



SUSTAINABLE PRACTICE

Switching from disposable to reusable PPE

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What you need to know

- Globally, demand for PPE is rising, despite a recent decrease relative to its peak in the covid pandemic
- In 2020, use of isolation gowns and surgical masks in the US alone contributed the carbon dioxide equivalent of 78 coal fired power plants running continuously
- Reusable PPE preserves safety, while offering less severe environmental consequences and reducing costs. Successful deployments of reusable gowns at large US medical centres have resulted in the diversion of hundreds of tons of landfill waste with cost savings of nearly 50% per gown with no impact on infection rates.

Sustainable sourcing, use, and disposal of personal protective equipment (PPE) can help healthcare providers reduce the environmental impacts of their work. In this article we review supporting evidence and provide guidance for healthcare institutions to adopt reusable forms of PPE as safe, cost saving, and sustainable alternatives to single use disposables.

The first step to reducing the environmental impact of PPE usage is to reduce unnecessary consumption of supplies.^{1,2} However, we discuss those situations where PPE use is unavoidable, and offer more sustainable alternatives with a focus on reusable isolation and surgical gowns, masks, and eye protection. The evidence for alternatives to single use gloves, surgical drapes, and other PPE is still emerging.^{3,4}

Why change is needed

Global PPE usage has been rising over the past several decades,⁵ driven by heightened attention to employee safety (particularly that of healthcare workers), increasingly stringent regulations for work environments, and robust economic growth in middle and high income countries.⁵ The covid-19 pandemic caused usage of PPE to surge globally to unprecedented levels.^{6,7} Unicef estimated that 2.2 billion surgical masks, 1.1 billion gloves, 13 million goggles, and 8.8 million face shields were needed to protect against covid-19 during the first year of the pandemic.⁸ Global production of healthcare PPE increased by approximately 300-400% during the pandemic, with the steepest increases in surgical masks.^{5,9,10} While demand for PPE has decreased relative to its peak during the pandemic, the global market for PPE, which was worth more than \$52.7bn (£41.7bn) in 2019, is estimated to be growing at a compound annual growth rate of 8.7% and will reach over \$92.5bn by 2027.¹¹

PPE is critical to protect healthcare workers and patients from highly infectious diseases. However, single use PPE requires extraction of resource intensive materials, manufacturing, packaging, and transportation, and generates large amounts of waste, which together are environmentally destructive and financially costly to healthcare systems.¹² Peer reviewed studies quantifying the global environmental impacts of PPE related pollutants are limited, but well established concerns include high emissions (primarily produced during manufacture) and environmental contamination from plastic waste.¹³ For example, in the US (the world's largest importer of PPE), use of isolation gowns and surgical masks alone contributed more than 70 million tons of carbon dioxide equivalent (CO₂e) in 2019 and more than 292 million tons of CO₂e in 2020, roughly equal to the emissions generated from the continuous running of 19 or 78 coal fired power plants for one year, respectively.⁵ China (the world's leading producer of PPE by a considerable margin) exported more than 220 billion disposable masks in 2020.^{10,14,15} Globally, an estimated 8-11 million tons of plastic waste associated with the pandemic were generated in 2021, creating strain on an already intractable global plastic waste problem and posing major threats to marine and oceanic ecosystems worldwide.^{6,7,16-18}

Together these impacts make switching to reusable PPE an important area for the healthcare industry to reduce its environmental impact. Reusable gowns, goggles, face shields, and N95 surgical masks all offer less severe environmental consequences while preserving safety. With increased demand relative to the pre-pandemic period expected to continue, and additional surges anticipated with future pandemics, adopting reusable PPE may increase resilience to PPE shortages during future public health emergencies, in addition to creating considerable environmental benefit.^{6,19,20}

Evidence for the solution

Evidence suggests that reusable PPE is as safe, cheaper, and more sustainable than disposable PPE. In a cradle-to-grave life cycle assessment from an independent research firm specialising in medical equipment, reusable isolation gowns were found to have a 30% reduction in greenhouse gas emissions and a 28% reduction in energy consumption compared with disposable gowns.¹² Reassessments of this comparison across various geographical regions may be needed to characterise how emissions vary depending on the energy generation mix in different countries. A recent study comparing the performance of reusable and disposable gowns found

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that reusables were safer: regardless of the number of times they were washed, reusables outperformed disposables in consistently meeting PB70 performance specifications (from the Association of the Advancement Instrumentation), and had greater seam strength and comparatively superior resistance to breaking, tearing, and pilling.²¹ Furthermore, deployment of reusable gowns at large US medical centres resulted in diverting hundreds of tons of landfill waste and creating cost savings of nearly 50% per gown, saving millions of dollars over years with no impact on infection rates.²²⁻²⁴ Similarly, pilot studies in a US tertiary hospital system showed a transition to reusable surgical gowns would be feasible and safe, and would reduce waste and costs.²⁵

A modelling study from the US found that using reusable respirators with filters in place of single use N95 masks would have decreased costs by \$5.2bn (80% reduction) and waste generation by 68 million

kg (81% reduction) across the country during the first six months of the covid-19 pandemic.²⁶ Many candidate respirators exhibit comparable or greater safety than disposable masks.²⁷

Finally, a large lifecycle decision analysis across the NHS found that switching to reusable gowns and face shields, reducing plastic glove use, and maximally recycling during the first six months of the pandemic would have led to a 7.5% reduction in total emissions and would have averted (direct and resource depletion related) costs of just over \$1.2m.²⁸

What you can do

Here we present a framework of potential steps towards, and the relevant stakeholders necessary for, initiating a transition to reusable PPE (fig 1).

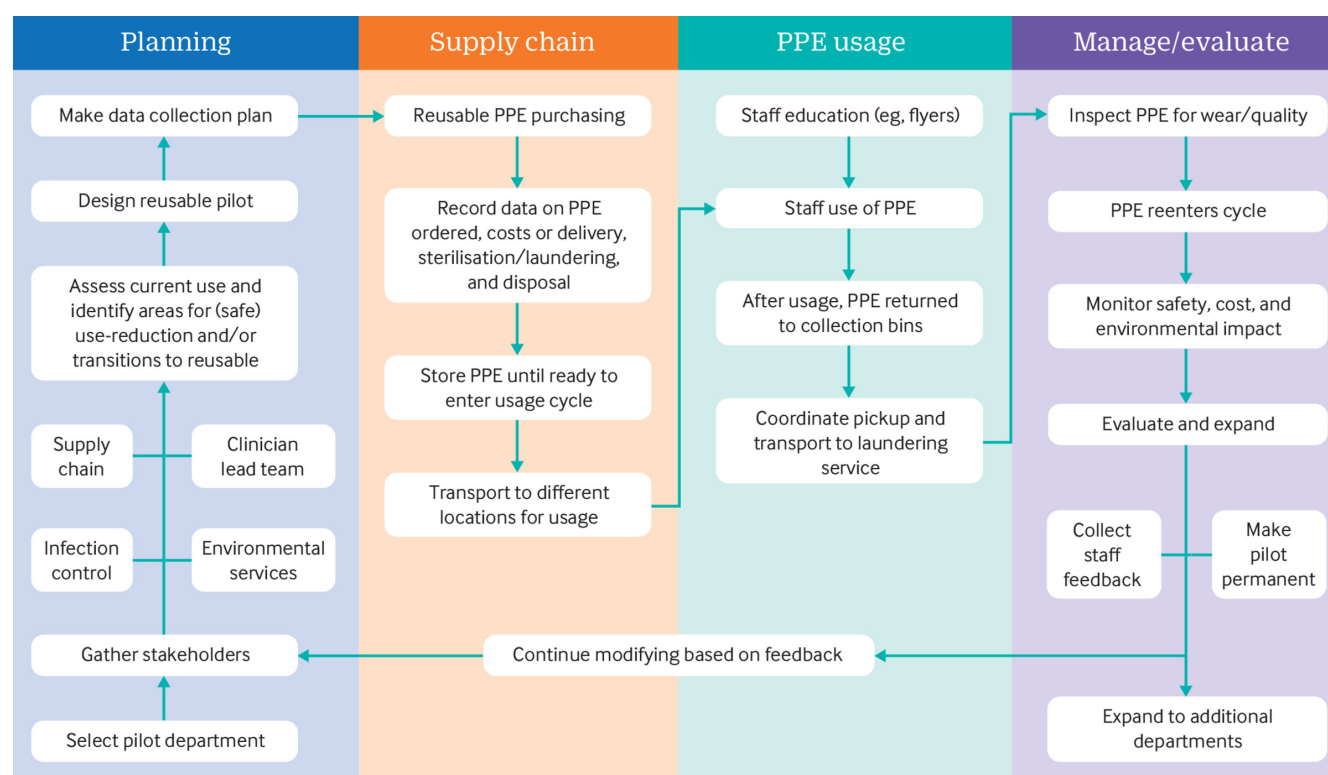


Fig 1 | Example step-by-step process map for implementing a reusable gown pilot programme within an institution. Figure adapted from an infographic from the Stanford Healthcare Consulting Group created by Sohayla Eldeeb

- Start with an assessment of current practice (identify areas for reduction or avoidance of PPE use, annual PPE usage, etc).
- Identify appropriate departments to pilot reusable PPE implementation (high volume departments, such as the emergency department or intensive care unit).
- Engage stakeholders, including infection control, operations, and hospital staff:
 - Involve stakeholders in the design and implementation of the new workflow.
 - Introduce training or educational materials to support staff with changes to workflows and with the correct reuse of PPE.
- Track safety, sustainability, and cost savings metrics (including but not limited to infection rates, tons of waste, and sourcing costs) from before and after implementation.
- Collaborate with environmental services for laundrying, tracking, transport, and disposal.
 - For reusable gowns, environmental services departments may want to consider chip and scanning technologies to track reusable gown laundry cycles and flag individual gowns for replacement when they reach their maximum number of uses (typically between 75 and 100 washes).
- Monitor the programme and iterate based on feedback (ie, anonymised surveys to staff and users), and scale up the programme.

- **Box 1** includes resources on how to safely implement reusable PPE and collect, analyse, and make actionable changes using results from quantitative and qualitative pilot studies.
- Engage with peer institutions to share knowledge and resources (**box 1**).
- Establish a public data repository with results:
 - For example, UCLA Health compiled a publicly available resource presenting data from their reusable gown pilot programme, which includes metrics such as cost effectiveness, sustainability, and staff receptiveness and comfort (**box 1**).
 - Publishing pilot results will support the creation of evidence based guidelines and policies that can enable broader adoption of sustainable practices and prevent healthcare supply chain shortages during future global health crises.

Box 1: Resources for transitioning towards reusable PPE

Gowns

- Practice Greenhealth. Ronald Reagan UCLA Medical Center: Reusable isolation gowns. <https://practicegreenhealth.org/tools-and-resources/ronald-reagan-ucla-medical-center-reusable-isolation-gowns>

Masks and respirators

- Centers for Disease Control and Prevention. Filtering out confusion: frequently asked questions about respiratory protection. <https://www.cdc.gov/niosh/docs/2018-128/pdfs/2018-128.pdf>
- Golladay G, Leslie KA, Zuelzer WA, et al. Rationale and process for N95 respirator sanitation and reuse in the coronavirus disease 2019 (COVID-19) pandemic N95 respirator sanitation and reuse. *Infect Control Hosp Epidemiol* 2022;43:40-4.
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Face shields and goggles

- Shah A, Zhuang E, German J. Surface contamination of reusable respirators and face shields during care of critically ill covid-19 patients. *Workplace Health Saf* 2023;71:137-43.
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Data collection and quality improvement

- UCLA Health reusable isolation gowns. https://cleanmedeu-rope.org/wp-content/uploads/2021/03/James-Evans_Victor-Mitry_UCLA-Health_reusable-isolation-gowns.pdf

Education into practice

- What does your organisation's current PPE usage look like (eg, what types of PPE are used and how frequently?)
- What are the areas of your clinical practice where you (and your department or institution) could reduce unnecessary PPE use and/or transition to using more reusable PPE?
- How might you engage with key stakeholders in your workplace about transitioning to reusable PPE? Who could you reach out to in your organisation to co-organise or partner on this effort with?
- What peer institutions could you reach out to for support, resource sharing, or collaboration?

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