

Sure Chill® Upright Vaccine Refrigerator door opening tests: Study confirms no thermal shock to vaccines on repeated door opening

Sure Chill® Vaccine Refrigerators have outstanding, independently verified performance. At an ambient temperature of 32°C the patented Sure Chill technology keeps vaccines safe at the required 2°C to 8°C on as little as 2½ hours of electricity per day, and can maintain this temperature for over 12 days without any power whatsoever. The Solar Direct Drive model has a similar performance and does not require any batteries to maintain internal temperatures overnight.

Introduction



“Chest type refrigerators require users to remove vaccines completely from the refrigerator in order to access stock stored in lower baskets”

An upright, front opening refrigerator design is often preferred by workers in the field as it facilitates stock management. Vaccines are easily visible and can be organised without taking them out of the vaccine compartment. By contrast, chest type refrigerators require users to remove vaccines completely from the refrigerator in order to access stock stored in lower baskets.

Despite this advantage of convenience, we are frequently asked whether vaccines are protected from thermal shock in upright, front opening refrigerators. There is a commonly held perception that “cold” is retained in chest type models whilst upright refrigerators “leak out cold” when the door is opened, making vaccines more likely to experience thermal shock in high ambient temperatures.



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The R&D team at Sure Chill therefore designed a study which replicated door openings in the field and which measured the temperature inside vaccine vials placed in various positions in the refrigerator.

Study Protocol

- The study was undertaken within Sure Chill's Research and Development facility using professionally calibrated equipment
- Thermocouples were installed within the vaccine compartment, top left back, top right front, bottom right back, bottom left front
- The refrigerator was stabilized at 43°C ambient temperature and was loaded with pre-chilled (8°C) dummy vaccine loads as per PQS testing.
- 3 vaccine vials containing 2ml water and a temperature sensor were placed in the vaccine compartment in the following locations: Top shelf at the back, middle shelf in the middle and bottom shelf at the front. In addition, an identical vial was placed on the top shelf, which could be removed from the refrigerator at each door opening to mimic removing vaccines from a chest freezer to access stock in lower level baskets.
- Temperatures in the vaccine vials were allowed to stabilize, and the refrigerator was run for an additional 24 hours before the start of testing, checking that compartment temperatures remained in the range 2-8°C for the whole time.
- During the testing period, the refrigerator door was opened to an angle of 90° for a period of 3 minutes. The removable vial was taken out of the fridge and placed on a surface at ambient temperature. After 3 minutes the vial was replaced in the refrigerator and the door closed. The door opening sequence was repeated morning and evening for 3 consecutive days. The temperature inside all vials was monitored during the door opening procedure and the length of time that any vial temperature deviated out of the 2 to 8°C temperature range was also recorded.

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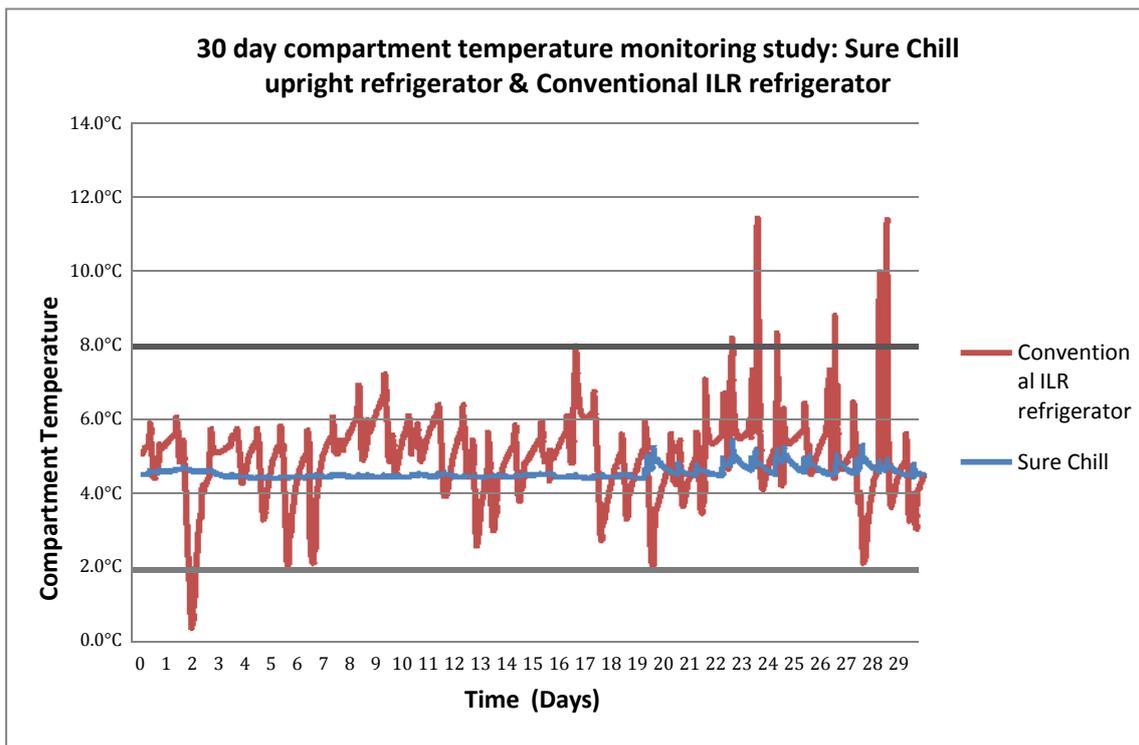
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Results

Throughout the study all vials positioned within the unit remained within the required temperature range of 2°C to 8°C. The maximum rise in temperature recorded in any vial within the refrigerator on door opening was 2.52°C. This was in the vial positioned in the middle of the middle shelf. This rise did not take the temperature in the vial above 8°C. The mean rise in temperature in the vials inside the refrigerator on door opening was 1.95°C.

By contrast the removable vial deviated from the 2°C to 8°C temperature range each time it was removed from the refrigerator, by a mean of 8.53°C and remained out of the temperature range for a mean of 26 minutes after being replaced in the refrigerator. A similar study was performed with the refrigerator in holdover, i.e. no power supply to a fully charged refrigerator. This produced similar results and moreover repeated opening of the door did not result in a significant reduction in holdover time. Further trials showed the following differences in temperature control between upright and chest PQS pre-qualified refrigerators.



Conclusion

Data obtained during this study indicate that vaccines stored in the upright front opening refrigerators are not subjected to thermal shock on opening of the door in high ambient temperatures.

Whilst this study was being undertaken in Sure Chill's research facility, a WHO/PATH Project Optimize study was field testing the Sure Chill solar direct drive Vaccine Refrigerator in difficult solar conditions in North Vietnam. The refrigerators were tested over a 3 month period and the refrigerator door was opened twice daily to 90° for 3 minutes. On a monthly basis a simulation of a National Immunisation Day was undertaken; 30 minutes of door opening in a 2 hour period. This involved 10 successive 3 minute door openings with 10 minute door closures in between during the 2 hour simulation. Temperatures within the vaccine compartment of the refrigerator were monitored throughout. Data recorded shows that safe temperatures were maintained within the vaccine compartment for the duration of the field tests, and the conclusion from this study is also that vaccines stored in the upright front opening refrigerator are not subjected to thermal shock on opening of the door.

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