

Reusable personal protective equipment in Canadian healthcare: Safe, secure, and sustainable

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Abstract

Personal Protective Equipment (PPE) that was intentionally designed and manufactured as reusable, including gowns, goggles, face shields, and elastomeric respirators, took on a heightened role during the pandemic. Healthcare workers who had access to these products and infrastructure for cleaning and sterilizing them had a greater sense of confidence to undertake their jobs due to an increased sense of personal safety. Using multiple data sources, including a literature review, roundtables, interviews, surveys, and Internet-based research, the project team investigated the impact of disposable PPE and role of reusable PPE during the pandemic in Canada. This research supports the claim that adopting and supporting reusable PPE systems throughout the health sector can, if used appropriately on an ongoing basis, provide continuous access to reusable PPE while also contributing many co-benefits, including lower costs, domestic jobs, and improved environmental performance such as reduced waste and greenhouse gas emissions.

Introduction

The pandemic forced a global scramble to purchase Personal Protective Equipment (PPE) for the primary purpose of protecting the healthcare workforce.¹ The types of PPE used in healthcare in most demand included surgical/medical masks, gloves, gowns, N95 respirators, goggles, and face shields—products that were largely disposable. These supplies were provided at considerable cost; indeed, PPE comprised the largest spending category (33%) in the Canadian government's pandemic response from March 2020 to October 2020, at \$7.55 billion.² Yet access to PPE, especially during the initial stages of the pandemic, was poor due to the challenges of the global supply chain.³ As well, some of the disposable PPE that was purchased did not meet quality standards.⁴ Finally, most of the PPE used in Canada is made of plastic and is disposable. Early in the pandemic, Health Canada estimated that 63,000 tonnes of plastic waste would be generated over a one-year period (June 2020–June 2021).⁵

Disruptions to the healthcare supply chain that affect the quantity or quality of PPE or other medical supplies can impact the safety of both patients and healthcare workers. Development of strategies to ensure 100% continuous access to essential healthcare products is needed.⁶ A comprehensive reusable PPE health system, which includes reusable products, local infrastructure for cleaning and disinfecting, and associated transport and tracking systems, should be explored as a strategy to ensure 100% access for some PPE, and for the many environmental, social, and economic co-benefits of such a system.

The purpose of this study was to identify opportunities to reduce plastic PPE waste focusing on opportunities for reduction and reuse in the health system, and exploring synergies with other government and health system priorities that would enhance opportunities and support for a reusable PPE system.

Methods

Environment and Climate Change Canada has particular interests in reducing plastic waste and were looking for innovative approaches to address this excess waste. A focus on investigating the role of reusable PPE was of interest due to existing reuse infrastructure including healthcare laundries in many areas across Canada. Other government priorities such as reduction of Greenhouse Gases (GHGs) from the health system, and promoting circular economy approaches to resolve resource and waste issues, could also be supported through this approach.

The study used multiple methods to gain a robust overview of reusable PPE utilization, experiences, and impacts during the COVID-19 pandemic. Multiple data sources included a literature review, roundtables, interviews, surveys, and Internet-based research.

This article describes results obtained from Internet-based research, surveys, and interviews related to the Canadian health system, with a focus on reusable gowns.

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Internet research

Publicly available PPE purchasing and use data reported from March 2020 to April 2022 were obtained through Internet searches to estimate waste quantities and Greenhouse Gas (GHG) emissions associated with PPE. Further details are available from the authors.

Surveys

The project team undertook two surveys to gather more detailed information from various healthcare perspectives on reusable gowns and other PPE and included:

- Healthcare workforce—where the responders were involved in providing direct care.
- Hospital facility—where the responders were generally support staff not providing direct care.

Healthcare Workforce Survey. The objective of this survey was to hear from healthcare workers across Canada on their experiences with reusable PPE such as gowns, elastomeric respirators, goggles, and face shields. This survey was developed by the project team and reviewed by the project advisors—including academics, the project healthcare partners, as well as individuals with expertise in this area. Twelve questions were developed including four background questions and eight questions probing experiences on a five-point Likert scale. The project lead was the Canadian Coalition for Green Health Care (CCGHC), a Canadian not-for-profit, where ethics approval was not required. The survey was distributed and promoted through partner networks and social media, and was open from February to May 2022.

Green Hospital Scorecard Survey. The GHS is a free hospital environmental benchmarking and recognition tool tracking energy, water, waste management, pollution prevention, transportation, food, climate change, and leadership hosted and delivered by the CCGHC.⁷ Six new survey questions were developed focusing on PPE and incorporated into the GHS for the data call issued for the 2019 and 2020 surveys.

Interviews

From March 2020 to April 2022, the project team conducted semi-structured qualitative interviews by phone or Zoom, with stakeholders from the healthcare workforce, PPE manufacturing and business community, waste/recycling companies, and government representatives. Over 75 interviews were conducted to obtain in-depth insights into stakeholder-specific issues, concerns, and perspectives related to reusable PPE.

Results

Results from our data gathering exercises are presented in [Tables 1-3](#).

Personal protective equipment plastic waste quantities and greenhouse gas emissions

Publicly reported PPE purchasing information was obtained from the Federal, Quebec, and Ontario governments to estimate plastic waste quantities and GHG emissions with estimated emissions are provided in [Table 1](#).

Survey results

Healthcare Workforce Survey results. The total number of respondents was 235 from nine provinces and territories, with the majority (91%) from Ontario, British Columbia, Quebec, and Newfoundland. The top reported work places included the following: hospitals: 66%, medical clinics: 9%, and long-term care homes: 9%. The top five areas within a hospital where reusable PPE was used were reported as emergency, intensive care, internal medicine, anesthesia, and surgery.

Green Hospital Scorecard Survey results

The total number of participating facilities was 75 with the breakdown of locations and peer groups of the participating hospitals as follows: 56 in Ontario, 5 in British Columbia, 1 in Alberta, 1 in Manitoba, and 12 in Newfoundland and Labrador. Hospital peer group breakdown: 28 community, 5 small, 33 academic, and 9 non-acute. The results from both surveys are presented in [Table 2](#).

Public statements, interviews, and testimonials

Public statements and interviews provided background perspectives and insights into reusable gown priorities, and testimonials from the healthcare workforce provided insights related to security, safety, costs, and environmental concerns are provided in [Table 3](#).

Discussion

Waste and greenhouse gas emissions from disposable personal protective equipment

Significant quantities of PPE waste and GHG emissions were generated from the top three procurement agencies in Canada: The Federal, Quebec, and Ontario governments where Ontario and Quebec together represent the majority (56%) of hospital beds in Canada.¹⁸

An estimated 93,800 tonnes of plastic from disposable PPE were purchased and disposed of during the first two years of the pandemic from these three agencies alone. The primary use of this PPE was in healthcare settings. The largest contributors to this waste quantity were gloves, at 51% of the total waste, followed by gowns at 36% of the total waste.

An estimated 581,700 tonnes of CO₂ equivalent (CO₂e) GHG were emitted from this disposable PPE throughout its life cycle during the first two years of the pandemic. The largest contributor to GHG emissions came from disposable gowns (48%) followed by gloves (39%).

Table 1. Selected PPE plastic waste quantities and GHG emissions from the Federal, Quebec, and Ontario government purchases, and estimated plastic waste and GHG emissions avoided by reusable gown use.

Summary of PPE waste estimate weights for two years of the pandemic (March 2020 to April 2022). Data sources included Federal Government reporting,⁸ Quebec auditors report,⁹ Ontario auditors report,¹⁰ and additional government reporting. Note: Federal data from purchase of surgical masks were not available and therefore estimated.

	N95 type respirators	Surgical/Medical masks	Gowns	Gloves (pairs)	Face shield	Goggles	Total PPE weights tonnes
Federal purchases of PPE (weight tonnes)	2,619	758	16,840	17,187	1,810	16	39,230
Quebec purchases of PPE (weight tonnes)	556	3,202	12,925	25,960	NA	NA	42,643
Ontario purchases of PPE (weight tonnes)	710	1,855	4,351	4,488	465	48	11,917
TOTAL	3,885	5,815	34,116	47,635	2,275	64	93,790
%	4%	6%	36%	51%	2%	1%	

Summary of PPE GHG emission estimates for two years of the pandemic (March 2020 to April 2022). Note: GHG emissions associated with PPE were estimated using values developed by Rizan et al.¹¹

	N95 type respirators	Surgical/Medical masks	Gowns	Gloves (pairs)	Face shield	Goggles	Total PPE GHG CO ₂ e tonnes
Federal PPE (GHG CO ₂ e tonnes)	26,321	2,590	138,544	81,250	13,935	NA	262,640
Quebec PPE (GHG CO ₂ e tonnes)	5,588	10,567	106,338	122,720	NA	NA	245,213
Ontario PPE (GHG CO ₂ e tonnes)	7,135	6,122	35,796	21,216	3,580	NA	73,849
TOTAL	39,044	19,279	280,678	255,186	17,515		581,702
%	7%	3%	48%	39%	3%		

Estimated plastic waste and GHG emissions avoided by reusable gown use in healthcare* between March 2020 and April 2022. *from publicly available information.

Plastic waste avoided: tonnes	83,097 tonnes/2 years (average of 41,548 tonnes/year)
GHG avoided: tonnes CO ₂ e	721,285 tonnes CO ₂ e/2 years (average of 360,642 tonnes CO ₂ e/year)

Available public data on use of reusable gowns during the first two years of the pandemic from healthcare sites across Canada revealed that reusable gowns displaced at least 83,100 tonnes of plastic disposable gown waste, while also displacing an estimated 721,300 tonnes CO₂e in GHG emissions. Generally, public reporting on PPE purchasing did not include use of reusables, except in the Quebec auditor's report. Many healthcare laundry facilities or hospitals they service did not disclose their use of reusable gowns, which impedes identifying possible challenges and opportunities. While gloves also constitute a high waste component of PPE, no reusable options are available. Another approach is to reduce unnecessary glove use, which is an initiative implemented by the United Kingdom's Royal College of Nurses through their "Gloves Off Week"¹⁹ campaign.

Healthcare workforce perceptions of safety and security

Early in the pandemic government agencies like Ontario Health advised hospitals to switch to reusables if they could, giving added credibility to the use of reusable gowns.

Forty-three percent of survey respondents reported that they started to use reusable gowns in the past two years, showing a shift of interest during the pandemic. Eighty-eight percent of respondents said they would continue to use reusable PPE even after the pandemic started to wane.

The majority of respondents (89%) reported feeling safe in their reusable gowns, and 80% reported feeling comfortable. There was confidence in the cleaning process (79%), but a lower range of satisfaction with appropriate sizing (49%), temperature control (46%), and breathability (45%). These results show opportunities for improvement in the design of reusable gowns.

Survey respondents reported a high level of importance for a number of variables such as safety, ability to perform work, meeting standards, confidence in cleaning process, durability, clear identification of clean PPE at worksite, reduced waste, widely available, reduced single use plastic, appropriate size, and comfort. A lower level of importance was placed on "made in Canada" and cost effectiveness. Knowledge about where the gowns were cleaned appears low, with 19-26% of respondents

Table 2. Survey results from the Healthcare Workforce Survey (2022) and the Green Hospital Scorecard Survey (2019, 2020).

I. Healthcare Workforce Survey results (2022)				
Timeframe: February-May 2022				
Number of respondents = 235				
Rating guide:				
A Over 80% approval				
B Between 60% and 79% approval				
C Between 40% and 59% approval				
I. Rate how important each of the following factors are regarding use of PPE, in relation to the same type of PPE which is disposable.				
	Rating	Reported as very important and important	Reported as neutral	Reported as somewhat important or not very important
Safety	A	98% (N = 230/235)	2% (N = 5/235)	0% (N = 0/235)
Ability to perform work	A	98% (N = 174/178)	2% (N = 4/178)	0% (N = 0/178)
Meeting standards	A	96% (N = 223/232)	4% (N = 9/232)	0% (N = 0/232)
Confidence in cleaning process	A	95% (N = 223/235)	4% (N = 10/235)	1% (N = 2/235)
Durability	A	92% (N = 214/232)	7% (N = 16/232)	1% (N = 2/232)
Clear identification as clean PPE at worksite	A	91% (N = 162/178)	7% (N = 13/178)	2% (N = 3/178)
Reduced waste	A	89% (N = 208/235)	5% (N = 12/235)	6% (N = 15/235)
Widely available	A	88% (N = 205/232)	10% (N = 23)	2% (N = 4/232)
Reduced single use plastic	A	88% (N = 207/235)	6% (N = 15/235)	6% (N = 13/235)
Appropriate size available	A	86% (N = 203/235)	10% (N = 23/235)	4% (N = 9/235)
Comfort	A	85% (N = 199/235)	8% (N = 19/235)	7% (N = 17/235)
Made in Canada	B	66% (N = 156/235)	24% (N = 57/235)	9% (N = 22/235)
Cost effectiveness	B	66% (N = 154/235)	26% (N = 60/235)	9% (N = 21/235)
2. How safe do users feel in reusable gowns?				
		Reported that they felt very safe and safe	Reported as neutral	Reported as unsafe or very unsafe
How safe do users feel in reusable gowns?	A	89% (N = 200/226)	4% (N = 10/226)	7% (N = 16/226)
3. What is the level of comfort in reusable gowns?				
		Reported that they were very comfortable and comfortable	Reported it as neutral	Reported it as uncomfortable or very uncomfortable
What is the level of comfort in reusable gowns?	A	80% (N = 176/219)	3% (N = 6/219)	17% (N = 37/219)
4. What is the satisfaction level for selected reusable gown characteristics?				
		Reported it was very good and good	Reported it was fair	Reported it was poor and very poor
Satisfaction with confidence in cleaning	B	79% (N = 153/194)	15% (N = 29/194)	6% (N = 12/194)
Satisfaction with comfort	B	65% (N = 126/193)	24% (N = 46/193)	11% (N = 21/193)
Satisfaction with appropriate size available	C	49% (N = 96/194)	30% (N = 57/194)	21% (N = 41/194)

(continued)

Table 2. (continued)

Satisfaction with temperature control	C	46% (N = 89/194)	25% (N = 48/194)	29% (N = 57/194)	
Satisfaction with breathability	C	45% (N = 87/194)	25% (N = 49/194)	30% (N = 58/194)	
5. Would respondents continue to use reusable PPE if it was available after the pandemic?					
		YES	Maybe	NO	
Would continue to use reusable PPE even after the pandemic wanes if reusable PPE is available	A	88% (N = 190/217)	5% (N = 11/217)	7% (N = 16/217)	
6. Where are the reusable gowns cleaned?					
		Off-site	On-site	Clean own gowns	Did not know
Where are the reusable gowns cleaned?		39% (N = 76/197)	34% (N = 66/197)	2% (N = 3/197)	26% (N = 52/197)
7. How long have respondents been using reusable gowns?					
		More than 3 years:	In the past 2 years:	Less than 1 year	Not applicable
How long have respondents been using reusable gowns?		56% (N = 107/190) - which includes 41% (N = 77/190) using reusable gowns for over 5 years	43% (N = 83/190)	6% (N = 12/190)	21% (N = 40/190)
8. Have they ever been consulted about the type of PPE that are purchased in their facility?					
		YES	NO	No, but interested in doing so	
Had they ever been consulted about the type of PPE that are purchased in their facility?		15% (N = 37/235)	52% (N = 125/235)	31% (N = 73/235)	

2. Green Hospital Scorecard Survey results

Timeframe: Annual surveys for 2019 and 2020 data

Number of respondents = 75

1. Does your facility use reusable gowns?

Data call year	YES	NO	Not applicable	No answer
2019	76% (N = 57/75)	8% (N = 6/75)	15% (N = 11/75)	1% (N = 1/75)
2020	81% (N = 61/75)	5% (N = 4/75)	12% (N = 9/75)	1% (N = 1/75)

2. What is the percentage of reusable gown use in the facility?

If yes, please estimate percent usage of reusable gowns (i.e. approximately what percentage of gowns used are reusable?).

Data call year	100%	75%	50%	25%	0%	No answer
2019	24% (N = 18/75)	43% (N = 32/75)	4% (N = 3/75)	4% (N = 3/75)	5% (N = 4/75)	20% (N = 15/75)
2020	24% (N = 18/75)	48% (N = 36/75)	5% (N = 4/75)	5% (N = 4/75)	3% (N = 2/75)	15% (N = 11/75)

3. Where is the laundry service?

Data call year	Off-site	On-site	No answer
2019	68% (N = 51/75)	12% (N = 9/75)	20% (N = 15/75)
2020	69% (N = 52/75)	12% (N = 9/75)	19% (N = 14/75)

(continued)

Table 2. (continued)**4. Reuse policy**

Does your facility have an environmental sustainability policy that promotes "reuse"? Where the policy specifically states that reusable products/systems should be considered, if they are available and meet quality and cost requirements, and have a system in place to ensure reusability, as preferable to recyclable or disposable products? An example would be a policy to purchase reusable gowns instead of disposable gowns.

Data call year	YES	NO	No answer
2019	16% (N = 12/75)	85% (N = 63/75)	
2020	20% (N = 15/75)	80% (N = 60/75)	

5. If your facility does not have a reuse policy, would you like more information?

Data call year	YES	NO	No answer
2019	68% (N = 51/75)	17% (N = 13/75)	15% (N = 11/75)
2020	65% (N = 49/75)	19% (N = 14/75)	16% (N = 12/75)

6. Facility collaboration in design of new products/services for circular economy

Has your facility been involved with or collaborated in the design of new products/processes which would support the circular economy? Some examples include developing new reusable N95 respirators or new reusable surgical masks; testing of existing N95 respirators to determine reusability; and developing new reusable medical devices.

Data call year	YES	NO	No answer
2019	32% (N = 24/75)	68% (N = 51/75)	
2020	32% (N = 24/75)	67% (N = 50/75)	1% (N = 1/75)

indicating they did not know where their gowns were cleaned. Healthcare workers also wanted to know how the gowns are cleaned, and the impact on the environment from the cleaning process. These factors should be included when developing knowledge translation materials for reusable PPE programs. It could be suggested greater acceptance of reusable systems may increase with improved knowledge of how the reusable systems work.

Reuse policies

The majority of facilities do not have specific reuse policies (average 18%), but 65-68% of facilities who do not have reusable policies would like more information, suggesting an opportunity to provide more information and education to support these types of policies. Even without reuse policies, hospitals are regularly employing other reuse activities in addition to reusable gowns, including reprocessing operating room instruments, reusable laryngeal mask airways, and reusable biomedical waste containers.

Health leaders can use the LEADS framework lens to help transform the health system from one with a significant reliance on single-use disposable products which can be highly susceptible to supply chain disruptions to a system which can rely on the safe renewal of supplies through reuse. This transformation can be supported by engaging the healthcare workforce for input, development of reuse policies which identify priority products and which are well articulated and communicated, working with community stakeholders to partner on reuse services for cleaning and sterilization as needed, and monitoring results for quality and costs.

Cost savings

The University Health Network in Ontario reported saving 60% of disposable gown costs when it switched to reusable level 2 isolation gowns.¹⁵ Surrey Memorial Hospital in British Columbia switched to reusable gowns and saved \$2 million between August 2020 and February 2021, reporting that reusable gowns are nine times cheaper per use than disposables.¹⁶ Savings identified for Toronto area hospitals were reported by Ecotex, revealing that over the first two year period of the pandemic, Toronto area hospital use of reusable gowns saved these hospitals an estimated \$70 million. In addition, added costs of disposable gowns accrued from over-purchasing and outdated supplies.

Healthcare laundries

While healthcare laundries are generally available across the country, some small or rural areas indicated lack of available healthcare laundry services. Some healthcare laundries and hospital sites reported their use of reusable gowns increased two to three times their normal use during the pandemic. Both healthcare facilities and laundries are considered critical infrastructure.²⁰ If there is to be a greater reliance on reusable gowns, there is a pressing need to assess the ability of healthcare laundries to continue service delivery during surges, and to develop contingency plans to cope with these surges. Options to explore include expanding healthcare laundry capacity by working with the underutilized hospitality laundry services.²¹

Table 3. Public statements, interview quotes, and testimonials focusing on security, safety, and costs of PPE.**I. Comments on security and supply concerns including availability of PPE****Source**

Ontario: Recommendations on the use and conservation of PPE from Ontario Health ¹²	<i>'Strongly consider moving to washable gowns. One hospital tested washing blue isolation gowns in-house and reported they laundered well.'</i>
British Columbia: PICNet, Provincial Health Services Authority support for using reusable gowns ¹³	Provincial support for using reusable gowns for Infection Prevention and Control (IPAC) purposes: <i>'Provincial working group indicates support for the use of reusable gowns for routine practices and additional precautions, if they are laundered through an approved laundry service which has the means to provide quality control and assurance of the laundry process.'</i>
Altaf Stationwala, CEO, McKenzie Health, Ontario	When switching to reusable gowns: <i>"...it (reusable gowns) also immediately introduced a predictable supply of product for the foreseeable future. The fact that it also reduced our environmental footprint was an added benefit."</i>
Dr. Andrea MacNeill, Surgical and Medical Director of Planetary Health, Vancouver Coastal Health, British Columbia	<i>"It is a lot easier to scale up your reuse cycles such as laundering gowns or replacing the filters in your reusable respirators than it is to remanufacture more of something ... and of course it creates less pollution."</i>
Federal Auditor ¹⁴	Access not timely for purchase of PPE in the early part of the pandemic. Disposable gowns took an average of 85 calendar days from requisition to first delivery.

2. Testimonials from Healthcare Workforce Survey

16% (N = 37/235) of respondents provided testimonials. Of these, 30 provided positive comments and seven had negative comments (or suggestions for improvements) for reusable PPE. Sample testimonials are provided below.

"Working in the ER during the pandemic I produce a huge amount of waste per shift. Easily garbage bags full just myself, every shift I work. I would go through a box of gloves or more, 20+ gowns, up to 10 face shields and multiple masks and n95 respirators (I was lucky enough to work somewhere that didn't ration them). I generally try to be environmentally conscious in my personal life and despite clustering care I would still throw so much away. I don't really believe this amount of waste is necessary or sustainable. I know the gloves don't have an easy work around, but I would love to see more reusable PPE. Due to shortages our hospital actually manufactured reusable shields and most of us preferred them. I found the reusable gowns to be comfortable and felt as though they provide better protection as well."

"As a healthcare professional, I am experiencing a profound sense of hypocrisy; we healthcare professionals are unwittingly contributing to a global healthcare crisis, in the form of microplastic contamination which has been scientifically proven to be damaging to human cells, and is implicated in cancers, endocrine disorders, infertility, and Alzheimer's, and is clearly destroying biodiversity across the globe. The regulatory bodies need to recognize this situation and make every effort to explore reusable options for IPAC compliance. Many of the current plastic single use items have no scientific efficacy, but are based on optics and convenience. We are 'conveniently' not addressing the long-term consequences of our actions and in so doing contributing to an environmental situation which will no longer sustain life. Shame on us."

"For us, the pandemic highlighted the excessive waste produced in healthcare with single use disposable PPE and the precarious nature of supply chains when single use products are relied upon. Reusable PPE is less wasteful, as effective, and likely far less expensive to use than disposables. Our healthcare system has to take responsibility for its effects on the environment as that ultimately impacts population health and rethink how we use and reuse PPE."

"This is a great choice that needs to be institutionalized so that there is no choice, and uniformity can really bring benefits to our reduction in waste. We need to know more about the impact of cleaning techniques and the impact on the environment of that."

"We never previously had reusable gowns for isolation rooms, and this was a point of contention and discomfort for many, including myself, due to implications for waste. Early in COVID, the regular disposable gowns ran out and were replaced by plastic, unbreathable gowns. The nursing team put in many complaints within our pediatric ICU, as these caused them to overheat quickly and created an unsafe work environment, which particularly disadvantaged perimenopausal women, who are the most experienced nurses. After this, the hospital replaced the plastic gowns with cloth reusable gowns, which spread through the rest of our hospital. We continue to have reusable gowns, and I have witnessed all hospital staff walk far distances from patient rooms to get reusable gowns if the room's supply has been depleted. In the patient wards, they often run out, and when staff have to use disposable gowns there are audible complaints and murmurs of distress. Overall, by aligning a sustainability goal with a staff safety goal, we achieved a major win for waste reduction, which also boosted staff morale."

"My only issue with reusable PPE is my confidence in knowing that the gowns have properly been cleaned and sanitized. Goggles and face shields I clean myself, so I feel more confident in reusing them."

"Reusable gowns were purchased in large quantity by our hospital but rollout has been limited and challenging due to lack of awareness of their safety, and ineffective labeling of clean versus soiled bins."

(continued)

Table 3. (continued)

3. Reported cost savings for using reusable level 2 isolation gowns		
Facility	Cost savings	Comments
University Health Network (UHN), Ontario ¹⁵	<ul style="list-style-type: none"> UHN switched to reusable level 2 isolations gowns and reduced costs by 60% when compared to conventional disposable gowns 	<ul style="list-style-type: none"> Switching from disposable to reusable isolation gowns resulted in improved comfort and reduced waste while protecting supply chains and lowering overall costs
Surrey Memorial Hospital (SMH), British Columbia ¹⁶	<ul style="list-style-type: none"> Saved \$2 million between August 2020 and February 2021 Report that reusable gowns are nine times cheaper per use than disposables 	<ul style="list-style-type: none"> Approximately 869,000 disposable gowns were kept out of landfills or incinerators during this time, saving \$45,000 in waste disposal costs SMH Site Operations plans to continue with the reusable gowns, which staff found to be comfortable and of high quality
Ecotex Healthcare Linen Service, Toronto—a commercial healthcare laundry operator	<ul style="list-style-type: none"> Over the first two-year period (March 2020–April 2022) of the pandemic, Toronto area hospital use of reusable gowns saved these hospitals an estimated \$70 million 	<ul style="list-style-type: none"> An estimated 40% increase in users of reusable gowns occurred in the Toronto area during the pandemic Toronto area hospitals avoided 5,350 tonnes of plastic waste from disposal and an estimated 45,250 tonnes of GHGs from being emitted
Reports of other costs related to PPE purchasing Ontario ¹⁷		
	The Ministry of Health and Ministry of Public and Business Service Delivery had a combined total of \$66 million of PPE that expired, was damaged, or became obsolete and was written off as of March 31, 2022.	

Reusable personal protective equipment health systems

A comprehensive reusable PPE health system, which includes reusable products, sterilization systems, and associated transport and tracking capacity can contribute to numerous health system priorities, including addressing reliable supply of this essential product. Many of these components are already in place across Canada. Further assessments of these components can help form the basis of health system strategies for reusable healthcare PPE textiles, such as is happening in the United Kingdom.²²

Reusable personal protective equipment systems align with other priorities

Accreditation Canada surveys hospitals to rate them on the extent to which they meet national standards for quality and hospital operations. New standards regarding environmental stewardship were adopted for Leadership in 2021 and for Governing Bodies in 2022. Reusable PPE systems for textiles including gowns can be used to show facility sustainability and climate action meeting a recommendation or Required Organizational Practice for both of these standards as provided in the referenced guidance document.²³ Reusable gowns have been assessed and shown to be more environmentally friendly than disposable gowns.^{24,25}

Limitations

Access to data on PPE purchasing was limited especially during the pandemic. The project team is aware that even though the Federal, Quebec, and Ontario governments reported on PPE

purchasing, other provinces and territories also made PPE purchases. Additional purchases were also made directly by hospitals and health authorities, which were not available for analysis. Therefore, we consider these numbers as preliminary and an underreporting of the actual numbers.

Conclusions

Reusable gowns forming part of a reusable PPE health system is a strategy to ensure 100% continuous access for these essential healthcare products. This research supports the claim that adopting and supporting reusable PPE systems throughout the healthcare system can, if used on an ongoing basis, ensure enhanced resilience in the face of future pandemics and other supply-chain disruptions such as extreme weather events which are expected to increase as a result of our changing climate.

Reusable PPE, particularly gowns and other textiles, offer multiple benefits to the healthcare workforce and the health system including safety, security, and financial, social, and environmental sustainability. Safety includes verified safe products, and security includes psychological and personal security, and a reliable supply through timely and consistent access to PPE. Financial sustainability includes stable and lower cost of reusable PPE. Social sustainability includes greater assurance that these products have been manufactured using fair labour practices and processes, and provides increased domestic jobs. Environmental sustainability includes improved environmental performance through, for example, reduced waste, reduced use of single-use plastic, and reduced GHG generation.

Opportunities should be explored to increase reusable gown acceptance by enhancing the design of some reusable gowns

and through education and awareness of reusable gown programs to the healthcare workforce. Engaging users of reusable PPE in the innovation and selection process could contribute to greater acceptance and system improvement. Greater access to information on PPE and reusable gown usage would improve the analysis of current practices, which could lead to deeper understanding of challenges and opportunities. Ensuring the reusable gown infrastructure is as robust as possible will help prepare the health system for the future. Combining reuse approaches with programs to prevent unnecessary use of gloves would prolong access to existing supplies while also conserve resources, reduce waste, and save money.

Finally, although this paper focused on reusable gowns, further work is needed to extend and support the concept of reuse within the health system, identifying which products should be prioritized to ensure medical devices and products are continually accessible, safe, affordable, as well as socially and environmentally responsible.

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References

1. World Health Organization. *Shortage of personal protective equipment endangering health workers worldwide*. Geneva; World Health Organization – Newsroom; 2020. <https://www.who.int/news/item/03-03-2020-shortage-of-personal-protective-equipment-endangering-health-workers-worldwide>. Accessed January 6, 2023.
2. Canadian Institute for Health Information. *National Health Expenditure Trends*. Ottawa, ON: CIHI; 2020.
3. Miller FA, Young SB, Dobrow M, Shojania KG. Vulnerability of the medical product supply chain: the wake-up call of COVID-19. *BMJ Qual Saf*. 2021;30(4):331–335.
4. McQuerry M, Easter E, Cao A. Disposable versus reusable medical gowns: a performance comparison. *Am J Infect Control*. 2021; 49(5):563–570.
5. Aldrighetti R, Zennaro I, Finco S, Battini D. Healthcare supply chain simulation with disruption considerations: A case study from Northern Italy. *Glob J Flex Syst Manag*. 2019;20(1):81–102.
6. Government of Canada. Government of Canada launches new COVID-19-related challenges to help reduce environmental impact of PPE in Canada; 2020. <https://www.canada.ca/en/innovation-science-economic-development/news/2020/10/government-of-canada-launches-new-covid-19-challenges-to-help-reduce-environmental-footprint-of-ppe-in-canada.html>. Accessed January 6, 2023.
7. Canadian Coalition for Green Health Care. Green hospital scorecard. 2022. <https://greenhealthcare.ca/ghs/>. Accessed January 6, 2023.
8. Service Public and Procurement Canada. Supplying Canada's response to COVID-19; 2022. <https://www.tpsgc-pwgsc.gc.ca/comm/aic-scr/provisions-supplies-eng.html>. Accessed January 7, 2023.
9. Office of the Auditor General of Quebec. Management of personal protective equipment during the pandemic. In: *Report of the auditor general of Québec to the national assembly for the year 2021-2022*. Performance Audit Department of Health and Social Services Government Procurement Centre; 2022.
10. Office of the Auditor General of Ontario. *Value for money audit: COVID-19 personal protective equipment*; Office of the Auditor General of Ontario; 2021.
11. 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;114(5):250–263.
12. Ontario Health. *Personal protective equipment (PPE) use during the COVID-19 pandemic recommendations on the use and conservation of PPE from Ontario health*; Ontario Health; 2020.
13. PICNet, Provincial Health Services Authority. BC. Provincial support for using reusable gowns for IPAC purposes. http://www.bccdc.ca/Health-Professionals-Site/Documents/COVID19_ProvSupportReusableGownsIPAC.pdf. Accessed January 7, 2023.
14. Office of the Auditor General of Canada. Report 10 - Securing personal protective equipment and medical devices. In: *Reports of the Auditor General of Canada to the Parliament of Canada*; Office of the Auditor General of Canada; 2021.
15. University Health Network. Energy and environment annual report 2021. <https://talkintrashwithuhn.com/annual-report-2021-energy-environment-at-uhn/>. <https://talkintrashwithuhn.com/annual-report-2021-energy-environment-at-uhn/>. Accessed January 7, 2023.
16. Fraser Health. *Greencare 2020 environmental performance accountability report: environmental sustainability is everyone's story*. Fraser Health; 2020.
17. Office of the Auditor General of Ontario. *COVID-19 contracts and procurement: 2022 value for money*; Office of the Auditor General of Ontario; 2022.
18. Canadian Institute for Health Information (CIHI). Hospital beds staffed and in operation 2020-2021. Canadian Institute for Health Information (CIHI). <https://www.cihi.ca/sites/default/files/document/beds-staffed-and-in-operation-2020-2021-en.xlsx>. Accessed January 7, 2023.

19. Royal College of Nursing, UK. Glove awareness week. 2022. <https://www.rcn.org.uk/Get-Involved/Campaign-with-us/Glove-awareness>. Accessed January 6, 2023.
20. Government of Canada. Public safety Canada: guidance on essential services and functions in Canada during the COVID-19 pandemic. 2021. <https://www.publicsafety.gc.ca/cnt/ntnl-scrtr/crtcl-nfrstrctr/esfsfe-en.aspx>. Accessed January 6, 2023.
21. Livingston E, Desai A, Berkwits M. Sourcing personal protective equipment during the COVID-19 pandemic. *JAMA*. 2020;323(19):1912–1914.
22. UK Parliament. *Hansard*. Washable PPE:Volume 827. Debated on Wednesday February 8, 2023. <https://hansard.parliament.uk/Lords/2023-02-08/debates/9C0F2251-F25C-4F4F-B702-6928C0B586EF/WashablePPE>. Accessed February 8, 2023.
23. Peach Health Ontario. *Environmental stewardship: An implementation guide for boards, executive leaders, and clinical staff: Meeting hospital standards and beyond*. Peach Health Ontario; 2022.
24. Baker N, Bromley-Dulfano R, Chan J, et al. COVID-19 solutions are climate solutions: lessons from reusable gowns. *Front Public Health*. 2020;8:590275.
25. Vozzola E, Overcash M, Griffing E. An environmental analysis of reusable and disposable surgical gowns. *AORN J*. 2020;111(3):315–325.