Temperature Variations in Chest-type Mechanical Freezers

To the Editor:
A recent report described temperature variations within upright mechanical freezers set at −80 °C (1). The range of internal temperatures was great, with the warmest specimen being at −43.5 °C and the coldest at −90 °C. These findings suggested that it might be useful to study the temperature variation within horizontal chest-type freezers.

In 1974, blood samples were obtained from 25,802 adult volunteers in Washington County, Maryland. In 1989, an additional 32,320 samples were obtained in a similar project. The separated serum samples from each project were stored in mechanical chest-type freezers set to hold an interior temperature of −73.3 °C. For subsequent studies, sera from newly diagnosed cancer cases and from healthy controls have been assayed for a variety of micronutrients, hormones, or antibodies.

In this study, serum samples were stored in 5-mL plastic Nunc tubes (Nunc), 100 in a cardboard box with the boxes stacked in racks in two sizes of freezers. Five freezers (Sow Low Environmental Equipment Company) were used in the study. Two were 27-cubic foot freezers (model no. SE 27-100) holding racks that are seven boxes high with four racks front to back and 11 across, for a total capacity of 30,800 samples. Three freezers (model no. PR100-7) had a capacity of 7 cubic feet. Two held 2.5 racks front-to-back and eight across, for a total capacity of 8,000 specimens. The third small freezer contained approximately one-half of its total capacity.

For temperature measurements, 22-gauge copper-constantan type T thermocouples were used, each threaded through the cap of a 5-mL Nunc tube of the same type as those containing serum samples, but with the thermocouple tip immersed in 3 mL of tap water. The tubes containing thermocouples were placed in the outer row of tubes in a box.

Temperatures were measured in degrees Fahrenheit, using an Omega model HH-25TF thermometer with a crystal display (Omega Engineering). The calibration of the Omega thermocouple indicator was verified by a Thermo Electric Micromite II thermocouple calibrator, which was traceable to NIST. Although all temperatures in this study were recorded in degrees Fahrenheit, we are reporting in degrees Celsius to simplify comparisons with other studies.

Temperatures were measured in sets of eight tubes per freezer. The tubes were placed in boxes at the top and bottom of each freezer, close to each of the four corners. A minimum of 24 h was allowed for stabilization before temperatures were recorded.

To determine the extent to which the thermocouple leads might cause heat leakage into the freezers, the ends at which leads were inserted were alternated for the freezers tested, and top temperatures were compared between the thermocouple tested and the other sealed end. The mean temperature difference between the two ends was only 0.1 °C.

Room temperatures during the study period were 20–25 °C. We could not detect any effect of this limited ambient temperature range on the study results.

The mean temperature differences between top and bottom varied by freezer capacity. For the 27-cubic foot freezers, the temperature differential was 15.9 °C with a difference of only 1.1 °C between the two freezers. For the two fully loaded small freezers, the mean top-to-bottom difference was 10.1 °C, and the difference between the two freezers was 2.4 °C. The small freezer filled to only one-half of its capacity had a top-to-bottom difference of 10.6 °C.

This study indicates that chest-type freezers provide greater uniformity of temperature than the upright front-door type. It also suggests that it might be prudent to match cases and controls based on the part of the freezer in which the specimens had been stored. Top-to-bottom temperature differentials of 10–15 °C are not trivial. Although they may have no deleterious effects on study analytes after short-term storage, this may not hold true when storage times are measured in years or decades.

A limitation of this study is that it involved only a few freezers from a single manufacturer and only a limited range of ambient temperatures. However, we can think of no reason that temperature variations within other makes of chest-type freezers should differ appreciably from those we observed. Temperature variation within freezers is likely to be a pervasive problem that warrants further investigation.

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Reference

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Presence of Birefringent, Maltese-Cross-appearing Spheres in Synovial Fluid in a Case of Acute Monoarthritis

To the Editor:
A 31-year-old Caucasian male presented to our hospital with an acute and painful swelling of the left knee joint. Two days before swelling was