

Research Paper

Hand hygiene innovation for low income households in India

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ABSTRACT

Our objective was to explore and prototype new products to facilitate improved hand hygiene after defecation by overcoming the constraints associated with soap use in low income settings, specifically urban slums in India. We used a systematic user-centred innovation process which led to the design of two products with user appeal ready for market trials, and one further concept ready for feasibility testing and further product development.

Key words | diarrhoea prevention, hand hygiene, user-centred innovation

HIGHLIGHTS

- New consumer insights into hand cleaning in urban slums.
- Prototyped three new products for hand cleaning without running water.
- Lead innovations ready for market testing.

INTRODUCTION

Diarrhoea is a major cause of morbidity and mortality around the world, and is the second leading cause of death among children under five. Around 525,000 children die every year from diarrhoea (WHO 2017), yet it is preventable through sanitation, safe drinking water, and good hand hygiene. The simple act of handwashing with soap at the correct moments, particularly after contact with faeces, may reduce the risk of

diarrhoea by 23–40% (Freeman *et al.* 2014). Despite this evidence, and despite many years of public and private efforts to promote handwashing with soap through behavioural change, only an estimated 19% of the world's population follow this good hygiene practice (Freeman *et al.* 2014).

It is hard to change handwashing behaviour in the absence of reliable running water, taps, sinks, and

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conveniently located soaps (White *et al.* 2020), which is often the case in LMIC countries. Overcoming such barriers may require not just behaviour change but also product innovation so as to make the act of cleaning hands easier for the user.

Innovation efforts thus far have mostly focused on hardware to facilitate soap use (e.g. the Happy Tap (Revell & Huynh 2016) in SE Asia). However, the potential to improve hand hygiene by changing the product itself has been shown by trials on soapy water (Amin *et al.* 2014) and the recent development of an antimicrobial towel (Torondel *et al.* 2019). Our objective was to explore the widest possible scope of options for product innovation, using a range of stimuli and a systematic innovation process which put the user, their lives, and the context for hand hygiene practice at its heart. Our studies focused on post-defecation hand hygiene among Indian urban slum families who go outside the home to use the toilet, which we considered to be representative of the challenges and the opportunities facing innovators in this area.

METHODS

Definitions

We define an 'idea' or a 'concept' as a hypothesis for a product described in terms of appearance, consumer use and mode of action. A 'Hotspot' is a means to focus creativity in generating ideas: it does not describe any specific product but provides an end point for product action that we hypothesized would represent a meaningful and desirable innovation. By 'insight' we mean a deep interpretation of observed consumer behaviour which helps to explain that behaviour and provides a platform for user-centred innovation. Finally, an 'area' is a broad grouping or approach to innovation where there is a shared mechanism or feature.

Stage 1: creative workshops and initial hotspots

We identified 8 areas, ranging from alternative cleansing technologies to behaviour changing objects, for creative exploration through 3 facilitated workshops of academics and designers. At each workshop we reviewed existing knowledge and used stimuli linked to a given area to help creativity. Outputs were synthesized into 4 initial hotspots

with the greatest scope for innovation as our starting points for exploration with our target audience in Stage 2.

Stage 2: ethnographic research and iterative co-design

The aim of this stage was to understand user experiences and better define innovation opportunities for hand hygiene, with a focus on post-defecation. It was conducted in 5 different slum districts of Pune offering a range of different housing, communities, religions, cultures, water availability, and sanitation arrangements (including open defecation fields and community toilets). Participants were selected to include both men and women and a range of occupations. Approval was given by the LSHTM Ethics Committee (number 5863).

This stage was carried out over an intensive 8 week period by Quicksand (a user-centred design agency based in India) staff and teams of design students from the MIT Institute of Design, the National Institute of Design, and Symbiosis Institute of Design in India. Research teams were briefed on hygiene, hotspots and research methodology. Initial research was undertaken and some additional hotspots and ideas generated (16 families). Field guides were designed and piloted for ethnographic research to understand people's beliefs, practices, and context (10 families). Perceptions of cleanliness were probed using sorting exercises (cleanest to dirtiest). Existing cleaning products were used to probe perceptions of product attributes and affordability. Common behaviours and perceptions were determined by an intuitive clustering of elements based on perceived inter-relationships.

Iterative co-design involved idea generation from hotspots, mocking up ideas with readily available products or materials and testing them with users to probe hygiene behaviour and attitudes further, then using insights from those conversations to refine the hotspots and associated insights. For example, to probe the idea of a protective skin layer, from the 'tool care' hotspot, a jar with skin cream inside was used. This process went through three iterations involving a total of 67 respondents.

Stage 3: total prototyping

Three products – 'Foam', 'Gel' and 'Super Water' – were selected as having the greatest promise based on Stage 2 results. The aim of Total Prototyping was to evaluate

which had the greatest appeal to our target users and the best chance of driving improved hygiene behaviour. We simulated and tested as many aspects of an actual product as possible, as realistically as possible, including product characteristics, sensory qualities, branding, positioning, packaging and pricing. After initial research during which prototypes were made and positioning, packaging and pricing agreed, products were placed in 60 selected homes (20 homes each for each prototype) for 2–3 weeks of in-home use.

The core team comprised Quicksand staff, who led the overall process, staff from FemS3 (an Indian not-for-profit organization) who led the qualitative research, and HT, WTG and RVR who gave direction to the prototype design. Additional experts in packaging, retail products, product development and slum communities were also involved. In-home trials were carried out in 3 different slum communities in Bangalore differing in terms of housing types, cultural and religious backgrounds, and where the householders went outside to use the toilet, either at a nearby open defecation site or a community toilet. Income levels of participants varied but were on average around Rs 3,000–3,500 per month, and family size was on average around 5.

The research was approved by the LSHTM Ethics Committee (number 6426).

Prototype development: Samples of Foam, Gel and Super Water were kindly prepared by Byotrol plc, UK. Formulations were based on products already developed and used by European consumers. Foam and Gel both contained the antimicrobial agent Byotrol™. Labels providing user instructions and precautions in English and the two most common local languages (Tamil and Kannada) were prepared in line with the positioning (i.e. the consumer offer in terms of mode of use and intended benefits) for each product. Packaging was selected and obtained based on the dosing required for each product and its physical properties.

Positioning

Use scenarios and potential positionings for each product were made up into concept storyboards and tested with individuals and families through in-depth interviews covering 1–2 products each (total of 12 interviews across two slums). These enabled the final product positioning and directions for use to be developed for each product.

In-home testing and wider prototype evaluation

Each household was supplied with a product prototype and a board offering key information about the product and product positioning. Householders were instructed on how to use the product during the trial and all members of the family were encouraged to use it. In the case of Super Water, households were also given a bucket to help with correct dosing. The bucket had a 2l mark and triallists were instructed to fill to this mark and add 10 ml of Super Water (10 ml measuring caps provided).

Gel and Foam triallists were instructed to use the product the same way throughout. Among those trialling Super Water, half were asked to use the product at the point of defecation for the first ten days then to swap to using it at the threshold of the home for the remainder. The other ten were asked to do the opposite.

Team members visited communities 5–6 times during trial, to ensure household compliance and gather feedback. While all households were visited, more in-depth feedback was sought from a subset of users who were interested and articulate in exploring product use. During the final visit any remaining product was collected.

Post the in-home trials, group discussions were held across all the participating communities, to explore positioning, packaging and pricing. At this stage we also introduced the other two prototypes to each of the communities to seek their responses.

We consulted three organisations with relevant experience, the Market Research Society of India, Quicksand and one other market research agency, on the need for local ethical approval and were informed that it was not required or usual practice in India for the type of research we undertook. Informed consent was sought for all consumers in the household trials.

RESULTS AND DISCUSSION

Hotspots

Our initial creative work, through workshops exploring different areas linked to cleansing, resulted in 4 initial hotspots that we considered to have the greatest potential to

act as springboards for user-led innovation. At this stage they were still being expressed in terms of insights rather than actual ideas and they are shown in Table 1 below, together with 3 supplementary hotspots generated from the user research in Pune.

Ethnographic research and iterative co-design

In such high density, low income Indian settings, it seems that cleaning marks the transition from one space to another, the movement between differing levels of perceived ‘contamination’ and cleanliness.

Thus we observed distinct boundaries or thresholds of cleanliness, and related cleansing behaviours, in relation to post-defecation hand cleaning. The most significant boundary was between the home, where control could be exerted to keep it as clean as possible, and the outside environment, which was shared, out of individual control and viewed as dirty. There was also a boundary between the defecation site and the general outside environment in that the place of defecation was usually even more filthy and unpleasant. Just outside the toilet there is a quick rinse with the remaining water taken for anal cleansing, to remove any visible soil and leave behind the feeling of

filth. The feet are rinsed along with the hands. Then back at the home there is a more thorough washing of the hands at this threshold, this rigour reflecting the perceived dirtiness of the environment from which they have returned, as well as the desire to preserve the cleanliness of the inside of the home. Users thus seem to make a distinction between an interim rinse at the place where their hands get dirty and a proper clean when about to enter the home.

Water played a central role in both types of hand cleaning. It was always available for this purpose, and was usually kept in large drums outside the home, from which it was transferred into a range of other smaller vessels. Some users were also observed to use soap outside the home but it is uncertain – and unlikely given the usage data – that this was always practised when there was no observer. Washing with soap was never used at the toilet for several reasons: people want to leave the toilet area as soon as possible, thorough soap cleansing was seen as having limited value as the path home will bring new sources of dirt, and it is believed that the filth of the toilet contaminates objects entering it. For the latter reason, the water can was the only cleaning accessory normally carried to the toilet.

This research suggested two broad opportunities around which the subsequent phases of iterative co-design were structured:

1. improving the effectiveness of the rinse on exiting the place of defecation
2. improving the effectiveness and/or convenience of cleaning at the home threshold, taking account of the physical environment

A total of 6 different product concepts were developed, and in each case different prototypes were made to probe and evaluate different product attributes with users (Table 2).






While all the concepts tested were based on an underlying insight, and offered significant potential benefits such as waterless cleaning, three concepts stood out as having the greatest user appeal and fewest concerns – ‘Handy Dose’, ‘Disinfectant Water’ and ‘Lather Spray’.

‘Handy Dose’ explored the idea of a portable, waterless hand cleaner, carried on the hand, that could be used immediately after defecation. Both traditional materials (clay and sandalwood, ash and sandalwood) in the form of sticky pellets

Table 1 | Hotspots

Hotspot	Concept to be explored
<i>Generated from initial creative work</i>	
Tool Care	<i>Hands are tools to be kept in working order ready for all the tasks they take care of</i>
Fresh Hit	<i>After going to poo I want to feel clean inside & outside, as I feel grubby & contaminated</i>
Right Here Right Now	<i>I rub or wipe my hands on whatever's to hand wherever I am in the moment that I need to get them clean</i>
Super Water	<i>Women's hands are in & out of water all day providing plenty of opportunities for hand cleansing</i>
<i>Generated from user research</i>	
Traditional yet Modern	<i>Aspiration of being modern while having the security of traditional knowledge or practices</i>
Nudges	<i>Ways to prompt hygiene at key moments</i>
Make it Special	<i>An incentive to make handwashing a special moment</i>

Table 2 | Iterative co-design product concepts**AT THE POINT OF DEFECACTION**

CONCEPT	IMAGE	DESCRIPTION	INSIGHTS ON WHICH BASED
Disinfectant Water		Powder, liquid or pellets added to toilet water.	Small amount of toilet water is retained for rinsing hands and feet post-defecation.
Handy Dose		Single dose of cleanser carried to toilet on back of hand. Waterless solution.	Limited water availability. Cleansing agents taken to toilet should not be brought back.
THRESHOLD OF HOME			
Friction Bowl		Bowl filled with abrading beads +/- powder. Waterless.	Preference for cleaning at home vs at a community toilet.
Hand Protector		Cream or gel designed to form barrier layer on skin on leaving home.	People try and protect themselves from filth at the toilet and prevent contact with germs.
Lather Spray		Non-sticky disinfectant foam dispensed from can. No rinsing needed.	Lather is linked to cleaning properties. Opportunity for faster hand cleaning at threshold – users will spend the least amount of time possible.
San Spray		Sprays fragrant liquid as mist or jet. No rinsing needed.	Opportunity for faster hand cleaning at threshold.

or a paste, and non-traditional materials (gel or cream) were tested. In all cases, a small amount was placed on the hand and cleansing simulated, without water. Users liked the concept overall and preferred the traditional clay and sandalwood mixture in the form of a paste, which has less perceived wastage than a single pellet. This mix was found to be non-sticky, easily spreadable and removed dirt on rubbing.

‘Disinfectant Water’ was tested either in pellet, liquid or powder form for addition to the water carried to the toilet, or as a tablet attached to the can used for carrying the water. Users liked the concept and the fact that they did not have to carry anything extra to the toilet. The liquid format was preferred. Interestingly users did not wish to change the appearance of the water although brief

effervescence seemed to cue treatment of the water and was thus associated with cleansing.

The ‘Lather Spray’ prototype was based around a facial foam container filled with fragranced sanitizer solution. The foam intrigued users who said it was not sticky and they would not need to rinse their hands with water afterwards. They did not mind sharing the bottle with others. This concept mimicked one key feature of soap use – lathering – without the need for water, and appealed to users’ understanding of what is essential for hand washing.

The limitations of the other concepts were in part due to practical execution: for example, children had difficulty using the actuator for ‘San Spray’ and the preferred cream format for ‘Hand Protector’ had an oily after effect. These could perhaps be overcome by further work. However ‘Friction Bowl’, while enjoyed, was not considered to be a suitable concept for post-defecation hand cleaning.

Total prototyping

Three product concepts were selected for further in-depth evaluation – ‘Foam’ (product name *Handy Foam* and

based on ‘Lather Spray’), ‘Gel’ (called *Instant Gel* and based on ‘Handy Dose’) and ‘Super Water’ (called *Water Plus* and based on ‘Disinfectant Water’) – based on their user appeal, strength of the underlying insight and technical readiness. Foam was an existing topical product containing the antimicrobial agent Byotrol™, Gel was specially formulated to have a high viscosity so it could be carried to the toilet as a drop on the back of the hand, and also contained Byotrol™, while Super Water was a proxy product that did not contain any active agent but only colour, fragrance and detergent to provide sensory cues.

In each case a prototype product for in-home use along with appropriate packaging, target and positioning were developed (Table 3) with the aim of giving users as real an experience as possible. Overall, products were positioned for germ kill on hands post-defecation, with different expressions of convenience and modernity being used in each case.

The feedback from interviews at the end of the two week period revealed positives and negatives for all three products, as highlighted in Table 4. There were no reports of any adverse reactions to any of the products.

Table 3 | Total prototyping – description of prototype products




Product Name	Packaging	Target Consumer	User	Point of Use	Positioning
 <p>Instant Gel:</p>	Tottle: Replacement rather than refill	Men	Family	Community toilet or open defecation site	<i>Modern, Instant, Get ahead.</i>
 <p>Water Plus:</p>	Bottle with dispensing cap: Refill from larger container	Mother	Family	Home threshold, community toilet or open defecation site	<i>How smart families start their day.</i>
 <p>Handy Foam:</p>	Actuator bottle: Refill from pouch	Mother	Family	Home threshold	<i>Easy, long lasting protection.</i>

Table 4 | Summary of user feedback after in-home trials

Product Name	Positives	Negatives
<i>Instant Gel</i>	<ul style="list-style-type: none"> • Fragrance • Modernity, novelty of pack • Not needing water • ‘Meaty’ in use feel conveys action • Left hands ‘cleaner’ and ‘softer’ 	<ul style="list-style-type: none"> • Slight stickiness before finally drying out
<i>Water Plus</i>	<ul style="list-style-type: none"> • Cleaner hands • More attention paid to washing post-defecation • Fragrance 	<ul style="list-style-type: none"> • Dosage – there is no ‘standard’ amount of water used for washing at the home or toilet. Measuring dose less convenient than usual practice. • Nondescript bottle
<i>Handy Foam</i>	<ul style="list-style-type: none"> • Novel, unique format, created curiosity • Fresh smell, differentiated it from soap and conveyed ‘clean’ • Convenience of use • Not needing water • Left hands feeling soft 	<ul style="list-style-type: none"> • ‘Lightness’ – appreciated in terms of lack of residue but raised doubts about its efficacy • Pack size too large to be affordable

Overall, Foam was very well received, particularly for its novelty and cool, fresh sensory impact. Most consumers were reluctant to return it and expressed a desire to buy and use it. This was also true for Gel. Super Water worked well as a concept and was readily understood as such, but the reaction during trials was lukewarm, probably because our execution was too complex. Measuring and adding something to the water became a chore and was informally designated as ‘women’s work’, aligning it more to a household product and leading to loss of interest from the rest of the family. Gel appeared to be a known yet modern and interesting format. There was almost no spontaneous association with hand sanitisers although on probing some women recalled seeing them at work.

There were some observations in common across all the products. The amounts used were less than expected, based on use directions and family size, probably reflecting the frugal use of products in such households. Fragrance had a major positive value in each case and was one of the most important sensory cues for effectiveness. The nature of the products and their purpose (germ kill on hands after the toilet) was quickly appreciated and understood. The concept of a product for post-defecation use appeared to make sense and the underlying need to clean hands was understood. Packaging and product format played a key role in generating curiosity and initial interest: novelty and modernity were key factors for these communities.

Focus group discussions at the end of the in-home trial revealed a preference amongst the whole group for Gel, which was considered to be a ‘stronger’ product in terms of fragrance and its nature, taking longer to rub in and dry than the lighter Foam. It was also felt that Gel would be more affordable and that Foam, with sophisticated packaging, would be a premium product. Users expressed a preference for smaller pack sizes, lasting say 2 weeks, to reduce the risk of wastage or loss. In relation to price, users were willing to spend slightly more than toothpaste on equivalent amounts of this kind of product.

It is interesting to note that our user-centred innovation process led us to two products which already existed in more developed markets but had not previously been applied in this context and were novel to our target users. In that sense they are not completely new but we consider they represent worthwhile additions to the portfolio of options to improve hand hygiene in such settings. All three product concepts could be taken further. In the case of Foam, it may well suit use for example in schools or community toilets where a large dispenser and refills could offset packaging costs and lower the unit cost. Gel resonated strongly with users for domestic use and the next step would be to evaluate demand and optimize pack size and price. The challenge for Super Water is to simplify dosing, which could be achieved by finding a suitable active ingredient which works over a range of

dilutions safely, thus removing the need for accurate measurement.

CONCLUSIONS

This work showed that there is major scope for innovation in hand hygiene products and resulted in three products, distinct from each other and from soap and water, all of which were new to our target slum households. Others have more recently reinforced this by developing innovations of their own. Now more than ever, in the light of the global Covid-19 pandemic, it is vital that all such innovations be further developed, evaluated and made available to those who need them.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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