BMJ Global Health

Lessons learnt from the rapid implementation of reusable personal protective equipment for COVID-19 in Malawi

Fumbani Limani,[1,2] David Garley,[2] Derek Cocker,[1,2] Priyanka Patel,[2] Pratiksha Patel,[2] Stephen Gordon,[2,3] Mulinda Nyirenda,[4,5] Servace Sakala,[6] Luis A Gadama,[7] Queen Dube,[8] Feggie Bodole,[9] Kwazizira Samson Mndolo,[1] Kelvin Mponda,[1] Bridget Freyne [10,11]

To cite: Limani F, Garley D, Cocker D, *et al*. Lessons learnt from the rapid implementation of reusable personal protective equipment for COVID-19 in Malawi. *BMJ Global Health* 2021;**6**:e006498. doi:10.1136/bmjgh-2021-006498

Handling editor Seye Abimbola

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/bmjgh-2021-006498).

Received 2 June 2021
Accepted 7 July 2021

For numbered affiliations see end of article.

Correspondence to
Dr Bridget Freyne;
bridgetfreyne@gmail.com

ABSTRACT

The SARS-CoV-2 pandemic has challenged health systems and healthcare workers worldwide. Access to personal protective equipment (PPE) is essential to mitigate the risk of excess mortality in healthcare providers. In Malawi, the cost of PPE represents an additional drain on available resources. In the event of repeated waves of disease over several years, the development of sustainable systems of PPE is essential. We describe the development, early implementation and rapid scale up of a reusable gown service at a tertiary-level hospital in Blantyre, Malawi. Challenges included healthcare worker perceptions around the potential of reduced efficacy of cotton gowns, the need to plan for surge capacity and the need for ongoing training of laundry staff in safety and hygiene procedures. Benefits of the system included increased coverage, decreased cost and reduced waste disposal. The implementation of a reusable cotton gown service is feasible, acceptable and cost-effective in tertiary centres providing specialist COVID-19 care at the height of the pandemic. This innovation could be expanded beyond low-income settings.

Summary box

- Components of reusable personal protective equipment (PPE) are recommended by the WHO where disposable items are not available or sustainable.
- Programmes which implement reusable PPE need to be underpinned by reliable supply, ongoing monitoring and evaluation, and robust contingency planning.
- Given the prospect of prolonged circulation of SARS-CoV-2 in low and middle-income countries (LMICs), reusable PPE is a sustainable, environmentally friendly option which supports local business.
- Studies are required to empirically prove the safety of reusable PPE and these findings may be generalisable beyond LMIC contexts.

INTRODUCTION

Pandemic preparedness stresses the need to stockpile essential equipment. In early 2020, worldwide stocks of personal protective equipment (PPE) became scarce and shortages were widespread.[1] Despite collaboration between international agencies and local governments, individual PPE items doubled in price early in the pandemic.[2] Ministries of Health in low and middle-income countries (LMICs) were unable to make the necessary purchases. Uncertainty about PPE contributed to industrial action by Malawian healthcare workers in April 2020.[3] In response, the WHO released guidance on alternative forms of PPE where disposable alternatives were not available.[4] In Malawi, disposable gowns were available for private purchase in April 2020 at a unit cost of US$10–US$15 which presented an unacceptable drain on resources.

The pandemic experience in Asia and Europe highlighted the risk of occupational exposure to SARS-CoV-2 for healthcare workers.[5] The risk of occupational COVID-19 infection is related to the nature of the exposure (ie, the level of aerosol generated) and the adequacy of PPE.[6] Reusable cotton gowns are not fluid repellent. Theoretically, they may not offer equivalent protection against prolonged droplet exposure when compared with fluid-repellent versions but the clinical relevance of this is unknown. Faced with the possibility of service disruption due to the cost and limited availability of gowns, the hospital administration at Queen Elizabeth Central Hospital (QECH) in Blantyre, Malawi opted for a reusable gown service on 8 April 2020. In anticipation of a surge in hospital admissions, the reusable PPE service was scaled up to 2700 gowns per week, across seven

departments over 15 weeks. The aim of this paper is to share lessons, costs and tools associated with this rapid implementation.

THE CONTEXT

Malawi is a low-income country in southern Africa with per capita health expenditure of US$19.[7] Eighty per cent of the 19 million strong population earn subsistence income, making effective lockdown impossible.[8] State healthcare is delivered by primary health centres supported by district and central hospitals. The QECH in Blantyre is the largest hospital in Malawi and the district hospital for Blantyre with a referral population of 5.5 million.[9] The hospital has 1200 beds and up to 6000 admissions per month across 10 clinical departments. In the era of COVID-19, QECH administration worked with the Blantyre District Health Office to provide tertiary care to patients with suspected or confirmed COVID-19 in isolation wards on site. Since the first case of COVID-19 was reported in Malawi on 2 April 2020, there have been 142 confirmed COVID-19-positive patients admitted to QECH. The annual budget for QECH is 5.5 billion Malawi kwacha (£5.6 million) and the Central Medical Stores Trust (CMST) is the authorised supplier of medical goods. Prior to 2020, CMST supplied up to 48% of QECH needs with the shortfall supplemented through private purchase or donations (QECH budget 2020/2021).

In the context of a worldwide shortage of PPE, several interventions aimed at reducing consumption of PPE items at QECH were initiated, including (1) home-based testing of contacts by mobile teams; (2) postponement of non-urgent hospital services and (3) promotion of rational PPE use. Despite these actions, both the cost and availability of PPE items posed a threat to supply. Disposable gowns and suits were the most expensive and hardest to procure PPE items and the hospital opted for a reusable gown service. The desirable system features were: low cost, rapid initiation, scope to upscale and the potential for long-term integration into the existing hospital laundry system.

PRE-IMPLEMENTATION PHASE

Development of a standard operating procedure

In the absence of specific guidance on sterilisation of reusable gowns, the WHO interim guidance on sterilisation of hospital linen in the era of COVID-19 was used.[4] This document emphasises that chlorine sterilisation is less effective in the presence of organic matter. Ideally, linen should be washed, then soaked in chlorine and washed again. This procedure is time-consuming and requires substantial water and electricity, the cost of which increased by 50% during the pandemic (QECH budget 2020/2021). Discussions were held with nursing managers, health and safety officers, and representatives from the Departments of Medicine and Paediatrics on how to amend the procedure to promote feasibility and sustainability without compromising staff safety. Given that gowns covered with a plastic apron were typically not heavily soiled following a single shift, a decision was made to start with a 30-minute chlorine soak carried out at the ward doffing station, followed by a hot wash (figure 1 shows images of the laundry team members who gave consent for their images to be used).

Gown sterilisation on the ward was affected by two issues. First, when gowns were doffed directly into a basin of 0.5% chlorine, laundry staff were unable to confirm the minimum recommended soak time of 30 min, particularly where large numbers of gowns meant that submersion was not possible. Second, prolonged soaking prior to collection resulted in damage to the gowns. Taking this into account, the standard operating procedure (SOP) was revised, and ward staff were retrained to doff into mobile bins, allowing the laundry staff to collect the gowns and do the chlorine soak at the laundry with a stronger 0.1% chlorine solution for 5 min.

Workspace

The main QECH laundry was running at capacity leaving existing hospital machines available only out of hours. The Malawi-Liverpool Wellcome Trust Research Programme had a furloughed laundry and an industrial drier previously associated with a paediatric research ward. This space along with a neighbouring disused storage room was recommissioned for this project. As capacity grew, a utility room in the Department of Obstetrics was added. This provided for a contingency laundry space and the potential for two teams to work in parallel during surge periods.

Machinery

The choice of laundry machine is influenced by cost, availability and projected peak usage.

Using the WHO interim guidance on the rational use of PPE and our local staff numbers, we projected the quantity of gowns which would be required in frontline areas at peak turnover.[4] We included all clinical and domestic staff from the adult and paediatric emergency departments, the COVID-19 isolation wards, the intensive care unit, the labour ward and operating theatres which resulted in a peak daily estimate of 250 gowns.

Following sterilisation in chlorine, gowns weighed 900 g giving an estimated requirement of 225 kg of laundry per day. To manage this volume of work, a large industrial machine was ideal but not locally available. To wash 225 kg of laundry in a day, an average 16 kg machine would need to run 14 times. At 45 min per cycle with a 10-minute changeover, this results in 10.5 hours per day. It was therefore decided to purchase two machines to shorten the laundry shift and avoid system failure in the event of machine malfunction.

Local tailors were approached to develop prototype gowns. The WHO guidance does not insist on fluid repellent material if a disposable plastic apron is used over the top of the gown. We chose close weaved polycotton as it is durable, low cost and widely available. Prototype gowns

Figure 1 Overview of laundry SOP. Box 1: main steps in a full laundry cycle. Box 2: laundry team in QECH. Box 3: donning and doffing memory aids for laundry staff. All tools and materials provided in online supplemental material (images credited to Dr Fumbani Limani). PPE, personal protective equipment; QECH, Queen Elizabeth Central Hospital; SOP, standard operating procedure.

were presented to hospital managers and clinical staff for feedback. This exercise led to tightening the neck space, increasing the length and size, and loosening the elasticated wristbands (figure 2 shows a laundry team member who gave consent for their image to be used).

Six furloughed research fieldworkers were recruited to run the laundry. They worked alternate weeks in two teams. The initial project implementation was overseen by a team of six volunteers whose duties included maintaining the staff rota, linking the service with hospital departments, and coordinating PPE training sessions in all frontline areas to consolidate evidence-based use of PPE and allow for more accurate estimations of need prospectively. Laundry staff were trained on the SOP and the appropriate use of PPE through a combination of didactic and practical sessions over the course of 2 days.

IMPLEMENTATION PHASE

The relatively slow progress of the COVID-19 pandemic in Malawi allowed a phased introduction of the laundry service over the course of 3 months (table 1). Early implementation was negatively affected by issues of acceptability and supply chain.

Figure 2 Details of the prototype reusable gowns (image credited to Dr David Garley).

Table 1 Overview of gown usage weeks 1–11 of pandemic and % capacity used at each level of contingency

	M	T	W	T	F	S	S	Total	% L1	% L2	% L3
Week 1	5	12	5	15	23	2	10	72	6	3	2
Week 2	27	39	55	55	62	54	56	348	29	17	8.2
Week 3	56	82	67	66	75	61	44	451	38	21	11
Week 4	29	82	61	78	78	75	73	476	40	22	11
Week 5	79	90	105	133	97	69	58	631	53	30	15
Week 6	91	116	113	98	122	76	62	678	57	32	16
Week 7	107	102	119	143	161	132	140	904	76	43	22
Week 8	165	185	176	230	212	217	155	1340	113	64	32
Week 9	228	242	218	247	215	236	125	1511	127	72	36
Week 10	192	297	230	240	267	178	192	1596	134*	76	38
Week 11	223	347	291	359	274	243	219	1956	164*	93	47

L1=initial laundry capacity (170 gowns per day); L2=extended laundry hours (300 gowns per day) and L3=a second domestic washing machine (600 gowns per day).
*Instances where baseline capacity was exceeded.

Acceptability

There were initial concerns from clinical staff about the relative safety of cotton gowns compared with disposable gowns or suits. This was particularly true in the emergency department, where the nature of the work made fluid repellent gowns preferable. Two strategies were employed to address these concerns. First, additional education sessions were arranged at a departmental level. During these sessions, it was acknowledged that reusable gowns were second line, and they were being deployed in the absence of a sustainable alternative. This validated staff concerns and provided a platform for further discussion. In addition, it was re-enforced that gowns were only one element of a system of PPE which needed to be kept intact in order to minimise infection. Thus, in the event of becoming soiled with bodily fluids, staff were advised to change the gowns and wash themselves. In addition, plastic aprons should be worn over the gown at all times to minimise this risk. Second, individual departmental heads were engaged by the hospital administration and the COVID-19 response team to address department-specific concerns.

Gown supply and staff confidence

There were several instances of delayed access to gowns in clinical areas which was damaging to staff confidence in the service. To improve continuity of supply, a laminated poster with the phone and WhatsApp contact of the laundry coordinator was delivered to every ward and the matrons were given access to an emergency supply of gowns which could be deployed if necessary. These interventions were acceptable to clinical staff who called the laundry coordinator directly several times per week.

The importance of service continuity for staff confidence re-enforced the need for clear contingency planning around surge capacity and unexpected disruptions to the service. The baseline laundry capacity could process 170 gowns per day. Level 2 capacity involved extension of the hours of operation of the laundry with existing staff and had a capacity of 300 gowns per day (table 1, L2). Level 3 capacity involved the deployment of an additional domestic washing machine and had capacity for 600 gowns per day (table 1, L3). Table 1 illustrates how escalation to level 2 was required at week 8 following admission of the first positive case of COVID-19 to QECH, with full capacity in operation by week 11.

Table 2 Contingency plans in place to support malfunction of any system elements

Event	Contingency
Washing machine malfunction	Procurement of 2nd and 3rd washing machine. Temporary out-of-hours usage of machine in the Department of Obstetrics agreed.
Drying machine malfunction	Drying lines identified with release of buffer gown stock. Temporary in-hours usage of the machine in the Department of Obstetrics agreed.
Reduced water supply	Washing machine manually loaded with bucket from alternative water source. Tank filling during hours of water availability.
Power cut	Use of generator. Drying via drying lines with release of buffer gown stock due to longer drying time.
Laundry staff worker contracts COVID-19	Team of three to self-isolate. Back-up furloughed staff completed laundry induction training in advance to allow immediate deployment. Back-up staffing by laundry supervisors as required.

Additional contingency planning is outlined in table 2. The most common contingency plan deployed was the release of the buffer stock of gowns. Temporary use of the drier in the Department of Obstetrics and the need to line dry gowns and deploy buffer stock were also necessary during malfunction of the laundry tumble dryer.

MONITORING AND EVALUATION

To support safe and effective delivery of the service, two indicators were selected for prospective audit and feedback: the appropriate use of PPE by laundry staff and the adequacy of gown sterilisation. A cross-sectional audit of these indicators was done at week 6 of implementation, feedback was provided and re-audit occurred at week 8.

Personal protective equipment

The correct use of PPE was essential for the safety of laundry staff. Observational audit (online supplemental appendix 2) was done to assess compliance with the SOP (online supplemental appendix 1). In addition, dedicated donning and doffing stations were established and equipped with memory aids (figure 1). Five episodes of donning PPE were observed over a 7-day period. The observed sequence of donning and doffing was checked against the sequence in the SOP including appropriate hand hygiene. For a single observation to be considered as correct, all steps needed to be complete. Initial fidelity with the SOP was low at 12.5% and was predominantly affected by inadequate hand hygiene. A refresher training session including a competency assessment was done and re-audit at week 8 showed improvement in fidelity to the SOP from 12.5% to 50% which resulted in the need for prospective review of procedures by supervisors. A third audit took place at 7 months and showed that PPE fidelity had increased to 60%.

Sterilisation

The process for gown sterilisation is outlined in full in the laundry SOP (online supplemental appendix 1). In brief, a tablespoon of dry chlorine approximates the required weight to make 40 L of 0.1% chlorine. The chlorine is made up once per day. Batches of gowns are soaked for a minimum of 5 min to achieve sterilisation over the course of the day. Prolonged soaking can lead to damage. To audit the fidelity of this process, observations were done once for each team over a 7-day period. Data were collected on (1) the concentration of chlorine produced and (2) the duration of the soaks. All six staff members were assessed making chlorine and 100% of concentrations were within at least 0.01% of the correct minimum concentration. Four soaks were observed with 100% exceeding the minimum 5-minute duration and no soaks exceeded 7 min 40 s.

Cost

Over the 8-week implementation phase, the local market cost for disposable gowns was £10.77 per unit. In contrast, the price of a reusable polycotton gown averaged £4.90 (£3.30–£6.60). With gown usage over those weeks at 4900 uses (from a total of 370 polycotton gowns in circulation), the total cost of disposable gowns would have been £52 773 compared with £1813 for provision of reusable gowns. Baseline infrastructural costs, staff wages, consumables and running costs are shown in online supplemental table 1 and detailed programme costings are available in online supplemental table 2. To estimate the crude cost–benefit of this service, we compared the costs of the reusable PPE system with the cost for disposable gowns at 2, 6 and 12 months (table 3). The unit price for disposable gowns has been adjusted down in line with local market values. The 2-month cost of the reusable service is relatively high as it includes all set-up costs, whereas subsequent evaluations include running cost only.

Table 3 Estimated savings provided by reusable gown service compared with disposable water repellent gowns

Month	Alternative PPE system costs	Cost of disposable gowns	Saving
2	24 997.75	52 773.00	27 775.25
6	35 177.75	158 319.00	123 141.25
12	50 447.75	316 638.00	266 190.25

The alternative system costs at month 2 include start-up costs while subsequent months are only running costs. The costs of gowns at 6 and 12 months have been adjusted for current market process.
PPE, personal protective equipment.

DISCUSSION

In terms of uptake, availability and cost-effectiveness, the system of reusable gowns was a success. Although there was a low incidence of occupational COVID-19 infection in QECH, we cannot draw conclusions on the relative safety of the reusable gown service. Overall, numbers of COVID-19-positive patients were low, the capacity for invasive aerosol-generating procedures is minimal and a limited supply of donated fluid repellent suits was deployed in the most high-risk areas when available. However, the overall effectiveness of a PPE system is a product of both PPE quality and coverage. The reusable PPE system provided full coverage of PPE to all front-line areas of the hospital which would not otherwise been possible, and which supported the uninterrupted provision of clinical services.

This implementation process was rapid and pragmatic with minimal capacity for evaluation which was limited to two process outcomes relevant to staff safety. Despite didactic and practical training sessions and the availability of memory aids and hand hygiene materials, adherence to PPE donning and doffing by laundry staff was very poor and only marginally improved by audit feedback. Interestingly, process outcomes related to procedural elements of the SOP were exceptionally well adhered to suggesting a significant behavioural element to poor adherence to PPE usage among staff. Given the implications for staff safety, regular audit of these activities including adaptations to improve adherence is essential to maintain a safe and reliable service.

Our experiences underline the importance of adequate and repeated stakeholder engagement to promote a system of alternative PPE use. Acceptability and uptake were improved through repeated education on the limitations of the system and transparency on the lack of a sustainable alternative. Departmental-level stakeholder engagement and open staff forums promoting debate on these issues improved uptake and acceptability and would be our key recommendation for sites hoping to implement a similar system.

Perhaps the most striking feature of the reusable gown service is the associated cost-savings for the hospital over a 12-month period even when adjusting for the stabilisation in unit cost of disposable gowns over time. The overall cost-saving, although substantial, is likely underestimated due to the lack of accurate hypothetical costs for procurement and distribution. Increased use of disposable PPE has resulted in increased medical waste around the world which has frequently overloaded municipalities' capacity to safely dispose of it.[10] The disposal of plastic waste is already a major environmental challenge in Malawi and the available facilities at QECH for incineration of biohazardous waste are limited, providing an additional advantage to this system in both cost and sustainability.

This implementation was designed to be as rapid as possible. It is now clear that the COVID-19 pandemic will present ongoing challenges to hospitals in LMICs for several years. Although not immediately possible in our setting, this service would have benefited from initial implementation within existing hospital sterilisation and laundry services to avoid the need for transition. In hospital settings where existing structures can be upgraded from the outset, this is to be encouraged.

CONCLUSION

A system for the provision and sterilisation of reusable gowns is feasible and cost-effective across multiple settings in a busy tertiary level hospital in Malawi. Regular monitoring and evaluation are key to ensure staff safety through adherence to SOPs. Early stakeholder engagement which acknowledges (1) staff concerns on the use of second-line PPE and (2) the autonomy and context-specific concerns of individual hospital departments is important in promoting uptake and should accompany early implementation. Studies to prove the definitive safety of alternative PPE compared with first-line options are required before their use could be recommended worldwide. However, the benefits of this system in terms of both cost and environmental sustainability are transferable to high-income settings and could provide an excellent example of the successful diffusion of an LMIC innovation.

Author affiliations
[1]Medicine, Queen Elizabeth Central Hospital, Blantyre, Malawi
[2]Medicine, Malawi-Liverpool-Wellcome Trust Clinical Research Programme, Blantyre, Malawi
[3]Respiratory Group, Liverpool School of Tropical Medicine, Liverpool, UK
[4]Ministry of Health, Queen Elizabeth Central Hospital, Blantyre, Malawi
[5]Department of Internal Medicine, University of Malawi College of Medicine, Blantyre, Malawi
[6]Hospital Information, Queen Elizabeth Central Hospital, Blantyre, Malawi
[7]Department of Obstetrics and Gynaecology, University of Malawi College of Medicine, Blantyre, Malawi
[8]Paediatric Department, University of Malawi College of Medicine, Blantyre, Malawi
[9]Nursing, Queen Elizabeth Central Hospital, Blantyre, Malawi
[10]Clinical Infection, Microbiology and Immunology, University of Liverpool, Liverpool, UK
[11]Paediatrics, Malawi-Liverpool-Wellcome Trust Clinical Research Programme, Blantyre, Malawi

Contributors The authors FL and DG contributed equally to the preparation of this manuscript. All other authors were involved in the development and deployment of the laundry service and have reviewed and contributed to the manuscript. BF supervised the development of the manuscript and submission of the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to this study are included in the article or iuploaded as supplementary information.

ORCID iD
Bridget Freyne http://orcid.org/0000-0002-9542-1582

REFERENCES

1 Unicef. *Malawi COVID-19 Situation Report 23rd June - 1st July 2020*, 2020.
2 WHO. *COVID-19 Supply Chain System: Requesting and receiving supplies. WHO publications [Internet]*, 2020: 6. https://www.who.int/docs/default-source/coronaviruse/covid-19-supply-chain-system-requesting-and-receiving-supplies.pdf?sfvrsn=cd25bbbc_6&download=true
3 Aljazeera. *Malawi health workers protest against lack of protective gear*, 2020.
4 WHO. *Rational use of personal protective equipment for coronavirus disease (COVID-19) and consideration during severe shortages*, 2020: 32. http://www.who.int/publications/i/item/rational-use-of-personal-protective-equipment-for-coronavirus-disease-(covid-19)-and-considerations-during-severe-shortages
5 Wang X, Zhou Q, He Y, *et al*. Nosocomial outbreak of COVID-19 pneumonia in Wuhan, China. *Eur Respir J* 2020;55:2000544.
6 Nguyen LH, Drew DA, Graham MS, *et al*. Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study. *Lancet Public Health* 2020;5:e475–83.
7 WHO. *Malawi country profile*, 2021.
8 USAID. Agriculture and food security: USAID, 2021. Available: https://www.usaid.gov/malawi/agriculture-and-food-security
9 Manda-Taylor L, Mndolo S, Baker T. Critical care in Malawi: the ethics of beneficence and justice. *Malawi Med J* 2017;29:268.
10 Patrício Silva AL, Prata JC, Walker TR, *et al*. Increased plastic pollution due to COVID-19 pandemic: challenges and recommendations. *Chem Eng J* 2021;405:126683.

LESSONS LEARNED FROM THE RAPID IMPLEMENTATION OF REUSABLE PERSONAL PROTECTIVE EQUIPMENT IN MALAWI DURING THE ERA OF COVID-19

Supplementary Materials

Supplementary Appendix 1: Standard Operating Procedure

STANDARD OPERATING PROCEDURE	**MLW.SOP.COVID.001**
MLW Laundering of Reusable Gowns	
Effective date: 20th May 2020	

	Name	**Signature**	**Date**
Author **Job Title**	David Garley Clinician		20/April/20
Reviewer **Job Title**	Derek Cocker Clinician		20/April/20
Approver **Job Title**	Bridget Freyne Clinician		20/April/20

Review History

Ver. No.	**Reviewed by (Name)**	**Review date**	**Summary of changes**

BACKGROUND

COVID-19 is spread via respiratory droplet and fomite transmission. Personal protective equipment (PPE) is essential for protecting the work force from nosocomial infection, however there is a global shortage and adequate procurement of single-use PPE cannot be guaranteed. Transferring to reusable gowns will improve supply.

PURPOSE

This standard operating procedure (SOP) provides guidance to trained staff in the collection and safe transport of soiled PPE, its laundering, drying and redistribution.

RESPONSIBILITY

The facility supervisors are responsible for ensuring that staff are adequately trained in the practices and procedures outlined in this SOP and that these are observed. All staff members carrying out these procedures are responsible for understanding and carrying out the procedures exactly as described in this SOP.

PROCEDURE

Personnel requirements

- Six laundry staff
    - Four staff each day, seven days per week

Line management of laundry staff will be under the supervision of the MLW facilities department.

Materials needed

PPE – all laundry staff must wear the following PPE when collecting and laundering gowns

PPE

- Medical mask
- Face visor
- Gown
- Re-usable waterproof apron

- Long heavy duty re-usable waterproof gloves
- Gumboots

Laundry Service

- Wheelie bin
- Storage box with lid
- Metal trolley
- Clean laundry sack
- Weighing scales
- Bucket
- 70% ethanol
- Spray bottle
- 50L bin
- 0.1% chlorine
- PPE receipts
- Ledger
- Receipt box
- Pen
- Laundry powder
- Measuring scoop

Procedures

4.2 Collection of soiled PPE

1. Used gowns will be doffed into a 50L bin
2. Ensuring you are wearing appropriate PPE, draw the wheelie bin close to the 50L bin.
3. Lift gowns out of the bin and place carefully into the wheelie bin.
4. Repeat until all gowns are placed in the wheelie bin, counting as you go
5. Close the lid of the wheelie bin
6. Clean gloves and outside of wheelie bin with 70% ethanol
7. Have assistant fill in the PPE receipt with the number of gowns and have it counter signed by the nurse in charge
8. Repeat for all wards in the order 4a, screening tents, AETC, O&G, paeds A&E, paeds short stay, 3a, 3b, paediatric research ward
9. Transport the gowns to the laundry.
10. Transfer gowns into 50L bin containing 0.1% chlorine. The gowns must be fully submerged and soak for 5 minutes.
11. Record in ledger the number of gowns received from each ward, then store receipt in the box

4.3 Laundering gowns

1. Use the same PPE as for the collection of gowns
2. Put the bucket onto the scales and press ‘tare’ to ensure the display reads zero.
3. Ensuring gowns have soaked for a minimum of 5 minutes, carefully wring gowns out over the chlorine bucket and transfer to bucket, filling up to 8kgs, then tipping into laundry machine. Do this no more than twice so the maximum load of 16kgs is not exceeded. You may put less than 16kgs into the machine.

4. Load one scoop of laundry powder into the machine drawer, then close lid.
5. Select 'soft cycle', '40L' water, and press 'start'.
6. Doff PPE at the doffing station
7. Spray outside of machine and wheelie bin with 70% ethanol

4.4 Drying gowns

1. No PPE is required for this stage
2. Gather small armfuls of gowns from the laundry machine and carry to drier. Close door when complete, select cycle 17 and start machine.

4.5 Storing gowns

1. No PPE is required for this stage
2. Unload the gowns from the drier onto the metal trolley
3. Fold and store the gowns in the storage box or storage sacks

4.6 Redistributing gowns

1.Read from the ledger the number of gowns collected from each ward – this is the number that needs to be returned.

2.Count that number of gowns into the laundry sack and carry through to the ward.

3.Redistribute gowns to ward in the following order – paediatric research ward, 3a, 3b, paediatric short stay, O&G, AETC, screening tents, 4a.

4.7 Chlorine doffing bin

1.The chlorine in the laundry doffing bin must be made up each day to 0.1% concentration using the MLW chlorine preparation SOP.

4.8 Correct doffing of PPE and prevention of cross contamination

1. PPE must be doffed at the laundry doffing station. Additionally, the reusable heavy-duty gloves, aprons and gumboots should be soaked in the 0.05% chlorine rinse for 30 minutes, then rinsed in clean water and hung out to dry on the line. Visors should be sprayed with 70% ethanol.
2. Upmost care must be taken in maintaining a clean laundry, particularly due to its small space. Any cross contamination of clean gowns would have serious negative IPC outcomes.

HEALTH AND SAFETY

Ensure that Universal Precautions are used at all times

Risk assessment

SOP for which the Risk Assessment is being done:
Queen Elizabeth Hospital Laundering of Reusable Gowns

<table>
<tr><td colspan="2">Brief description of procedure:

Collection of soiled gowns and their transport to the laundry. Laundering, drying and redistribution of gowns.</td></tr>
<tr><td colspan="2">Cadre of staff carrying out the work:

Laundry workers</td></tr>
<tr><td>Main hazards:

Risk of infection

Risk of contamination of laundry worker from soiled gowns during collection, transport and laundering.

Risk of contamination of clean gowns leading to infection of healthcare workers</td><td>Precautions required:

Wear personal protective equipment at all times in line with MLW COVID-19 PPE policy.

Contamination incidents separately risk-assessed according to WHO criteria and in line with MLW COVID-19 PPE policy

Strict adherence to collection, transport and laundering instructions and immediate decontamination of spillages should they occur.

Strict adherence to laundry procedures with use of separate equipment for clean and soiled laundry.</td></tr>
<tr><td>Special risks:

-</td><td>Precautions required:

-</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Any spillage or other emergency procedures required?</td></tr>
</table>

Any and all spillage should be decontaminated with Virkon or 70% alcohol and removed with paper towel. Dispose of in designated biohazard waste bin.		
Date for review of assessment:		
PI / Delegate:	**Signed:**	**Date:**
H&S Officer / Deputy:	**Signed:**	**Date:**

ASSOCIATED DOCUMENTS

WHO COVID-19 PPE guidance

REFERENCES

MLW.SOP.HS.006. Chlorine preparation and use

ACKNOWLEDGEMENTS

Signing below indicates that I have read and understood this SOP, have been trained and will adhere to the processes contained in it.

Supplementary Appendix 2: Laundry Audit Plan and Results

Aim

To ensure the laundry service is introduced according to the standard operating procedure with all quality standards maintained, in particular those relating to staff safety and infection control.

	Objective	Target
1	To ensure correct PPE use by laundry staff	100%
2	To ensure correct minimum chlorine concentration	100%
3	To ensure gowns soaked for correct minimum amount of time	100%

Standards

MLW laundry standard operating procedure
MLW laundry PPE donning and doffing guide

Method

Objective 1:

Spot checks of laundry workers donning and doffing PPE to be carried out. Cross checking observed behaviour against a checklist of the correct sequence. Observations carried out once for each team during the week and once at the weekend.

Each laundry team is of three workers, one of whom don PPE for each collection. The one who dons PPE is rotated each time. The donning and doffing sequence will be recorded for up to four different collections. Doffing may be done differently depending on whether it is mid-shift and the PPE will be sprayed with ethanol and used again, or the last shift of the day, when the PPE is doffed into a chlorine soak. The two possible correct sequences are accounted for in the audit tool.

Objective 2:

In the SOP dry chlorine is measured out with a spoon and dissolved into 40L water to make 0.1% chlorine. As the chlorine is measured out it will be intercepted and weighed with an electronic balance. The weight should be correct for the volume of water used. Chlorine is made up once per day. Observations will be once for each team during the week and once at the weekend.

We will record the weight of chlorine measured out by each of the three team members – person A, B and C. Usually only one person weighs out the chlorine, so this is not the most natural observation, but will give us an idea of how accurate the entire team is at weighing out chlorine.

Objective 3:

Using 0.1% chlorine, gowns with potential COVID-19 contamination must be soaked for a minimum of five minutes to sterilise. If gowns are soaked for significantly longer then damage can be caused to the gowns. Gowns should start being removed from the soak from 5 minutes. The duration of soaks will be timed once for each staff team both during the week and at weekends.

While chlorine is made up once per day, there are multiple chlorine soaks throughout the day. Every soak in a day will be recorded.

Requirements:

1. 2 x observers
2. Audit tool
3. 1 x digital balance
4. 1 x stopwatch

Audit Tool

Checklist of objective observations to reduce inter-observer bias that cover the three objectives. Also include a white space area for general observations that do not directly relate to an objective but are still relevant.

Data

Audit observations were carried out over two days during the week and two days at the weekend.

	Objective	Target	Result
1	To ensure correct PPE use by laundry staff	100%	12.5%
2	To ensure correct minimum chlorine concentration	100%	100%
3	To ensure gowns soaked for the correct minimum amount of time	100%	100%

Analysis and conclusion

1) Nine donning procedures were observed, 2 (22%) completed all steps correctly. Of the remaining seven none used appropriate hand hygiene but three otherwise followed the correct steps. Four neither cleaned their hands first nor followed the correct steps.

2) Eight doffing procedures were observed. One (12.5%) was carried out with all steps in the correct order. Of the seven, four failed by not completing hand washing steps and the remaining two neither cleaned their hands nor followed the correct steps.

3) All six staff were audited on the chlorine concentration they made. In 100% cases the concentration was within 0.01% of the correct concentration

4) Eight chlorine soaks were observed and 100% were over 5 minutes. Some soaks went on as long as 26 minutes.

In both donning and doffing the commonest problem is not cleaning hands, either with alcogel before and during, or with soap and water at the end.

The chlorine solution is consistently made to the correct concentration

Soaks are carried out for the minimum time but should be stopped by transferring gowns to a water rinse to prevent further damage to gowns.

Intervention planning

1) Donning and doffing refresher course
2) Introduction of a separate water rinse once 5-minute chlorine soak is complete

Re-audit

	Objective	Target	1st Audit	2nd Audit
1	To ensure correct PPE use by laundry staff	100%	12.5%	50%
2	To ensure correct minimum chlorine concentration	100%	100%	100%
3	To ensure gowns soaked for the correct minimum amount of time	100%	100%	100%

1) Five doffings were observed, 4 (80%) carried out all steps correctly. One did not wash hands prior to starting donning.

2) Four doffings were observed, 2 (50%) carried out all steps correctly. One did not spray their gloves before removal, and one did not clean hands their hands with soap and water at the end

3) All six staff were assessed making chlorine and 100% concentrations were within at least 0.01% of the correct minimum concentration

4) Four soaks were observed with 100% exceeding minimum 5-minute duration. No soaks exceeded 7m40s.

Third Audit

While the results of the second audit showed improvement in PPE use, the results were still below the standard of 100%. Objective 1 and 3 were re-audited.

The reaudit results are as follows:

	Objective	Target	1st Audit	2nd Audit	3rd Audit
1	To ensure correct PPE use by laundry staff	100%	12.5%	50%	60%
2	To ensure correct minimum chlorine concentration	100%	100%	100%	N/A
3	To ensure gowns soaked for the correct minimum amount of time	100%	100%	100%	100%

1) Five donning procedures were observed, three of which were carried out entirely correctly. One donning had 4 out of 6 steps correct, and one had 5 out of 6 steps correct.

2) Five doffing procedures were observed, all of which were carried out with all 12 steps correct.

3) Five soaks were observed, all of which were over the minimum time.

	Target	1st Audit	2nd Audit	3rd Audit
Donning	100%	22%	80%	60%
Doffing	100%	12.5%	50%	100%

The results of the first objective have been broken down into donning and doffing.

Supplementary Material 3: Laundry Audit tool

Date:

David Garley/Fumbani Limani

Objective 1

Donning								
Correct Order	Person A	Person B	Person A	Person B	Person A	Person B	Person A	Person B
Clean hands								
Gown								
Apron								
Mask								
Visor								
Gloves								
Number correct								

Doffing								
Correct Order	Person A	Person B	Person A	Person B	Person A	Person B	Person A	Person B
Mid/end doff								
Spray gloves								
Remove gloves								
Clean hands								

Spray/soak apron								
Doff gown								
Clean hands								
Remove and spray visor								
Clean hands								
Remove mask								
Doff gumboots and spray/soak								
Wash hands soap/water								
Number correct								

Objective 2

Staff member	Weight of chlorine	Volume of water	Conc of chlorine
Person A			
Person B			
Person C			

Objective 3

Load Number	Time	Load Number	Time

Additional Comments

Start-up costs				
Category	**Item**	**Quantity**	**Unit Cost (£)**	**Price (£)**
Machines and Maintenance	16kg washing machine	2	480	960
	Industrial washing machine	1	15,622	15,622
	Initial machine servicing	1	100	100
	Sub Total			**16,682**
General Equipment	160L wheelie bins	2	480	960
	Wall mounted gel dispenser	1	50	50
	Plastic storage box	1	25	25
	50L bin	2	100	200
	20L bin	1	5	5
	Tailored laundry sacks	3	6.25	18.75
	Plastic scoops	1	5	5
	Stirring rod	1	0.5	0.5
	Mop	2	3	6
	Broom	1	2.5	2.5
	Spray bottles	2	1.50	3
	Sub Total			**1,275.75**
Reusable PPE	Overalls	6	13	78
	Heavy duty gloves	5	1.8	9
	Heavy duty aprons	4	3	12
	Gumboots med/large	5	6	30
	Gumboots small	1	8	8
	Gowns	370	4.9	1,813
	Sub Total			**1,950**
Start-up Total				**19,907.75**
Monthly running costs (total 6 months)				
Sterilisation	Washing powder	6kg	6	36
	Chlorine	8kg	29	174

	Ethanol	6L	4	24
PPE & hand hygiene	Alcohol Hand Gel	1.5L	30	180
	Hand soap	100ml	1	6
	Non-sterile gloves	150	10	60
	Medical masks	75	40	240
Maintenance	Machine maintenance	1	100	600
	General maintenance	1	35	210
	Gown repair	50	245	1,470
Sub total				**3,000**
Staff costs (total 6 months)				
Wages (6 staff)		1 month	1830	10,980
Transport allowance (6 staff)		1 month	215	1,290
Sub Total				**12,270**
Total				**15,270**

Suuplementary Table 1: Itemised start-up and running costs for laundry service for 6 months.