

Hand Hygiene Apron Solution

By

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1. Participation Type- Please select how you are participating in this challenge.

Solver (Individual)

2. Category of solution – please choose either category 1 (novel designs and innovative solutions), or category 2 (existing technologies, solutions, and potential partners).

1. Novel designs and innovative solutions

3. Solution Level - please confirm the Technology Readiness Level (TRL) of your proposal: TRL1-3 ideation, TRL4-6 proof of concept, TRL7-9 production ready.

TRL4-6 proof of concept

4. Problem & Opportunity - highlight the innovation in your approach to the Problem, its point of difference, and the specific advantages/benefits this brings (up to 500 words).

Hand hygiene is a very important aspect of health care delivery, and a lot of care giving personnel recognize that fact and should comply with its practices accordingly; however, constraints and inconvenience often lead to personnel ignoring and abandoning these hygiene practices while handling patients. Availability, complexity, accessibility and proximity are major factors that influence the adherence of personnel to the hygiene practices, and improving these factors definitely improves the compliance and adherence of health personnel to those practices.

The solution aims to make simple and intuitive the hand hygiene process and also keep it physically as close to each personnel as possible. The solution also emphasizes on sustainability and efficiency by synthesizing its cleaning fluid locally and also proffering both single-use and recyclable options for its handwipes. The proposed solution is an apron– specifically sewn as both a protective wear and a housing for holding a dispenser bladder that stores and dispenses cleaning fluid for the hand wash and sheets of paper towels (PT) or recyclable absorbent fabric (RAF) for removing the cleaning fluid from a personnel's hands after the wash process. The apron solution is ergonomic and it holds the hand-cleaning materials snugly in three main pocket spaces on the apron. The solution is integrated primarily into a waist apron that can be worn by personnel throughout their shift without feeling much of its presence (just like waitresses in restaurants), this helps them keep the

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cleaning kit on themselves at all times and thus allow them the ability to perform hand hygiene on the spot in all situations and locations. The cleaning process is simple and convenient, it is performed by opening a valve on the dispenser bladder with one hand and receiving the cleaning fluid from the nozzle with the other hand—half a handful is sufficient for a typical hand wash unless it's heavily soiled. The cleaning fluid (CF) is rubbed thoroughly throughout the hands and this action separates dirt and germs off the skin and into the fluid. The high percentage of water in the CF makes it very much easy for an absorbent material to soak off the fluid without leaving a sticky/slippery soap residue, however, the soap concentration in the fluid is also kept high enough to still actively function as a surfactant. An antiseptic agent needs to be added to the fluid to improve its antimicrobial effect. A stack of absorbent handwipes is kept in one of the apron's pocket, each wipe is to be used for each cleaning moment and thereafter transferred into a collection bin for disposal or recycling. The RAFs are recyclable through washing, drying and steam sterilization, however, the paper towel is a single-use option and is most preferred since it's cheaper and it eliminates future interactions with a used wipe and thereby reduces the possibility of recontamination as it is not the case with the RAF's after-use recycling processing.

5. Solution Overview – Please ensure that you describe the features of your proposal and how they address the SOLUTION REQUIREMENTS in the fields relevant to your category (up to 500 words).

The proposed solution is a mobile hand cleaning apparatus intended to be worn by its user and requires no running water to complete the cleaning procedure. The solution features a bladder dispenser meant to hold and supply the cleaning fluid through an access valve on its lower end. The other main component of the apparatus are the absorbent handwipes (RAFs or PTs) stacked and secured in one of the apron's pockets where each piece can be removed and used for an hygiene moment. The two main components are carried around in an apron which health personnel are expected to wear and have on them at all times in the clinic. The solution proposes two apron options depending on the use case— there's a waist apron for all staffs to wear and carry around at all times and there's a full-torso apron for need-based cases like surgery and child birthing, in this case, the apron functions both as a carrier for the hand hygiene kit and as well as a PPE. The apron features 3 main pockets, a large one at the center holds the soft bladder dispenser, the one on the right holds a stack of handwipes (for right handed staffs), and the last one on the left is an extra capacity pocket meant to temporarily hold used handwipes or to hold extra stacks of clean wipes or anything else like personal hand lotion or moisturizer the staff might decide to have at hand. Staffs performing hand cleaning away from locations where collection bins for the handwipes are placed can easily keep used handwipes temporarily stored in the apron's left pocket until a collection bin is reached. The bin collects the handwipes for disposal or recycling,

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depending on the selected option for the facility or MMU. Recycling is done by washing the wipe fabric, drying and fully disinfecting them with steam created by an iron press. Afterwards, the wipes are stacked and stored at a known location in the clinic where each staff can pick a stack at the beginning of his/her shift or revisit to pick a refill after that. Likewise, a dispenser bladder is also able to refill from a large tapped container where the cleaning solution is stored. This means each staff can always carry around a considerable amount of cleaning packet for fulfilling the hand hygiene moments at any time and location in or outside the clinic and then return to replenish and refill the cleaning materials when it's most convenient. A single fill can complete at least 10 hand cleaning procedure before running out. The handwipes can either be paper towels or recyclable absorbent fabric, these two represent the different options available to different facilities based on their capacity to store and resupply their available resources. Paper towels are most preferred for reasons already explained (low-cost and single-use), however, in a context where resupplying the paper towel stock is impossible or too difficult, recyclable absorbent fabrics are the go-to option since they can be reused over many cycles before needing to be replaced.

6. Experience - Expertise, use cases and skills you or your organization have in relation to your proposed solution. The IRC may wish to partner at the conclusion of the Challenge; please include a statement describing your expertise and indicating your interest in volunteering towards realizing your prototype solution (up to 500 words).

I'm a co-founder of a small research and innovation startup –Frontier Innovations– where I lead a team of bright minds dedicated towards research and development of innovative ideas from a conceptual stage up to the prototyping stage of product maturity. This team can be facilitated to provide further development and testing of the proposed solution to ensure its effectiveness in a real-world health facility.

The proposed solution in this submission is partly inspired by a creative real-world practice in a primary health care facility in a remote town in the western part of Nigeria where I reside. Hand washing has been a regular practice in that clinic ever since the COVID-19 pandemic some few years ago, and the clinic found a way to limit resource consumption while maintaining this practice. The PHCC is a privately owned struggling facility which is limited in resources and budget spending, and its water is manually fetched into a large storage container. The challenge was– staffs and visiting patients use up the facility's liquid soap too fast due to them often dispensing more than needed to wash the hands, so consequently they use up more water in an effort to get all the excess soap off their hands afterwards. To address this challenge, the facility mixes the liquid soap with significant amount of water to lessen its concentration and increase its quantity thus making it use much less soap-saturated and water-demanding. This solution method saves on both soap and water at the same time. The new diluted soap solution removes dirt and germs

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all the same, but the tradeoff is that more physical effort need to be exerted in the hand scrubbing to mechanically aid the removal of dirt and germs and suspend them in the surfactant fluid. Staffs and patients now take a handful of the diluted soap liquid or less for the hand washing, and after a vigorous scrub of the hands, most of the dirt is removed and the rinsing process is much quicker and less water-demanding. Some antiseptic liquid is often added to the soap liquid for increased germicidal effect. While using the diluted soap myself, I realized the advantage and ingenuity in the approach, it's just like washing the hands with already prepared soap water rather than a soap itself, this gives you a better judge of quantity and therefore ensures the minimum amount of everything is consumed to achieve sparkling clean hands. I therefore took this brilliant idea and miniaturized it into an apron-sized apparatus with handwipes substituting for the need of water to rinse off the soap. Handwipes made from absorbent fibers are very effective in completely absorbing fluid from the hands after the cleaning process, this effectiveness have been tried and tested with the proposed soap solution with a satisfactory hand cleanliness very similar to using water for the rinse. Nevertheless, water rinsing still need to be done at comfortable times once or twice in a day to prevent any form of contact dermatitis.

7. Solution Risks - any risks you see with your solution and how you would plan for this (up to 500 words).

Hand hygiene practices are intended to keep patients and health providers safe from healthcare associated infections, and that is the target goal to be achieved by a solution proposed to address this challenge. To track where the dirt and germs go and thus assess its safety level and risks, let's take a look at the hand cleaning procedure proposed in this submission.

The hand hygiene apron works by dispensing a cleaning fluid (antiseptic soap water) when the valve on the dispenser bladder is open, the fluid is collected with the other hand until it's roughly half full. The fluid is then distributed across both hands and wrists and this is followed by a vigorous scrubbing to remove/transfer any and all dirt and germs present on the skin into the fluid, this process forms a mild lather indicating the soap content of the fluid is active and sufficient. The antiseptic agent also takes effect to inactivate/eliminate some or all the germs suspended in the fluid. The personnel then grabs a paper towel or a clean absorbent fabric from the apron's right pocket to remove the fluid from the skin by soaking it off. This means most or all removed dirt and germs have been inactivated and then absorbed by the handwipe fibers. The handwipe should immediately be transferred into a collection bin to prevent any further interaction with the used handwipe, however, if a collection bin isn't close by, the used handwipe can be temporarily stored in the left pocket of the apron for a short while until a collection bin is reached (although this isn't eagerly desired due to the increased possibility of germs being re-transferred

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from the wipe). The collection bin can then be taken out for disposal, or in the case of recyclable absorbent fabric, they are washed and steam sterilized to be reused. The first point of contact and potential contamination is the act of touching the valve on the dispenser bladder and gripping to hold it open, this leaves the valve and the bladder surfaces possibly contaminated, however, since the hands are to be washed after touching the bladder and dispensing the fluid, any contact with the bladder is quickly negated by the washing of the hands. Although the apron and bladder surfaces will now need standard sanitary cleaning to rid them of any possible contamination. Another major point of potential contamination occurs through the moving, washing and processing of the used fabric handwipes. Due measures and procedure for cleaning and decontamination should be implemented to ensure no infection transmission occur through the washing and processing of the handwipes. Charcoal fueled iron press can be used to steam sterilize and straighten the fabrics for easy stacking, this means some residual moisture is left or added to the handwipes after drying and then a charcoal heated hot iron press is passed over them repeatedly to steam the moisture out and therefore sterilize and straighten the fabrics. This is excellent for contexts without electricity.

8. Timeline, capability and costs - describe what you think is required to deliver the solution, estimated time and cost – please note the cost constraints of 25 USD per healthcare worker per year for already existing technologies/solutions and the cost constraint of 66 USD per healthcare worker per year for novel solutions, technologies, or concepts/designs. (up to 500 words).

A multipocketed quality waist apron cost between \$2-\$5 from Chinese manufacturers and a full-torso apron cost roughly the same. An apron is a simple piece of sewn craftwork which can easily be manufactured locally for a much lower cost per unit. The bladder dispenser is made from soft PVC with a dispenser valve at its lower end; its form and design is most comparable to soft PVC bags used for packaging saline solution in the pharmaceutical industry, this cost \$0.2 per piece. The handwipes are simply paper towels or absorbent fabric cut into a uniform square shape and completed with a hem finish around the edges, commercially available versions cost a mere \$0.05 per piece. Most of these components for the hygiene setup can be locally manufactured anywhere in the world with the right fabric quality and sewing equipment. The bladder dispenser on the other hand needs to be shipped down from a manufacturer somewhere in China and the cost per unit can get as high as \$0.5-\$1 for the bladder design and the dispenser valve and cap integrated onto that. A common practice down here in Nigeria is to use old cotton clothes as hand and surface cleaning towels due to their high absorption and cleaning capability, this can also be adapted in this case as a low-cost option of manufacturing the handwipes for this solution. Square shaped cutouts can be made from old cotton clothes and hemmed around the edges to prevent fraying, this

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works as an excellent high absorbent handwipe at a very low cost and is also reusable over many wash cycles.

The cleaning fluid is a soap solution with added antiseptic agent, It can be created by adding sufficient water to a liquid soap until it's diluted to such a concentration that its surface active agent is still moderately active (therefore dirt and germs removal is achieved) but water-saturated enough that it leaves the skin easily with minimal rinse water or a wipe from an absorbent fabric. The actual concentration ratio will be further researched with progress on the solution. [Chlorhexidine](#) or triclosan are strong and suitable antiseptic agents that can be used in this application, it comes in both a liquid and powdered form that can be added into the soap solution in the right proportion. In a stationary facility, the cleaning fluid is stored in a large container with a spigot at the bottom to dispense the fluid into a dispenser bladder during refill; in the case of an MMU, it can be brought on-site in smaller containers or prepared onsite.

With local production and manufacturing, the estimated total cost of setting up each staff personnel with an hygiene apron is under \$10 (apron, bladder dispenser and handwipes), and given this is a novel solution design, there's at least \$56 of the budgeted spending left per staff to supply the cleaning fluid, periodically clean the wipes and apron, and repair or replace any part of the solution components for a time period of a year, this amount is more than sufficient to fulfill that.

9. Online References - provide links to any publications, articles or press releases of relevance (up to 500 words).

- From Soap and Water, to Waterless Agents: Update on Hand Hygiene in Health Care Settings— <https://doi.org/10.1155/2002/105306>
- Burton, Maxine & Cobb, Emma & Donachie, Peter & Judah, Gaby & Curtis, Val & Schmidt, Wolf-Peter. (2011). The Effect of Handwashing with Water or Soap on Bacterial Contamination of Hands. *International journal of environmental research and public health*. 8. 97-104. 10.3390/ijerph8010097.
- Aras, Neny & Santi, Santi & Amaliah, Nur & Isma, Isma & Yusriadi, Yusriadi. (2023). Antiseptic Liquid Soap from Corn Oil (*Zea mays* L) and Aloe Vera Extract with The Variation of SLS (Sodium Lauryl Sulfate). *Jurnal Akta Kimia Indonesia (Indonesia Chimica Acta)*. 23-31. 10.20956/ica.v16i1.26653.
- Huang, Cunrui & Ma, Wen & Stack, Susan. (2012). The Hygienic Efficacy of Different Hand-Drying Methods: A Review of the Evidence. *Mayo Clinic proceedings*. Mayo Clinic. 87. 791-8. 10.1016/j.mayocp.2012.02.019. <https://doi.org/10.1016/j.mayocp.2012.02.019>
- Embedded Video 2: It can be observed in the embedded video with the doctor scrubbing in for a surgery that he didn't rinse off the soap lather from the wash (at least not completely), he just simply cleaned and soaked it off with a clean

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towel and he's ready, the same idea is proposed in this submission— a hand wash with an heavily diluted but still surfactant active soap solution and then a clean off with an absorbent paper towel or a reusable fabric towel.

10. How did you find this Challenge? – please indicate what drew you to this Challenge, including any relevant advertising or marketing that you followed to this Challenge.

I keep track of available challenges on the Wazoku website and I was notified via email as well.