Portable refrigeration

Background
There are many substances that must be kept cold in a hospital. Vaccines are the best known. For this reason, most health care facilities have at least one refrigerator. However, these cold boxes are typically concentrated in one part of the hospital, perhaps the blood bank. A subset of substances are sometimes needed on very short notice, far from the refrigerator. For example, oxytocin (used to contract the uterus after delivery) is unpredictably needed on short notice. Or, they may be required in very remote areas, where they must be carried by hand. Having no access to refrigeration, but knowing the need for the substances, many facilities simply leave a vial of the substance on the counter or exposed to heat and hope that it does not lose its potency.

Specifications

What is needed is a refrigerator of very small volume. It should be sufficient to store one days worth of the chemical (perhaps 5 ml) without the need for electricity or, preferably, any outside fuel. The cavity should be able to be maintained at about 10 degrees C for 12 hours. It could require shaking, cranking, solar, a hot piece of charcoal or any other non-electric fuel source. Costs should be below $100 in quantities of 500.

Information on oxytocin is available in the attachments tab.

Zeer pot experimentation

The design team spent the first two weeks working with zeer pots, refrigeration devices that use evaporative cooling. Click the above link for the documentation and results.

Insulated box testing

The design team is currently experimenting with insulated containers. The idea is to put the 5mL sample that we're trying to keep cold in an insulated box and surround it with other cold items like cold packs or ice. Click the above link for more information and test results.

Thermoelectric Cooler

Numerous portable refrigerators make use of a thermoelectric cooler. Wikipedia does a good job defining the Peltier Cooler: "The effectiveness of the pump at moving the heat away from the cold side is totally dependent upon the amount of current provided and how well the heat from the hot side can be removed." A very crude equation describes this, given here (http://en.wikipedia.org/wiki/Thermoelectric_effect#Peltier_effect).

Unfortunately, as engineers, we know this isn't always the case, and so a better (but much more complicated) description of the cooler's effectiveness is given by multiple factors, many of which depend on the environment in which they operate. This may prove difficult in trying to optimize a system. The equation (http://electronicsdesign.com/Articles/Index.cfm?AD=1&ArticleID=6325) has many unknowns, many of which may be difficult in trying to elucidate from manufacturers we try to contact.

As a last resort of trying to understand these heat sinks, we can try and test several out, by using a method described in this paper (PeltierConstantDetermination.pdf), which has been uploaded. But based on experience, it seems that most commercial coolers are very broad in their ability to cool in different environments. Understanding all this (something I don't have enough knowledge to do...yet), will be the next step in trying to build a fridge from scratch.

Ideas

- The zeer pot (pictured) makes use of evaporative cooling. It's difficult to find a figure for the the extent of cooling possible; it likely varies with pot and filler types.
  - another zeer pot link: http://solarcooking.wikia.com/wiki/Pot-in-pot_cooler with experimentation results
- Cold Packs consist of ammonium nitrate (fertilizer) mixed with water. They can allegedly drop to 35F for 10-15 minutes. Combining the packs with a thermos or some type of insulator could allow us to maintain the required low temperature. Consuming a lot of the cold packs would be an immediate problem; ammonium nitrate would need to be produced on site.
- Traditional small-scale refrigerators could be modified to run on solar. A Duke design team has worked on this concept in the past.
- Thermoacoustic refrigeration would provide for some interesting experiments but would probably be less effective than a traditional design.
  - Thermoacoustic and traditional methods both require electricity and the latter approach has higher efficiencies.
- Another possible design would be using a readymade portable USB mini fridge and powering it with AA batteries. The device costs about $35 and the AA battery power source can be built ourselves. The thing that we need to figure out is how much total power (C) the USB fridge needs, and how much the AA could provide. We could modify the design to incorporate larger C batteries or even 9V batteries.
  - The author of the Power device says there is only a 60% efficiency problem we will need to fix. Better find some EE kids!

Past work

Click the link above for a page with reports and summaries from "legacy" work with this project.

Contact

if interested, contact Matt Ball (matt.ball.2 atgmail)