High temperature inside PPE kit

By- Abhishek Prasad
Shirish Shekhar Jha
Saroj Narayan K
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Problem statement

Creating a practical solution for reducing the temperature inside the PPE kit for health workers
What are its causes and effects?

CAUSES

- Non-breathable PPE material
- Body heat gets trap inside the PPE
- High humid condition inside PPE kit decreasing rate of sweating hence affects natural cooling.
- Extensive physical work with long shifts
- Tropical climate of India and non AC wards
- Cant use simple ventilation technique to cool down due to contamination issue

EFFECTS

- Heatstroke
- Rashes caused by rubbing of highly sweaty skin with PPE material
- Dehydration
- Affects the efficiency of doctors in their work
- Dizziness
Why we are not using available solution?

Most of the currently available solution rely on air ventilation system. Their issues are

- Only works for 2-3 hours then they are dead weight making them heat more.
- They are noisy and uncomfortable due to vibration
- There form factors hinder in their work
- Issues in air filtration

Possible Solutions

- Use of super absorbent fiber to absorb sweat.
- Use of PCM as heat reservoir
- Water cooling system
- Use of chemicals which endothermically react with sweat (still finding the material)
- Use of Peltier module as heat pump
- Material change of PPE garment
Things to keep in mind

Solution should be

- comfortable and not obstruct their work
- light weight
- last around 5-6 hours
- Reusable

Working condition of doctors

- Very high physical activity is involved
- PPE kit cant be removed at will
- Works in non-AC ward
- Works in long stretch with little or no rest
Finalized solutions

PCM + SAF Garment

- SAF absorbs sweat and PCM stores the body heat
- A bit heavy
- PCM can be placed internally or externally (still deciding)
- Reusable
- Dedicated refrigerators required to cool down PCM
- Only works for around 4-5 hours (purely an estimate without any prototyping)
WORKING

The health workers wearing this gets cooled by two ways. When they first wear this the pre-cooled PCM (phase changing material) maintains a constant temperature of 25-30 degree celsius inside the PPE kit for first few hours. After the PCM melts and is not able to absorb heat inside ppe, then the SAF layers comes into play. It absorbs excessive sweat released by the body. This process decreases humidity inside ppe kit and enhances the natural cooling of body by sweating through other parts of the body.

After health workers shift gets over they can remove their vests. The PCM packs are removed from the vests and are cooled down for next shift.
Some photos for reference

White SAF garment worn by the fire-fighter for cooling

Commercially available PCM cooling vests
CONCLUSION

- Currently used solution are not suited for the environment in which health workers work.
- The solution presented requires a lot of prototyping and testing before finalizing the design.
- Technologies used in solution are available but are not used in PPE kit.
- Need a lot of designing work
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