White Paper Study on Refrigerator Safety and Solving Airflow Problems

Are Your Refrigerators Really Safe?

By Butch Wilcox

If a health inspector arrived at your Facility and asked a pointed question on one or more of your refrigerator temperatures, are you prepared to answer it quickly and accurately?

Here is one example of a difficult question:
Inspector: I see you have a medication Refrigerator in room A 101, what was the temperature last Tuesday at 3 am? How about at 1 pm or 4 pm?

Your first reply might be the Joint Commission only requires temperatures to be checked and recorded once every 24 hours. That answer might satisfy this inspector. But what if the inspector is from the FDA and is investigating a complaint from a mishap in an organ transplant? What if a CAP investigator sends an inquiry regarding research refrigerators or freezers?

At The Children's Hospital (TCH) in Aurora, Colorado our Refrigerator Committee asked these kinds of questions. This was the beginning of a long process of insuring our refrigerators were being properly monitored 24/7 every 15 minutes. That is 96 times per day! Yes, 95 times more than the Joint Commission is requiring at this time.

How do you monitor 24/7 96 times per day?
As we started this process, we knew we had to have an electric monitoring system that would be affordable and accurate. While electronic monitoring and recording is somewhat new to hospitals (within the last ten years), an increasing number of hospitals are incorporating it. In the past, at the end or beginning of a shift we had nurses do temperature checks. This of course is a complete misuse of time. A nurse should be administrating the much-needed healthcare patients are requiring.

We started with a small self-constructed in-house system that was working. The system was exposing issues requiring attention. It was noted refrigerators weren't maintaining steady temperatures for 24 hours. At this point we only had the system on a few units in our Pharmacy but realized the need to check all refrigerators and freezers. We started to explore an outside vendor that could supply us with a reliable system that would electronically monitor all units. There are a few companies marketing this type of system. We elected to use CheckPoint by Tempsys (Mesa

Monitoring). We chose this system because it was wireless, and it was compatible with our DAS (Distributive Antenna System). This is important because tether cords are inconvenient and running wires through walls in existing buildings becomes cost prohibitive.

After we installed our electronic wireless monitoring system on all units, the justification became clear we did the correct thing. Yes, we made a large dollar investment, but at TCH we put patient safety first and foremost.

We immediately noticed how erratic many of our refrigerators were during the course of the day. This led to a timely investment of man-hours to bring all our units into safe operating ranges. As we monitored our units we realized the importance of properly stocked refrigerators. An over stocked refrigerator will not have the ability to insure proper airflow. Airflow is the driving force in refrigerator performance and controlling even temperatures from the top to the bottom of the unit.

Having many types of refrigerators in our system, we decided to resolve one model at a time. The first model was the Kenmore 253. After we tried stocking the unit correctly and realizing we still had erratic temperatures, we decided to modify our refrigerators with a false back, as shown in Figure 1.

Figure 1 – The false back allows for airflow in a fully-stocked refrigerator

The false back design was installed into our Kenmore model 253 refrigerators. It is constructed completely of plastic, which satisfied our infection control specialist. It is easily installed in less than 5 minutes and completely solved our Kenmore model 253 problems. Before we installed these backs, we were experiencing 1 or 2 out of range alerts per day. Since each in-house technician service call to a refrigerator takes half an hour, the cost to manufacture the false back was quickly recovered.

How does the false back work?

To install the backs you simply remove all the shelves and place the back against the rear of the refrigerator. The back has 30 airflow holes and six plastic blocks that hold the back 3/4 of an inch off the refrigerator rear wall. Top and bottom airflow U-shape channels were incorporated to allow air inlet and exhaust. Finally, re install the shelves to hold the back in place. No glue or screws. If you encounter a spill in the unit, simply remove the back and wash it with soap and water. What could be easier?

Airflow is the most important driving force in the efficiency of refrigeration. Always remember hot air rises and cold air falls. In the Kenmore 253 upright air flows from the top and down the back side and up the front side. If for any reason airflow is disturbed, uneven refrigeration occurs. Any product placed to the rear of the refrigerator will stop airflow. With our false backs airflow is maintained through the 3/4 inch open space between the back of the refrigerator and the rear of the false back. We have over 75 false backs in use. A local plastic manufacture using our design supplies the backs for $75 each (parts and labor). A Kenmore 253 with a false back allows us to refrigerate our patient food safely and economically.

During my experimenting with inside air temperatures of the refrigerator I placed the electronic sensor throughout the inside (top-middle-bottom), noting temperatures varied as much as 5 degrees depending on sensor location and how the unit was stocked. With a false back installed, the difference in temperature was less than a degree.

U-line Refrigerators with glass shelves:

Glass shelves and restricted airflow in U-line medication refrigerators go hand and hand. While glass shelves have an attractive appearance and won't allow small items to fall between shelves, they certainly restrict airflow. One would think cold air would easily travel through the glass shelves by convection, but in the case of U-line unites the transfer of cold air was being restriced. I have placed CheckPoint electronic sensors on top of the shelves and underneath the shelves, and if there is no air gap at the rear, the sensor was indicating as much as a 5-degree difference. The air gap that maximized airflow for the U-line units was 1/4 inch.

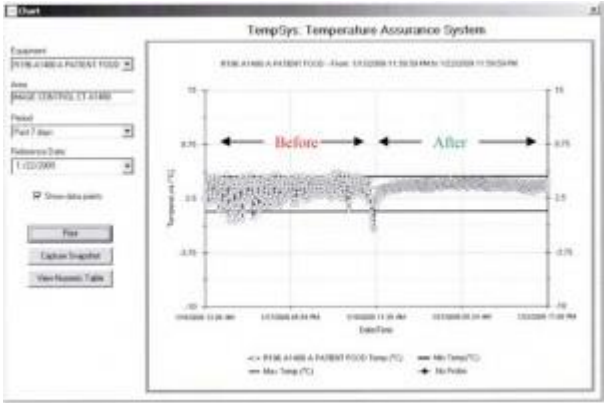

Figure 2 – CheckPoint graph

A CheckPoint Monitoring graph is shown in Figure 2 of a U-line medication refrigerator. This graph illustrates the ability to control the temperature range. In the middle of the graph the temperature is

erratic, but after the fhelf clips are installed, the temperature range stabilizes. This stabilization was accomplished with establishing a permanent gap (1/4 inch) between the rear of the refrigerator back and the glass shelf.

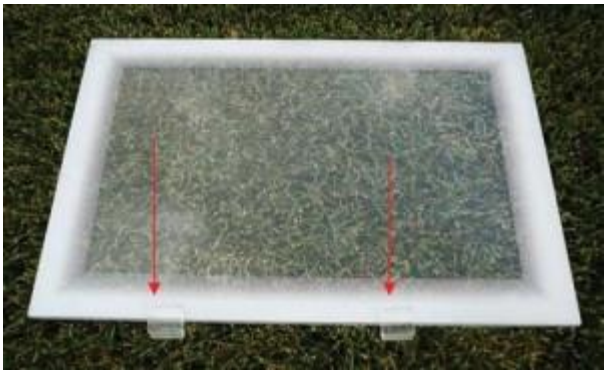

Figure 3 – Glass shelf with plastic clip design

The solution, as shown in Figure 3, is simple, easy to install with no infection control issues, at $1.00 per clip (2 per glass shelf required). This is a real bang for the buck.

How does this little inexpensive clip work?

U-line medication refrigerators do not operate on fan-enhanced airflow. They solely rely on convection transfer of cooled air. The glass shelves have a nice appearance but reduce airflow. Refrigerators with glass shelves that don't touch the back of the unit are more efficient than ones that do (U-lines).

Here is what happens. with opening and closing the door and the inability of the unit to properly defrost, the glass shelf will freeze to the rear wall. A small frost seal will prevent air transfer at the rear of the unit. When this happens, the temperature range fluctuates, as noted in Figure 2. After designing the false back for the Kenmore model 253, this solution was much easier to design. At first a false back for the U-lines was considered, but the design shown in Figure 3 was less expensive and easier to incorporate.

Figure 4 – Lower-level coolers

Even an expensive commercial walk-in coller, shown in Figure 4, with all the airflow one could ever wish for can have evaporator frosting if the unit doesn't support a defrost cycle. On these units in our lower kitchen we solved the evaporator-frosting problem with a $25.00 cycling timer. we had to turn off our walk-in coolers about every 45 days to let the ice melt that had completely frosted up the evaporator. Our units never had defrosting off cycle timers installed and were problematic from the beginning. After the units warranty ended we knew we had to do something to stop the time used in thawing the evaporators. It became clear what the problem was when the head refrigeration mechanic invested the time to examine the units. The installation of the cycling timers was completed in-house in less than six hours. The labor saved over the last six months not having to perfomr manual defrosts has been enormous.

Summary

The Children's Hospital has and always will continue to be proactive regarding patient safety. Our monetary and labor investment has paid off with amazing results. We currently have 470 units on a safe electronic monitoring system allowing our staff to spend their valuable time giving patient care. We currently monitor all patient food, specimen, research and medication refrigerators and freezers, and yes, we even monitor our 105 blanket warmers.

Our idea of installing false back or spacer clips into refrigerators of any style will enhance airflow. If the units are like U-lines, the small plastic clips will be successful in enhancing airflow. Understanding the principles of airflow (cold air falls and hot air rises) attributes to controlling temperature distribution inside refrigerators. This will save many frustrating hours of experimentation. Always remember that glass shelves disturb airflow convection. Air has to be directed around the glass shelves to insure proper cooling.

The approach used by TCH to solve refrigeration problems was accomplished utilizing Root Cause Analysis. Ask why this happened and keep asking why at least 5 times, and the root cause will surface and the problem will disappear.

The ideas and designs in this white paper are not patented.