Medical Kits

Thermoformable Wrist brace

Positives

• Custom fit - better performance therefore better health outcomes than standard size/fit alternatives
• Cost in MOST cases - better use of financial resources for a cheaper device
• Biodegradable - can be disposed of safely without harming the environment
• Faster in SOME cases - can be produced in the field with a 3DP and PLA without a supply chain

Negatives

• What happens if people try and clean/re-use this product? Will this lead to health risks?
• Is PLA and 3DP texture safe to be in contact with the skin for such a long time?
• What if it snaps? (mechanical testing, expert consultation on impact of failure on health)
• Is there a risk of burning the doctor/patient during the thermoforming procedure? (Process documentation/training)
• What are the negative impacts on health of an imperfect brace? Are there risks associated with the size being wrong for a patient?
• Economic risk - is cost saving misleading if the device cannot be cleaned and reused, unlike other more expensive devices?
• ABS printing fumes in a health clinic (design process/communication)
• If we put a 3DP in a clinic, are we putting people at risk of theft/damage/personal harm?

Risk Classification:

• High risk
• Refer to standards and experts

Questions

• 3D printers in health clinics - fumes
  – Internet trawl on dangers of particulates from 3DP process, and what would be considered reasonable steps against harm (e.g. HEPA filter + enclosed printer)
  – Potentially there may be standards, and if not maybe we need to do our own tests

• Is a 3D print sterile when it comes off a printer?
  – FR or external body with **scientific or engineering skillset** to design and conduct tests
  – Send off 3DP items to independent test house
  – Check existing standards for how sterile items are certified (internet trawl)
• Appropriate temperature of items in contact with the skin (device must be placed in hot water to soften it, risk of burn injury to practitioner and patient)
  – Testing by FR or external party to develop safe SOP (standard operating procedure) for this
  – There is probably a standard somewhere for appropriate temps - internet trawl

• Materials: Incorrect material selections - what other materials might other people use, with what implications? (for example Dr Markert used ABS and a lighter to thermoform the brace, people might use recycled plastic). Is PLA an appropriate material for extended body contact? Can PLA prints be cleaned and reused? How clean? How many times can PLA be deformed without failure?
  – Medical device engineer - materials specialist
  – Experimentation by FR or engineering specialist

• What are the important aspects of the design for best health outcomes - is our product with a custom fit genuinely an alternative/improvement on alternative solutions in a similar price bracket
  – Are there any orthotics specialists who can consult on this?
  – Need to do internet trawl for standards pertaining to this item

• **When** is it economically sensible to 3DP a wrist brace?
  – do the sums - Dan or equivalent

• What are the risks associated with equipment of this value placed in the field? What are typical ways to reduce this risk?
  – Literature study/talk to humanitarian specialists?
Tweezers

Positives
• Faster/more accessible in SOME scenarios - tweezers may be printed when otherwise unavailable
• Higher performance than SOME other plastic tweezers

Negatives
• What if the tweezers aren't sterile
• What if someone tries to autoclave them - they aren't autoclavable as they are now
• What if they are used for something vital - like tightening stitches that normal tweezers would be used for - and the performance is too poor to handle fine objects?
• What if they snap while holding the last sterile bandage, or while removing an object from a facial orifice (and cause eye damage, for example)?

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• How many cycles will the tweezers withstand before breaking? What is the force/likelihood of small debris if they break under tension?
  – In house tests by FR or equivalent, engineering, scientific background required
• Performance - what is a good performance test (e.g. picking up a thread?)
  – medical practitioner - Abi Taylor’s mum who is a nurse recommended that we and anyone who prints it test whether tweezers can pick up a thread
• What materials are appropriate (Thinking of mechanical strength, sterility coming off a printer, whether if higher temp materials were used we could autoclave...) ? What are the consequences of someone using something else?
- Medical device engineer - materials specialist
- Experimentation by FR or **engineering** specialist

- Is a 3D print sterile when it comes off a printer?
  - FR or external body with **scientific or engineering skillset** to design and conduct tests
  - Send off 3DP items to independent test house
  - Check existing standards for how sterile items are certified (internet trawl)

**Umbilical cord clamp**

Very similar to tweezers, but higher risk due to length of time in contact with the body and likely vulnerability of patient

**Fetoscope**

Tool for diagnosis - needs full comparison with equivalent products and other likely alternative solutions in an emergency situation ie. is a 3DP fetoscope better than no fetoscope?

**Otoscope**

Tool for diagnosis - needs full comparison with equivalent products and other likely alternative solutions in an emergency situation

**Speculas for otoscope**

Sterilisation issues similar to tweezers

Tool for diagnosis - needs full comparison with equivalent products and other likely alternative solutions in an emergency situation

**IV Hook**

Similar to mechanical aspects of tweezers. No body contact.

**Kidney Tray**

Economic analysis of when it's appropriate to print a kidney tray - don't want to con people. Does it have to be autoclavable to be viable?

**Hose Clamp**

Similar to mechanical aspects of tweezers. No body contact.
WASH Kits

Water Pipe Fitting

Positives

• more secure water pipes in SOME situations (no loss of pressure, contamination)
• safe drinking water if applied to drinking water systems
• better water systems in SOME scenarios - aid agencies previously limited by slow procurement can adapt design to changing needs
• potential for communities to adopt process and sustainably maintain their systems?
• potential for useful product from waste plastic?

Negatives

• Selection of safe materials for application. e.g. ABS in drinking water systems could harm people. ABS in non-potable water systems fine.
• Safe manufacturing - ABS fumes, chemicals for making o-rings
• Process errors - if someone sets their printer to 20% fill rather than 100% fill (error, forgetfulness) how can they recognise the error before installation?
• Could ownership of manufacturing devices lead to differences of power, and lead to social conflict (e.g. giving machines to one 'class' within a camp who then exclude other 'classes' of people? Saw this in Selang IDP Nepal with caste system.)
• Competition with local suppliers, livelihood impact?
• Mechanical failure - loss of water, or in pressurized systems, physical injury. (clamp fails, seal fails, explodes)
• Lifespan and degradation over time
• Failure

Classification:

• High risks
• consult standards and experts

Questions

• Is injection moulding (or something else) a better way to make these in the field anyway?
  – Preferably a mixed capability team of economics/engineering/humanitarian who can discuss different real life scenarios, and put some rough numbers to it with an understanding of technological opportunities and limitations.
What materials are safe for which applications? What materials might people try and use, with what implications (ABS, PLA, recycled plastic). What happens to these materials over time?

- Consult materials specialist for similar applications
- Consult standards

For selected process and material, what errors could arise in the production process, and what impact could these errors have? What steps can be taken to prevent them/make them recognizable before installation?

- Someone with product development background and a 3D printer? New territory!

Pressure testing

- Perform in house tests (FR or external group with eng/science background)

Mechanical clamping force - testing

- Perform in house tests (FR or external group with eng/science background)

How to test quality of plastics in the field?

- Fun project - spin out potential!!

Economic risk - how can we quickly check in different scenarios whether this is a cost saver and will not damage existing businesses?

Social risk - could ownership of this production machine at a local level lead to conflict?

- Is this a thing? Do we know anyone who can tell us how to go about answering this question?

Airbag Kits

Airbag

Positives

- cost reduction enabling more widespread use of the technology
- locally appropriate design enables availability even under extreme supply chain conditions (siege, blockade)

Negatives

- What happens if one fails in use? Harm someone, reputational damage. (hose (quick connect prevents bag deflation)/valve box (ditto)/bag (follow standard testing procedures))
- Bag failure in use - are standard testing procedures and safety factors robust against the unusual variables we are introducing into the process?
• Risks associated with manufacturing by manual heat welding - how do we test if one has weaknesses incurred in manufacturing process before use?

• Material variability - every material will be bought locally, and may very in quality even across one roll. How do we know how strong/reliable quality it is?

• Design for production under siege/blockade means manufacturers and users cannot be directly trained. How do we do quality/use control?

• Variable quality might lead to caution/strange behaviors in use

Classification:
• High risks

• consult standards and experts

Questions
• Are there things to consider from our specific context which mean that we should be introducing additional testing procedures/safety factors/quality checks/quality control processes into the mix?
  – Expert consultation and dialogue between engineer from this field + humanitarian experienced person.

• Easy DIY field material strength tester
  – Internet research for existing solutions
  – fun design project... could probably spin this out!

• Untrained user testing of our manufacturing instructions
  – Anyone with a workshop!

• Monitor behaviour of those using early, most sketchy versions. Does behaviour change to respond to DIY nature of airbag?
  – how do we track this?