Locally produced personal protective equipment can offer hospital staff protection against Covid-19 if combined with surgical masks and rigorous personal protective equipment cleaning routine

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Abstract
Locally made, washable and reusable personal protective equipment (PPE), used in combination with N95 masks that were reused safely, has proven to be a viable alternative to disposable gowns and caps for hospital staff in low- and middle-income countries. Muhimbili University Hospital's children's cancer ward in Dar es Salaam, Tanzania, developed locally made PPE and created rigorous cleaning and disinfecting protocols, when the daily use of imported, disposable materials were not an option. These items continue to protect staff, children and parents. The novel PPE approach was able to prevent staff from becoming infected during the pandemic despite the fact that several parents, and subsequently their children, became infected with Covid-19 during cancer treatment at the facility.

KEYWORDS
Covid-19, hospital management, infection control, low- and middle-income countries, PPE

The Covid-19 pandemic has shown that health systems across the globe were ill prepared for an event of such magnitude; many countries witnessed overwhelmed ICUs and struggled to procure essential items such as personal protective equipment (PPE).¹ For many hospitals in low- and middle-income countries (LMICs), the global COVID-19 pandemic has meant putting in place infection control measures with limited financial resources and under challenging circumstances. A lack of fiscal space in the national budget² meant that hospitals and clinics in many
LMICs had insufficient disposable protective equipment to keep health workers safe at all time, and had to come up with alternative innovative solutions. For the paediatric oncology ward at Muhimbili National Hospital, the largest government hospital in Dar es Salaam, Tanzania, it was no different. Its solution was locally sourced reusable PPE, which has kept its staff safe and infection free.

In early March, when there were mere rumours of the virus across the continent, the children’s oncology ward management decided that everyone (including administrators, cleaners, patients and guardians, as well as nurses and doctors), would wear a mask at all times regardless of symptoms, and carry disinfectant gel to clean hands as frequently as possible. This decision was made at a time where no-one fully understood the patho-clinical nature of the virus. The Muhimbili oncology team based its decision on their joint medical knowledge and prioritisation of patient safety, using the same ‘fundamental principles of decision making in healthcare', which Ferrinho et al. described as being so important to guide best public health practices when faced with an absence of robust scientific evidence.

Muhimbili’s oncology ward had a vital but limited supply of N95 and surgical masks. During this time, the type of masks offered (cloth, surgical or N95) depended on defined clinical situations. Where medical grade masks were required, a sterilisation process to extend the life of N95 masks was instituted, guided by the medical literature. Surgical masks remained single use only. Children for whom N95 masks were too large were fitted with double masks, a surgical and a cloth mask.

Cloth masks were frequently changed, cleaned, and sterilised. Outpatients and staff were issued clean cloth masks to wear on their journey from the hospital and back again, providing them and their communities needed protection.

Cloth bags to store all types of masks were also produced, ensuring that every mask, clean or dirty, could be stored separately before it was cleaned, and that clean supplies could be taken home without fear of contamination before use. Safety guidelines outlining safe use, laundering and disinfecting procedures were translated, printed and distributed.

To help meet the need for cloth masks and full-body PPE, Tumaini la Maisha, the local NGO that supports the cancer ward, received masks donated by an international NGO, and saw a group of teachers, business owners and volunteers from the local community unite to work in partnership with Tanzanian seamstresses, producing over 1500 cloth face masks in 2 months. The volunteers and fundraisers produced other reusable PPE items; gowns, scrubs and caps were adjusted to fit individual staff members, who ultimately received three sets, along with laundry bags to keep clean and dirty PPE separate.

The reusable PPE stays at the hospital, where, at the end of a shift, it is steeped in a water and bleach solution, before being washed at 60 degrees Celsius and ironed. The material used for the PPE is locally available Kitenge, which is tightly woven cotton. The Kitenge PPE brings colour to the wards and was well received by staff and patients, who explained that it added to a collective team spirit which has replaced the overwhelming sense of fear initially felt by all. The team has gained confidence in the protective measures and pride in overcoming this difficult time together. The seamstresses have spoken of feeling proud to support doctors and nurses carrying out important jobs for their community.

While the paediatric oncology ward did experience a number of Covid-19 cases among parents and patients, widespread outbreaks were prevented due to the well-rehearsed hygiene protocols and the reusable PPE. No staff is known to have contracted the virus. The ward management chose to go well beyond the original international advice on the wearing of masks, and emerging evidence and recent advice from the WHO now supports this decision.

Reusable PPE offered the ward many economic benefits. At a cost of 1.30 US$ for masks, 5.40 US$ for medical gowns and 1.08 US$ for caps, compared to 0.69 US$ per disposable mask and 10.00–15.00 US$ per disposable gown, reusable products have greater value for money, and are more environmentally sustainable. For the seamstresses making products, this model provides important economic benefits.
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CONFLICT OF INTEREST
The authors declare no conflict of interest.

ETHICAL STATEMENT
1. This material is the authors' own original work, which has not been previously published elsewhere.
2. The paper is not currently being considered for publication elsewhere.
3. The paper reflects the authors' own research and analysis in a truthful and complete manner.
4. The paper properly credits the meaningful contributions of co-authors and co-researchers.
5. The results are appropriately placed in the context of prior and existing research.
6. All sources used are properly disclosed.
7. All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

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