



Protecting vaccines stored in refrigerators

An [NIST \(National Institute of Science and Technology\) study](#) in 2009 found that several factors improved the ability of a freezer-less refrigerator to store vaccines safely. [A follow up publication by NIST in 2017](#) gives guidelines for storing vaccines.

Things not to worry about:

1. **Load density.** Regardless of how many vaccines were stored inside a freezer-less refrigerator the temperature was maintained sufficiently to stay within the safe zone of 2° to 8°C. The study stated,

“Vaccine storage density did not appear to have a major impact on the refrigerator’s capability to maintain the desired temperature range. Throughout the course of the study, average thermometer temperatures remained within approximately a 2 °C range regardless of whether the refrigerator load was low, medium, or high density”.

2. **Packing style.** The vaccines packing style did not affect the vaccine temperature except in the case of a refrigerator compressor failure. Vaccine packed in plastic trays, cardboard boxes, the original shipping containers or free standing remained within the safe temperature range during normal operation of the refrigerator.

3. **Periodically opening the door for short periods of time.**

“The results of the periodic door-opening trials also support the efficacy of the freezerless refrigerator model. Although thermometers attached to refrigerator walls and hanging in the air recorded temperatures above the allowed maximum temperature of 8 °C, all thermometers attached to vials remained within the desired range in spite of the repeated exposure to room temperature air.”

Vaccine vials stored in the open air as opposed to plastic trays or some type of cardboard container, recorded a larger temperature change during periodic door openings but as long as the doors remained open for brief periods of time but recovered quickly once doors were closed.

Things to worry about:

1. **Where you position a temperature sensor.** Thermometers or temperature sensors of any type should be placed in a vial of liquid to accurately determine the temperature of the vaccines. They should not be placed on refrigerator walls, at the top or bottom of the refrigerator cavity as the cold air in those places can be warmer or colder than in the center of the refrigerator.



2. Power failures. Vaccine temperatures as well as air temperature shot up dramatically during a power failure. Temperatures rose to above 8°C between 2 and 8 hours after the refrigerator power was interrupted. The time difference was caused by how the vaccines were stored. Vaccines packed in heavy cardboard boxes took the longest to heat up whereas vaccines stored in the open air or on top of cardboard boxes heated up more quickly.

In the NIST trials the refrigerator remained unpower for 15 to 17 hours. Once power was restored it took as long as 6 hours for the vaccines to be cooled to a temperature below 8°C.

3. What you use to monitor the temperature. The 'Vaccines for Children' (VFC) requires that the temperature be recorded twice a day. This is not adequate. Because so many variables exist which affect the internal refrigerator temperature it is very possible for temperatures to rise into the unsafe zone and then cool back down between the twice a day measurements required by the VFC program. The study found and recommends that a data-logger be used to record temperatures continuously.

A factor not addressed by NIST, but obvious, is the need for an alarm of some sort. Since so many factors can influence the vaccine temperatures, any data-logger which does not alert personnel of unsafe temperatures will only show that the vaccines are no longer viable after an unsafe temperature occurs. And that is only the case if it is noticed. Data loggers which only store data in memory will not indicate unsafe events until they are downloaded and the data viewed.

4. The use of water bottles as ballast. It was found that water bottles stored on the door of the refrigerator did have a minor effect during a power outage.

“Depending on how the vaccines are stored, water bottle ballast can provide an extra 2 min to 15 min of leeway before vaccines are subjected to out-of-range temperatures during a power outage”.

5. Room Temperature: For every 1°C rise in room temperature the internal temperature of the refrigerator rose one-tenth of a degree. So if an air conditioner fails during a hot summer day it needs to be quickly repaired and the vaccines moved to a safer environment. Again vial stored in cardboard boxes will stay colder longer than ones stored in the open.