35.3 million refugees worldwide

REFERENCES

The problem

Gov.uk, as part of their general health assessments on refugees and newly displaced persons, have addressed the management of wounds. In their guidance document, it says: "You should assess all patients for open wounds and treat these immediately to avoid infection. There is a particular risk of Streptococcus bacterial infection."

In 2015, a United Nations High Commissioner published a report, stating that the number of people displaced worldwide had exceeded 60 million, including 20.2 million refugees displaced due to war and famine. Our patch seeks to efficiently screen for the most prevalent illnesses that could pose a risk to refugees. These illnesses would be more difficult to identify in remote locations - far from hospitals with labs - and would come into play immediately or a couple days following a natural/man-made disaster where there are several casualties. When a large number of people are injured, as is frequently the case, and they have not had emergency medical assistance, infection is a major risk factor.

Chromacare

Ameen Product future, Social acceptance, Advantages
Gabriel Product design and feasibility
Haadiya Product design and feasibility
Haider Clinical trials, Safety of volunteers, Referencing
Naeha Sustainability, Illustrations, The problem
Nila The problem, Illustrations, Poster design

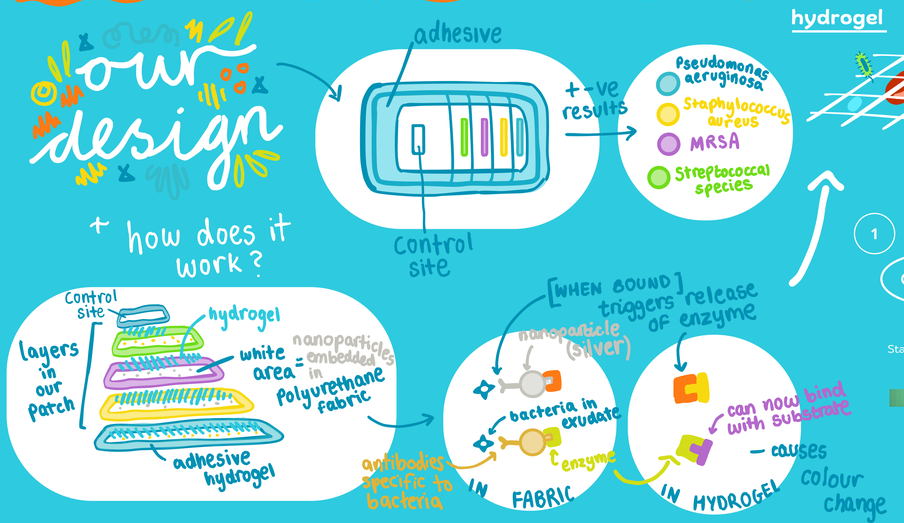
OUR IDEA

We aim to design a patch that can screen for 4 common bacteria (found in open wounds): Streptococcal species, Staphylococcus aureus, MRSA and Pseudomonas aeruginosa.

Normal protocol for treating an open wound is a simple 3 step process: disinfect, direct pressure and covering. However, for refugees and other displaced persons, the lack of resources makes treating open wounds difficult, causing vulnerability to diseases.

Rather than sterilising and sealing the area, our patch aims to speed up the screening process for these injured people. It does this by detecting the presence of common infections in the wound via a patch that contains nanoparticles which trigger enzyme-substrate reactions, resulting in a colour change when certain bacteria found present in the wound exudate bind to them. Similar to bandages, the product is accessible and obtainable in different sizes based on the extent of the injury. Its compact design facilitates transportation and availability.

	Pseudomonas Aeruginosa	Staphylococcus Aureus	MRSA	Streptococcal species
Nanoparticles	Gold	Gold	Silver	Silver
Functionalisation	Antibodies specific to **P.aeruginosa** are joined with **horseradish peroxidase**	Antibodies specific to **Staphylococcus aureus** are joined with **alkaline phosphatase**	Aptamers specific to **MRSA** are joined with **alkaline phosphatase**	Peptides specific to **Strep** are joined with **horseradish peroxidase**
Chromogenic Substrate	Tetramethylbenzidine **(TMB)**	p-Nitrophenyl phosphate **(pNPP)**	Nitroblue tetrazolium **(NBT)**	3,3',5,5'-tetramethylbenzidine **(TMB)**
Colorimetric Mechanism	When Pseudomonas is present in the wound exudate, it binds to the antibody-functionalized nanoparticles. This binding triggers HRP to catalyse the oxidation of TMB, resulting in a visible blue colour change.	Staph in wound exudate binds to the antibody-functionalized nanoparticles. ALP catalyses the reaction of pNPP, resulting in a visible yellow colour change in the hydrogel layer	MRSA in wound exudate binds to the aptamer-functionalized nanoparticles. ALP catalyses the reaction of NBT, resulting in a visible purple colour change in the hydrogel layer.	When Strep is present in the wound exudate, it binds to the antibody-functionalized nanoparticles. This binding triggers HRP to catalyse the oxidation of TMB, resulting in a visible green colour change in the hydrogel layer.



In our patch, the absorbent polyurethane fabric is embedded with nanoparticles functionalised with antibodies/aptamers specific to the corresponding bacteria and an enzyme for the coluorimetric mechanism. If the bacteria is present in the wound exudate then it will bind to the antibody/aptamer. This binding triggers the release and conformational change of the attached enzyme. The released enzyme will then go on to catalyse the reaction of the chromogenic substrate that can be found in the hydrogel between layers - which will cause a colour change. Healthcare officials will then be able to identify which infection is present based on which colour the patch changes. The patch will also contain a control layer, which will include encapsulated leuco-dye pigments. The pigments will be mixed with biocompatible polymers that are safe for the skin, changing colour to red when they come into contact with the wound exudate. This will show that the exudate has travelled through all the layers the patch.

Sustainability Of Our Product

Our product is sustainable because it detects infections early, preventing their spread and complications, which ultimately reduces long-term healthcare costs. Additionally, it minimizes the need for extensive lab work when screening blood samples for infections.

Although medical waste cannot be recycled due to the high risk of contamination, we made efforts to ensure our product is as eco-friendly as possible. Specifically, we have designed the disposable bag (that holds the used patch) to be made from recycled materials, as well as having efficient packaging and distribution methods to reduce transportation emissions.

Future Of Our Product

After successful wide scale distribution of our current product, we will aim to create different versions of our patch with the same basic structure. We began thinking about testing for anaerobic bacteria after reading an article on "Wound Microbiology" on PubMed. Anaerobic bacteria can grow and reproduce where there is poorly oxygenated blood, in the human body, and they can often cause necrosis (tissue death) and abscesses. Hence we would like to expand Chromacare by testing for dangerous anaerobic bacteria such as *Peptostreptococcus magnus*: the most frequently found species of the Peptostreptococcus genus in infections. P. Magnus can contaminate acute wounds, similar to how *Staphylococcus aureus* can, therefore the different version of our patch would work in the same way.

Feasibility

Cost breakdown

Cost per patch - approx. £6.18 per patch:

- Gold nanoparticles - £0.08
- Silver nanoparticles - £0.04
- Antibodies/ aptamers/peptides- £0.80
- TMB- £0.16
- pNPP- £0.08
- NBT- £0.24
- Polyurethane- £0.08
- Hydrogel preparation and layering- £2.36
- Sterilisation- £0.80
- Assembly and packaging- £1.57

Why we chose polyurethane:

- Great liquid absorbption capabilties
- Reliably sticks to wounds
- Waterproof when woven

Pricing

- Researched current market prices for the raw materials
- Calculated a realistic cost breakdown
- The cost of each patch came to £6.20
- We plan on selling bulk packages of up to 50 patches as this lowers the cost per patch

Social Acceptance

- Decreases need for staffing + has ethical benefits as less health care specialists are taken to dangerous areas, such as refugee camps, where their lives are put at risk
- Does not need to be placed on the open wound for long periods of time since it is not a monitoring-patch - it does not hinder the refugee/displaced person in their day to day life

Production timeline

Phase 1: research and development (0–3) months

- Research existing solutions and create a design criteria
- Select the appropiate materials and functionalisation methods
- Identify substrates that will produce a visible colour change upon detection
- Develop a prototype
- Test the binding efficiency and specificity

Phase 2: optimization and small-scale testing (4–8 months)

- Fine tune size, chemistry and functionalisation of nanoparticles, to ensure maximum sensitivity and specificity
- Test the colour change response limits
- Adjust nanoparticles based on test results
- Create initial wound dressing prototypes

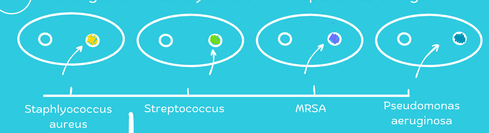
Phase 3: preclinical testing (9–11 months)

Clinical Trials

Safety Of Our Volunteers
All ethical issues will be taken into account during the making of the patch. We will ensure the safety and confidentiality of personal information of volunteers that take part in the clinical trials, using the data and safety monitoring board. We will ensure that the volunteers give full consent before participating in the trials, ensuring that they sign a consent form beforehand.

diameter of **5nm** - to prevent haemoglobin from blood from seeping in and affecting the results

1 Testing the efficiency of the 4 nanoparticles on agar:



Gather a group of healthy individuals who have a non-infected open wound, and test the patch on them. This testing will ensure that contact with blood causes no side effects and that the materials used prevent unwanted diffusion into the blood. The patients will be screened after the trial to ensure that there are no foreign objects in their bloodstreams.

3 GROUP SIZE: 300 - 400
TYPE: HEALTHY VOLUNTEERS WITH OPEN WOUNDS

2 GROUP SIZE: 400 - 500
TYPE: HEALTHY VOLUNTEERS

Gather a group of healthy volunteers and test whether the patch is suitable for the skin. They won't have an infection, but this phase of the trial determines whether the patch is safe to use on the skin and to ensure that there are no (allergic) reactions - if the components within the patch comes in contact with the skin.

4 In this phase, the patch is trialed on patients with an infection (shown through positive lab results) and an open wound. This ensures the efficiency and efficacy of the patch.

GROUP SIZE: 200-300
TYPE: INFECTED VOLUNTEERS

Phase 4: scaling up and manufacturing (12-15 months)

- produce a pilot batch of patches
- implement quality control measures so that consistency and safety can be ensured
- perform additional tests on the pilot batch so that quality and optimum function can be ensured

Phase 5: full-scale production and market launch (after 17 months)

- create a large-scale manufacturing process
- ensure all necessary quality control measures are in palce
- launch the product to the market

PROS	CONS
Easy to use- not complicated	Cannot be recycled- true with all medical waste
Patch will not affect the day-to-day activities as it doesn't require lifestyle choices to be made	Can only be used on wounds that produce exudate- new
Quicker screening- for infections	Displaced person/refugee could be infected with different disease
More readily accesible	
Cheap - affordable	