCR test. This results in an estimated total cost of $1,314.52 at the unit level, $18,769.98 at the site level (FMC), and $200,050.08 provincially (Table 4). These estimates are based on previously contracted service rates and do not include a detailed breakdown of individual cost components due to sensitivity and variability in procurement arrangements.

Overall Estimated Economic Savings per year

The estimated provincial cost savings from implementing the use of Ct values to support clinical decision making – based on a reduction of 3.09 isolation days and 2 medication days per patient – exceeds $11.5 Million, resulting from earlier de-isolation and discontinuation of treatment (Table 8).

Population	Estimated total reduction in PPE savings (CAD$)	Estimated total reduction in medication savings (CAD$)	Estimated Overall Cost Savings (Medications + Isolation Days CAD$))	Cost of additional testing CAD$)	Estimated overall reduction in savings (CAD$)
Unit Level (PCU61)	39,018.21	39,903.60	78,921.81	1,314.51	77,607.30
Site Level (FMC)	553,002.45	565,301.00	1,118,303.45	18,769.98	1,099,533.47

Provincial (AB)	5,890,282.86	6,024,113.48	11,914,396.34	200,050.08	11,714,346.26

Table 8. Overall Projected Cost Savings

Social Outcomes:

Beyond the more readily measurable environmental and economic implications of inappropriate isolation practices, the associated social costs—impacting both patients and healthcare personnel—represent a significant yet often underappreciated burden within clinical settings.

Patients

Although the patient feedback presented in Figure 4 was not collected specifically for this study, the Engagement and Patient Experience Team gathered input from patients between January 1, 2021, and December 31, 2022, regarding their experiences while on isolation for COVID-19 infection. Several patients described experiences of delayed care, emotional distress, and perceived inequities in service delivery. Comments highlighted issues such as missed meals, long wait times for assistance, visible staff fatigue, and a general sense of disparities in care (Figure 4).

Figure 4. Patient Perspectives on the social impact of isolation for COVID-19 at FMC.

"[My] meal tray was left outside the door with no notice...Hours before a nurses aid brought it in"

"...it seemed like the same people [worked] double shifts.... seemed like there was a lot of stress in them"

"I paged the front desk, and I was waiting for forty minutes for someone to come in"

"...because of COVID and because of the conditions of staffing, I felt that the level of care was uneven"

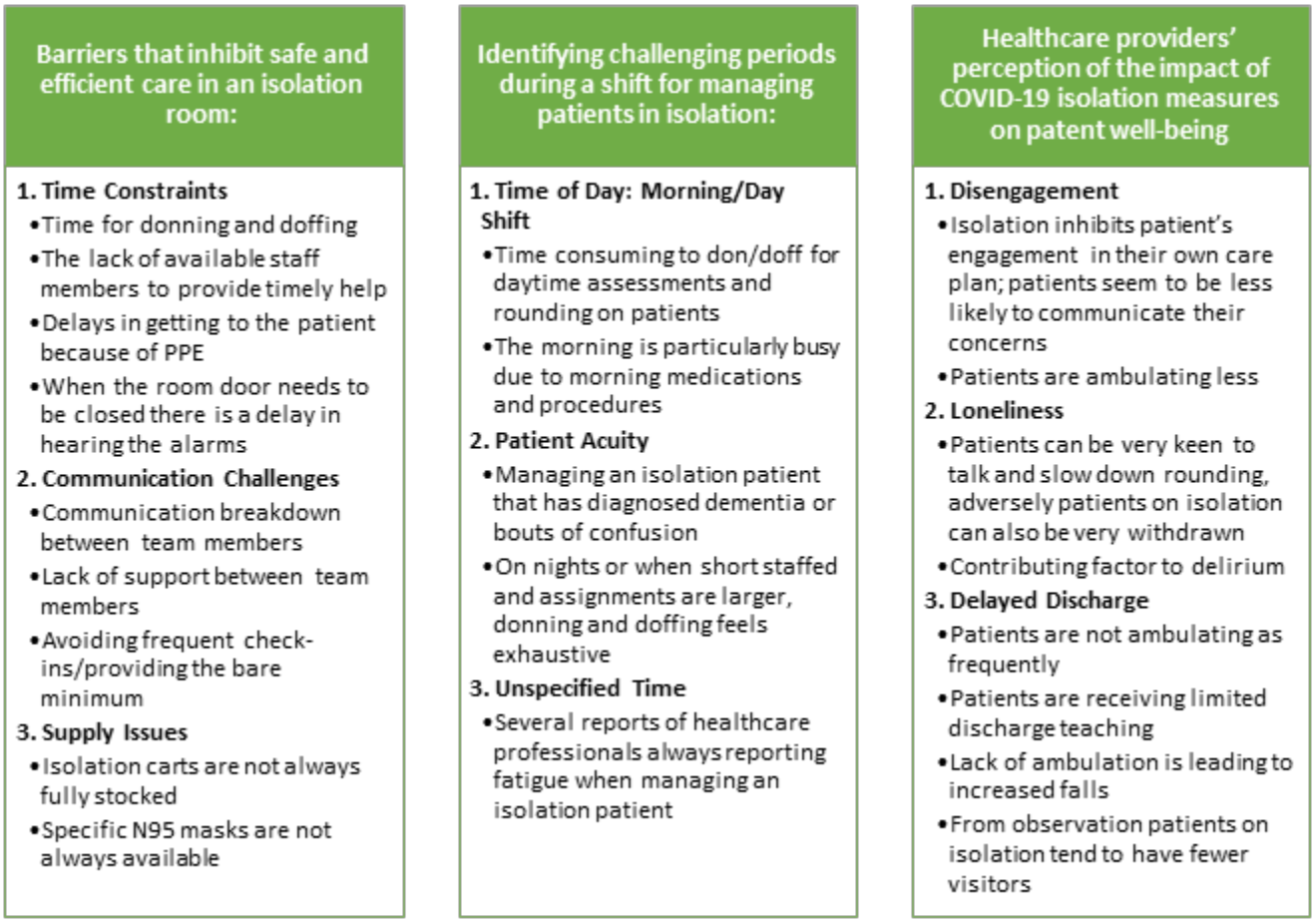
Staff

Responses from a staff survey conducted on Unit 61, in which participants were asked about the challenges of caring for patients isolated due to COVID-19 responses indicated that 66.7% of staff felt that the isolation precautions *always* or *often* impacted their ability to provide timely care, compared to 33.3% of staff that felt they were *rarely* or *sometimes* impacted.

Survey results were thematically analysed and categorized into three key areas: barriers to safe and efficient care in isolation rooms, challenging periods during shifts, and perceived impacts of COVID-19 isolation measures on patient well-being (Figure 5). The figure illustrates how staff perceived time constraints, communication breakdowns, and supply issues as barriers to delivering timely and effective care in isolation settings. Staff also identified specific periods—particularly during busy morning shifts or when managing high-acuity patients—as especially challenging for donning and doffing PPE. Finally, the perceived impact of prolonged isolation on

patients included reduced engagement in care, increased loneliness, and delays in discharge due to limited mobility and fewer opportunities for education and social interaction. By reducing isolation days through this QI project, we will be removing the barriers to care and negative outcomes to patients perceived by staff due to isolation.

Figure 5. Thematic analysis of staff experience on U61 caring for patients on isolation for COVID-19.



Discussion:

This quality improvement initiative evaluated the clinical, financial, environmental, and social impact of using Ct values from COVID-19 PCR tests to support earlier de-isolation of patients on Unit 61 at FMC. The strategic selection of this primary respirology unit, combined with strong interdisciplinary collaboration ensured a clinically relevant and evidence-informed approach.

The major challenge was not having any eligible patients admitted during the project period (April–July 2025). Retrospective data from 2024 enabled robust modelling of the intervention's potential impact. Based on a reduction of 3.09 isolation days and 2 medication days per patient, it was estimated that on a unit level nearly $40,000 in PPE saved (Table 8). The overall estimated cost savings provincially per year resulting from earlier de-isolation and discontinuation of treatment is over $11.5M (Table 8). These savings are equivalent to over 1,500

hospital admission days or 978 hip arthroplasties (34,35) (Figure 6), highlighting the substantial financial benefit to the healthcare system.

The environmental benefit is equally compelling. The negative environmental impacts of widespread isolation practices are increasingly recognized. Reliance on single-use PPE contributes significantly to plastic waste, microplastic contamination, and carbon emissions, while cleaning demands place additional strain on water and chemical waste systems. Provincial implementation of this initiative could reduce greenhouse gas emissions by over 1.8 million kgCO_2e (Table 7)—equivalent to powering 420 homes or preserving more than 8,000 trees (Figure 6). These findings underscore the environmental sustainability of optimizing isolation practices.

Beyond economic and environmental outcomes, the project also assessed the social impact of prolonged isolation. Thematic analysis of staff survey responses revealed that isolation precautions disrupt workflow, increase cognitive and emotional burden, and contribute to staff fatigue. Patients, meanwhile, experience reduced interaction, delayed care, and psychosocial distress. Integrating Ct values into clinical decision-making offers a pathway to mitigate the identified harms, while improving staff morale and the patient's experience—two often underappreciated dimensions of care.

From a clinical outcomes' perspective, earlier de-isolation may reduce risks associated with prolonged isolation, such as reduced quality of care and increased length of stay (3–6,9,12–14). While the risk of premature de-isolation and potential transmission may be a concern to some, this is mitigated through strict clinical criteria, exclusion of immunocompromised patients and IPC oversight, as needed.

IPC practices are fundamentally designed to prevent the spread of infection and support safe, high-quality patient care. As evidence evolves, there are opportunities to refine these practices in ways that reduce unintended impacts—whether clinical, social, financial or environmental. This project reflects an ongoing commitment to supporting evidence-based approaches to care by exploring how Ct values can inform more efficient and patient-centred isolation practices for COVID-19 patients.

This project also demonstrated robust measurement of impact, using retrospective data, cost modelling, and environmental metrics to quantify benefits. While real-time data collection was not possible in the time frame due to no COVID-19 admissions on Unit 61, the methodology remains sound and scalable**.**

Limitations of this project include variability in PPE use across sites and potential differences in laboratory or laundering logistics, particularly in rural areas, which may affect the precision of cost and environmental estimates. While specific figures may differ, the overall trend toward reduced isolation days, cost savings, and environmental benefit is expected to remain consistent across settings. While COVID-19 admissions may decline, as trends suggests (36), the principles of this project remain highly relevant to other respiratory pathogens such as influenza, RSV, and rhinovirus (37). This concept mirrors the well-established use of HIV viral load monitoring, which, though now central to treatment and transmission risk assessment, took years of research and validation before becoming a routine part of clinical care (37).

The estimated CO_2e savings associated with reduced personal protective equipment (PPE) usage are derived from values reported in published literature, rather than direct measurement within this specific patient cohort. While existing literature suggests an average of 4–5 room entries per hour, patient-reported experiences (as reflected in the social impact data) indicate that, in some cases, no staff entered their room for periods ranging from 40 minutes to several hours.

It is important to recognize that certain clinical tasks require the coordinated involvement of multiple staff members, which can lead to frequent and successive room entries. Moreover, room entries may involve a range of individuals, including but not limited to housekeeping staff, family members, allied health professionals,

and other members of the interdisciplinary care team. In accordance with unit policy and established nursing standards, hourly rounding on patients is required practice. While patient anecdotes are valued, it is essential to recognize that these standards of care are in place to ensure consistent and high-quality treatment

Regarding the CO_2e savings attributed to medication changes, a conservative approach was employed. A reduction of 2–3 days of medication use was considered a feasible estimate, and for calculation purposes, a conservative value of 2 days was applied. While this approach aims to minimize overestimation, it cannot be definitively confirmed that all doses would have been avoided. Consequently, the inclusion of high-cost medications may have led to an inflated estimation of the overall impact. Continuous monitoring of individual patients admitted to Unit 61 that meet criteria will be maintained to evaluate true impact.

To work towards adoption and sustainable improvement, next steps would include disseminating our findings, expanding real-time data collection, piloting in additional units, advocating for broader access to Ct values, developing standardized protocols and integrating Ct-based decision-making into clinical decision making.

Figure 6. Real-World Equivalents of Projected Environmental and Economic Savings per year.

Data in Figure 6 was calculated using Microsoft Copilot (Microsoft, 2025), with source data from CIHI patient cost estimator (34), hip and knee replacements in Canada (35) and the Centre for Sustainable Systems Carbon Footprint Factsheet (38)

Conclusions:

This QI initiative demonstrates that integrating Ct values into clinical decision-making is a feasible, evidence-informed strategy with the potential to deliver meaningful financial, environmental, social, and clinical benefits. Despite the absence of real-time data during the project period, retrospective modeling revealed substantial potential cost savings, reduced environmental impact, and improved patient and staff experience through earlier de-isolation. By reducing unnecessary isolation, the initiative also offers a scalable opportunity to mitigate the environmental harms associated with single-use PPE and intensive cleaning practices—such as plastic waste, microplastic contamination, and increased water and chemical use.

Importantly, the project aligns with Alberta Health Services' strategic goals of achieving a balanced budget, improving emergency department and acute care flow, and enhancing patient experience. The intervention supports more efficient use of isolation resources, reduces unnecessary PPE consumption, and improves care delivery—contributing to system-wide sustainability and resilience.

Critical success factors

Please select one or two of the below factors that you believe were most essential to ensure the success of your project changes.

People	Process	Resources	Context
☐ Patient involvement and/or appropriate information for patients - to raise awareness and understanding of intervention	☑ clear guidance / evidence / policy to support the intervention.	☐ Dedicated time	☑ aims aligned with wider service, organisational or system goals.
☑ Staff engagement	☐ Incentivisation of the strategy – e.g., QOF in general practice	☑ QI training / information resources and organisation process / support	☑ Links to patient benefits / clinical outcomes
☑ MDT / Cross-department communication	☑ systematic and coordinated approach	☑ Infrastructure capable of providing teams with information, data and equipment needed	☑ Links to staff benefits
☑ Skills and capability of staff	☑ clear, measurable targets	☑ Research / evidence of change successfully implemented elsewhere	☑ 'Permission' given through the organisational context, capacity and positive change culture.
☐ Team/service agreement that there is a problem and changes are suitable to trial (Knowledge and understanding of the issue)	☐ long-term strategy for sustaining and embedding change developed in planning phase	☐ Financial investment	
☑ Support from senior organisational or system leaders	☑ integrating the intervention into the natural workflow, team functions, technology systems, and incentive structures of the team/service/organisation		

References:

1. Alberta Health Services IP and C. Acute Care Discontinuation of Contact and Droplet Precautions for Suspected or Confirmed Viral Respiratory Infection [including COVID-19] [Internet]. 2024. Available from: https://www.albertahealthservices.ca/assets/healthinfo/ipc/hi-ipc-vri-dc-precautions.pdf
2. Geneva: World Health Organization. Infection Prevention and Control of Epidemic- and Pandemic-Prone Acute Respiratory Infections in Health Care. [Internet]. 2014. Annex B, Isolation precautions. Available from: https://www.ncbi.nlm.nih.gov/books/NBK214342/
3. Sharma A, Pillai DR, Lu M, Doolan C, Leal J, Kim J, et al. Impact of isolation precautions on quality of life: a meta-analysis. J Hosp Infect. 2020 May;105(1):35–42.
4. Tran K, Bell C, Stall N, Tomlinson G, McGeer A, Morris A, et al. The Effect of Hospital Isolation Precautions on Patient Outcomes and Cost of Care: A Multi-Site, Retrospective, Propensity Score-Matched Cohort Study. J Gen Intern Med. 2017 Mar;32(3):262–8.
5. Abad C, Fearday A, Safdar N. Adverse effects of isolation in hospitalised patients: a systematic review. J Hosp Infect. 2010 Oct;76(2):97–102.
6. Sprague E, Reynolds S, Brindley P. Patient Isolation Precautions: Are They Worth It? Can Respir J. 2016;2016:5352625.
7. Donisi I, Colloca A, Anastasio C, Balestrieri ML, D'Onofrio N. Micro(nano)plastics: an Emerging Burden for Human Health. Int J Biol Sci [Internet]. 2024;20(14):5779–92. Available from: https://www.ijbs.com/v20p5779.htm
8. Marfella R, Prattichizzo F, Sardu C, Fulgenzi G, Graciotti L, Spadoni T, et al. Microplastics and Nanoplastics in Atheromas and Cardiovascular Events. N Engl J Med. 2024 Mar;390(10):900–10.
9. Stelfox HT, Bates DW, Redelmeier DA. Safety of patients isolated for infection control. JAMA. 2003 Oct;290(14):1899–905.
10. Ray SS, Lee HK, Huyen DTT, Chen S-S, Kwon Y-N. Microplastics waste in environment: A perspective on recycling issues from PPE kits and face masks during the COVID-19 pandemic. Environ Technol Innov [Internet]. 2022;26:102290. Available from: https://www.sciencedirect.com/science/article/pii/S2352186422000128
11. Khan MT, Shah IA, Hossain MF, Akther N, Zhou Y, Khan MS, et al. Personal protective equipment (PPE) disposal during COVID-19: An emerging source of microplastic and microfiber pollution in the environment. Sci Total Environ [Internet]. 2023;860:160322. Available from: https://www.sciencedirect.com/science/article/pii/S0048969722074228
12. Cignarale C. Analysis and optimization of patient bed assignments within a hospital unit while considering isolation requirements. [Abad, C., Fearday, A., & Safdar, N. (2010). Adverse effects of isolation in hospitalised patients: a systematic review. The Journal of Hospital Infection, 76(2), 97–102. https://doi.org/10.1016/j.jhin.2010.04.027 Abdelrahim, Z., Abu Tabar, N., Abualruz, H]: Rochester Institute of Technology; 2013.
13. Qureshi SM, Bookey-Bassett S, Purdy N, Greig MA, Kelly H, Neumann WP. Modelling the impacts of COVID-19 on nurse workload and quality of care using process simulation. PLoS One. 2022;17(10):e0275890.
14. Abdelrahim Z, Abu Tabar N, Abualruz H, Othman E, Sawalha M, Alqurneh M, et al. The experience of nurses caring for patients with infectious diseases in isolation rooms: A qualitative approach. 2021 Nov 12;
15. Idowu GA, Olalemi AO, Aiyesanmi AF. Environmental impacts of covid-19 pandemic: Release of

microplastics, organic contaminants and trace metals from face masks under ambient environmental conditions. Environ Res. 2023 Jan;217:114956.

16. Lin Y-C, Malott RJ, Ward L, Kiplagat L, Pabbaraju K, Gill K, et al. Detection and quantification of infectious severe acute respiratory coronavirus-2 in diverse clinical and environmental samples. Sci Rep [Internet]. 2022 Jan 1;12(1):5418. Available from: https://www.nature.com/articles/s41598-022-09218-5

17. Bruce EA, Mills MG, Sampoleo R, Perchetti GA, Huang M-L, Despres HW, et al. Predicting infectivity: comparing four PCR-based assays to detect culturable SARS-CoV-2 in clinical samples. EMBO Mol Med. 2022 Feb;14(2):e15290.

18. Relich RF, Van Benten K, Lei G-S, Robinson CM, Carozza M, Sahoo MK, et al. Determination of the cycle threshold value of the Xpert Xpress SARS-CoV-2/Flu/RSV test that corresponds to the presence of infectious SARS-CoV-2 in anterior nasal swabs. Microbiol Spectr. 2024 Apr;12(4):e0390823.

19. Chen Y-Y, Shen X, Wang Y-J, Xie J-W, Fang Z-X, Lin L-R, et al. Evaluation of the cycle threshold values of RT-PCR for SARS-CoV-2 in COVID-19 patients in predicting epidemic dynamics and monitoring surface contamination. J Infect Public Health. 2022 Dec;15(12):1494–6.

20. Lin, Yi-Chan, Conly, John M, Evans DH. Correlating SARS-CoV-2 Infectivity in Clinical Samples with Cycle Threshold. In: The Pandemic Evidence Collaboration 2025 conference. 2025.

21. Qirjazi E, Kaunda J, Andersen T, Peterson J, Iwaasa K, MacRae J, et al. SARS-CoV-2 Shedding in Dialysis Patients With COVID-19. Kidney Int Reports [Internet]. 2021;6(11):2897–9. Available from: https://www.sciencedirect.com/science/article/pii/S2468024921014017

22. O'Grady H, Rennert-May E, Leal J, Lyachovics R, Tremblay I, Patel H, Attamah O, Curammeng L, Almond J, Kumar V, Kanji JN CJ. The Utility of Trending Serial Cycle Threshold Values for SARS-CoV-2 Allowing for Early De-Isolation and Cost Savings from Unnecessary Use of PPE and Bed Blocking. In: The Pandemic Evidence Collaboration 2025 conference. 2025.

23. Alberta Health Services. AHS 2024-27 Health Plan [Internet]. Available from: https://www.albertahealthservices.ca/assets/about/org/ahs-org-hp-2024-2027.pdf

24. Alberta Innovates. ARECCI Ethics Screening Tool [Internet]. Available from: https://arecci.albertainnovates.ca/

25. Hologic. Panther Fusion SARS-CoV-2 Assay [Internet]. 2022. Available from: https://www.hologic.com/package-inserts/diagnostic-products/panther-fusion-sars-cov-2-assay

26. Alberta Blue Cross. Alberta Blue Cross Drug Price List (ABCDPL) [Internet]. 2025. Available from: https://www.ab.bluecross.ca/dbl/pdfs/ABCDPL_2025_04_04.pdf

27. Rizan C, Reed M, Bhutta MF. Environmental impact of personal protective equipment distributed for use by health and social care services in England in the first six months of the COVID-19 pandemic. J R Soc Med. 2021 May;114(5):250–63.

28. Database TI. Embodied Carbon Footprint - The ICE Database [Internet]. 2024. Available from: https://circularecology.com/embodied-carbon-footprint-database.html

29. Goverment of Canada. Emission factors and reference values. Available from: https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/output-based-pricing-system/federal-greenhouse-gas-offset-system/emission-factors-reference-values.html

30. United States Environmental Protection Agency. GHG Emission Factors Hub [Internet]. Available from: https://www.epa.gov/climateleadership/ghg-emission-factors-hub

31. Bank of Canada. Bank of Canada - Inflation Calculator. Inflat Calc [Internet]. 2021; Available from: https://www.bankofcanada.ca/rates/related/inflation-calculator/

32. Goverment UK. UK and England's carbon footprint to 2022. Available from: https://www.gov.uk/government/statistics/uks-carbon-footprint

33. Courdier S, Bouchet A, Karlen M, Boucher J, D'Acremont V, Vernez D. The direct emissions related to Global Warming Potential of different types of diagnostic tests at different phases of the COVID pandemic: A climate-focused life-cycle assessment. PLOS Clim [Internet]. 2025 Jan 22;4(1):e0000561. Available from: https://doi.org/10.1371/journal.pclm.0000561

34. Canadian Institute for Health Information. Patient Cost Estimator. Available from: https://www.cihi.ca/en/patient-cost-estimator

35. Canadian Institute for Health Information. Hip and Knee Replacements in Canada - CJRR Annual Report 2021–2022 [Internet]. Available from: https://www.cihi.ca/sites/default/files/document/hip-knee-replacements-in-canada-cjrr-annual-report-2021-2022-en.pdf

36. Alberta. G of. Alberta Health Respiratory Virus Surveillance Reports. [Internet]. Available from: https://www.alberta.ca/stats/covid-19-alberta-statistics.htm

37. Bentahar I, Loubet P, Salipante F, Choquet C, Descamps D, Visseaux B, et al. Respiratory viruses Ct values and association with clinical outcomes among adults visiting the ED with lower respiratory tract infections. PLoS One [Internet]. 2025 May 29;20(5):e0320503. Available from: https://doi.org/10.1371/journal.pone.0320503

38. Michigan U of. Center for Sustainalbe Systems. Available from: https://css.umich.edu/publications/factsheets/sustainability-indicators/carbon-footprint-factsheet

Appendix A: Educational Material

1.Unit 61 Cycle Threshold Physician Information for Trial (email message)

Unit 61 is officially starting our Cycle Threshold trial on June 2, 2025. As part of this trial, patients on Unit 61 will need to have COVID swabs run with cycle threshold values attached. Each patient will need at least 2 cycle thresholds in order to determine if they are eligible to come off isolation earlier than the current practice of 10+1 days.

In order to ensure cycle thresholds are run off the nasopharynx swab, please ensure COVID 19 swabs are ordered as "Respiratory Infection (incl. COV-19) Nasopharynx".

Then in the options check off:

- Reason for testing: Outbreak Screen Requested by Infection Control
- Testing Required: Rapid COVID-19 PC

If you patient comes back with 2 cycle threshold values greater than or equal to 30 or indeterminate, then you have the option to review the patient's signs and symptoms of COVID-19 and based off your assessment, cancel the isolation and discontinue Remdesivir.

If you choose not to end the isolation early with these results and your assessment. Please enter a separate note in Connect Care with the type "plan of care" along with the header "cycle threshold" then document your reason for not removing the isolation early. This is so we can extract the data from Connect Care and compile the reasons why isolation was not discontinued.

For checking the pt's signs and symptoms of COVID-19, use the COVID-19 Symptom ID & Monitoring flowsheet.
