Cold Chain Maintenance

The term **cold chain** refers to all the material, equipment and procedures used to maintain biological products within the required range of 2° to 8°C at all times during handling, storage, and transport. Breaks in the cold chain can result in the lack of vaccine effectiveness, undue vaccine failures and an increased rate of local reactions after vaccine administration.

Many biologicals can be inactivated by exposure to heat or freezing. The specific effect of temperature on the potency of biologicals depends on the type of biological, and the temperature and duration of exposure. Inadvertent freezing can substantially reduce the potency of alum-adsorbed vaccines such as DPTP and Hepatitis B. Exposure to heat and light can compromise the stability of live-virus vaccines, such as MMR.

A. Maintaining Equipment:

Regional Public Health Services

a) **Equipment—Refrigerator**

1. Industrial quality refrigerators must be used for storing central inventory of vaccines (main office). Kitchen-style refrigerators are suitable for smaller quantities (sub-office). Ideally, kitchen refrigerators should not be frost-free models as the temperatures in frost-free models cycle over a wide range.

2. “Bar” or half sized fridge must not be used for vaccine storage in health units.

3. All refrigerators containing large quantities of vaccine (e.g., main office) must be connected to a temperature alarm monitoring system.

4. A suitable alarm, one that provides either a pre-recorded message (dial out to staff on-call or security service) or a recognizable tone monitored after office hours. Security service or staff on-call must be trained in the appropriate procedures in response to an alarm.

5. All vaccine storage refrigerators must have a maximum-minimum thermometer (sub-offices) or a constant temperature chart recording device (main office).

6. Place the refrigerator approximately 10 cm (4 inches) from the wall to allow for proper movement and ventilation of warm air.

7. Ideally, refrigerators should be placed in low traffic areas or in rooms with lockable doors to prevent refrigerator tampering after office hours.

8. Keep the vaccine refrigerator plug in a protected area where it cannot be knocked out accidentally. Connect the refrigerator to a dedicated circuit that is not required for other appliances. Label vaccine refrigerator electrical outlet and power-breaker switch: **"VACCINE REFRIGERATOR—DO NOT UNPLUG/DO NOT SWITCH OFF."** Instruct janitorial personnel on the importance of fridge function and ask them to report any problem noted in or near the vaccine fridge.

9. Keep vaccine refrigerator failure procedures on hand, e.g., by posting on or near vaccine refrigerators.

10. Identify an emergency back-up refrigerator for use in the event of a power failure or an equipment malfunction. If possible, this emergency back-up should be functional and accessible at all times (e.g., if a power failure occurs, the emergency back-up should be in an area where power is not out.)

11. If a short power outage is anticipated (less than one hour), do not open vaccine refrigerator during the power outage. If a longer power outage is anticipated, plan for transfer of vaccine.

Routine Maintenance

1. Defrost the freezer compartment of the vaccine refrigerator if there is an accumulation of more than 1/4 of an inch (or 1 cm) of ice in the freezer compartment. Transfer vaccines to a vaccine carrier box or another refrigerator while this is being done. Monitor the temperature during this contingency period.

2. Regular maintenance of refrigerators (cleaning coils, replacing door seals, etc.) must be performed and records kept.

3. Refrigerator alarms must be tested and batteries replaced every 6 months (minimum).

a) Temperature Control

1. Maintain the central temperature of the vaccine refrigerator between 2°C to 8°C.

2. Use a high-low thermometer to monitor the vaccine refrigerator temperature. At the start of each workday, check the high and the low temperatures reached over the previous 24-hour period. Record these temperatures on the "Vaccine Refrigerator Temperature Record."

3. Calibrate electrical thermometers with manual thermometers every six months and whenever they are suspected of being faulty. Change the thermometer batteries as soon as they run down, or annually, to ensure continuous function. Fridge, thermometer problems and temperature incidents should be reported to the Regional CDPC Coordinator and appropriate manager.

4. Ensure that all vaccine-handling staff knows how to read and interpret maximum-minimum (high-low) thermometers.

5. Store sealed bottles of water or saline in all the less used areas of the refrigerator (near freezer units, on the door and bottom shelves, at backs of shelves). Store ice packs in the freezer. These practices help to preserve the refrigerator temperature if there is a power failure, and buffer temperature rises during periods of frequent refrigerator opening. This will also prevent rapid temperature rise in the event of power failure, provided the refrigerator door is not opened.

6. Make sure that the refrigerator door is closed when not in use.

7. Do not open the refrigerator door more often than necessary.

8. Do not store other materials whatsoever in vaccine refrigerators including staff lunches.

9. Do not store contaminated matter such as urine, stool specimens or animal matter.

A. Physician Offices, Hospitals and Other Sites

1. All sites where publicly funded vaccines are handled must:

    a) have a maximum-minimum refrigerator thermometer in all refrigerators containing vaccines;

    b) check refrigerator temperatures at least once a day (on office opening) to ensure vaccines administered that day are potent.

2. Individuals and institutions handling publicly funded vaccines are required to comply with the guidelines presented in this section. If a site is unable to maintain refrigerator temperatures between +2°C and +8°C, or unwilling to comply with vaccine handling requirements, this must be documented

by the Regional Public Health Services personnel, as well as the actions taken to assist the site in complying.

3. If site does not comply, the Medical Officer of Health may inform them that their access to publicly funded vaccine will be revoked. Once the site provides the Regional Public Health Office with written documentation of compliance, publicly funded vaccine will again be provided.

b) Monitors

Time temperature indicators are used to facilitate monitoring of cold chain maintenance. Each device is used for specific reason to ensure vaccine temperature is maintained at the recommended levels in the fridge, during shipment and transportation, or at the "Immunization Clinics".

Description about each time temperature indicator is provided below. Monitoring and appropriate use of these indicators is the responsibility of each Public Health staff handling vaccines.

If there is a cold-chain breakdown, inform Regional CDPC Coordinator for necessary follow-up actions.

1. FreezWatch™ Indicators

The FreezWatch™ indicators are used to monitor vaccines that may run the risk of being exposed to freezing temperatures during shipment and storage. When exposed to freezing temperatures, the ampule fractures, releasing the liquid that stains paper behind the ampule. Should you observe this, contact Regional CDPC Coordinator for necessary follow-up actions.

<u>How to Use FreezWatch™ Indicators</u>

1. Attach the FreezWatch indicator using the pressure sensitive adhesive on the back. Peel the release liner off the back and adhere the indicator to a clean, dry surface.

2. Before reading, the indicator should be in an area above freezing temperature for at least fifteen minutes.

3. To detect if the product has been exposed to freezing temperatures, observe the FreezWatch indicator. If the indicator paper is stained with color, your product has been exposed.

4. If the indicator paper shows no color indication, remove indicator from the surface to which it is attached. Vigorously tap the bottom edge of the indicator three times on a hard surface. If the paper becomes stained, your product was exposed to freezing temperatures. Tapping will not cause color staining in an unexposed indicator.

Storage:

To prevent premature indication, keep from freezing prior to use. Storage in a controlled environment at 5° to 32°C (41° to 90°F) 20 to 60% relative humidity, is suggested.

2. Monitor Mark™, High Temperature Indicators

MonitorMark High Temperature Threshold Indicators are to monitor exposure to temperature above 10°C. When exposed to high temperature, exceeding 10°C, Monitor Mark indicators irreversibly turn blue. May be used for shipping or in the fridge.

How to use Monitor Mark™ High Temperature Indicators

1. Peel off release liner (the adhesive back).

2. Place the indicator on the secondary shipper box, on dry, clean surface.

3. If exposed to temperatures above the threshold, the indicator will turn blue.

4. Call Regional CDPC Coordinator to inform and seek advice for follow-up actions.

Storage:

Store indicator at 22°C (72°F) or below at 20 to 60% relative humidity. Keep away from heating vents, hot pipes or direct sun.

3. Monitor Mark™ Time Temperature Integrators

Monitor Mark Time Temperature Integrators not only signal when a critical temperature has been exceeded, but provide visual signal to estimate the time of exposure over the threshold temperature.

Monitor Mark Time Temperature Integrators feature a high contraxt indicator that turns blue as a result of exposure to rising temperatures. The indicator is irreversible, providing a permanent record of temperature exposure even after temperatures return to acceptable levels. Time required for the blue color to move through the middle of the fifth window during exposure at a constant temperature 2°C above the 10°C in a 48 hour period.

<u>How to Use Monitor Mark™ Time Temperature Integrators</u>

1. To prevent premature response, must be conditioned before removing the activation strip (Peel off adhesive) and activating the integrators. Condition indicates for a minimum of two hours in a refrigerator or in a freezer for a minimum of 2 hours. Once conditioned and ready for use, the indicators can be maintained at any temperature below their threshold temperature.

2. Peel off adhesive release liner. Place directly on shipper box (carton, etc.) or in the fridge.

3. The appearance of **any** blue color in the indicator's first window signals that the indicator's pre-set threshold temperature has been exceeded.

   The extent of color movement ("runout") through the indicator's windows provides a measure of accumulated time spent above the threshold temperature. *A short exposure at a relatively high temperature will produce coloration comparable to a longer exposure at a lower temperature.*

4. Contact Regional CDPC Coordinator to inform and seek advice for follow-up actions.

Storage:

Monitor Mark™ Time Temperature Integrators should be kept at 22°C (72°F) or below at 20 to 60% relative humidity. Keep away from heating vents, hot pipes or direct sun. Shelf life is two years from date of manufacture.

B. Storing

1. Store biologicals in the vaccine refrigerator immediately following their receipt.

2. Store all biologicals at 2°C to 8°C.

3. Do not remove vaccines from the refrigerator except for: withdrawing dose(s); shipping to clients; or transporting to immunization clinics.

4. Place the same type of vaccines adjacent to one another in the refrigerator.

5. Store vaccine packages with longer expiry dates behind shorter-dated products. Shorter-dated products must be used first.

6. Do not store vaccines on the door shelves of the refrigerator, in vegetable bins or on the shelf below the freezer as temperatures in these areas fluctuate. Store vaccines on the middle shelves of the refrigerator.

7. Allow space between products in the refrigerator to allow air to circulate.

8. Separate the different types of biologicals. For freeze-dried products (for example MMR, ACT-HIB) for which diluent is provided in separate packages, diluent can be stored at room temperature to conserve refrigerator space (unless the product insert specifies that diluent must be refrigerated).

9. Keep all adsorbed vaccines, and inactivated vaccines, such as DPTP, Hib, HepB and Influenza, away from the freezer compartment and away from direct contact with ice. These vaccines lose potency if frozen.

10. Store Yellow Fever vaccine in a freezer (–30°C to 0°C) until time of use. Diluent used to reconstitute Yellow Fever Vaccine is NOT to be kept in the freezer; store it in the refrigerator at 2°C to 8°C.

11. Protect measles, mumps, and rubella vaccines (both the monovalent and the combined MMR) and PPD from light in order to avoid inactivation.

12. Maintain vaccines being used at off-site immunization clinics (e.g., schools) between +2°C and +8°C using insulated containers and ice packs if a refrigerator is not available. A towel or bubble wrap must be placed over an ice pack to avoid placing vaccine packages directly on ice

during clinic. A thermometer must be placed in the insulated container to monitor temperatures throughout transport and clinic use.

13. Educate and inform all staff handling vaccine about the importance of good vaccine storage and transportation techniques.

C. Handling

1. Return all biologicals to a 2°C - 8°C dark environment as quickly as possible when not in use. Keep handling to a minimum.

2. Reconstitute biologicals immediately prior to use and **ONLY** with the diluent provided by the manufacturer. For multi-dose vial, print the date on the label after opening.

3. For reconstituted products, refer to the manufacturers' package insert for stability information following reconstitution. For example, reconstituted MMR and Rubella vaccines must be discarded if not used within eight hours, PPD could be used within 30 days, etc.

4. Adhere to strict aseptic technique when handling biologicals.

5. Check biological stock for expired products at the end of every month. Also, check for products that will expire in two months' time to ensure that they will be used. If they will not be used before their expiry, contact Biologicals Desk Central Office, as some products are eligible for a credit from the manufacturer, or could be used in other regions.

D. Transporting

1. To ensure optimum storage conditions during transport:

    (a) Use insulated coolers or re-use insulated transport boxes/units (used by distributor to ship biological products). Cooler bags are only suitable for short-term transport e.g., between Health Unit and physician's office.

    (b) Determine the number of frozen ice packs to be used during transport according to the volume of biologicals to be transported and the anticipated length of transport time.

    (c) When a transport unit is new, and periodically thereafter, test the transport unit's capability of maintaining the temperature

range of 2° to 8°C for the anticipated length of time it will take for transport. Test the transport unit by placing in the bottom of the unit the number of frozen ice packs anticipated to be used during biologicals transport. Wrap thermometer in newspaper or packing paper and place in the unit. Check the temperature at the end of the anticipated transport time. If the temperature range of 2° to 8°C was not maintained, re-test the transport unit with a greater number of frozen ice packs. If the unit is unable to maintain the desired temperature, discard it.

(d) To avoid the freezing of biologicals during transport, prior to use leave frozen ice packs at room temperature for a few minutes until condensed water appears on the surface.

(e) Place frozen ice packs in the bottom of the transport unit.

(f) To prevent biologicals freezing, loosely cover biologicals with bubble wrap or packing paper to avoid direct contact with frozen ice packs.

(g) Tightly secure the lid/top of the transport unit by taping, tying with string, or zipping closed.

2. Clearly label biological transport unit: “Vaccines—Maintain temperature between 2° to 8°C. Refrigerate immediately. Do not freeze.”

3. Advise all shipping companies transporting biologicals that the product is perishable and must be refrigerated immediately upon receipt at destination. Obtain guarantee that vaccines are kept in a refrigerated container or vaccine transport unit from receipt to delivery. Ensure transport companies keep biologicals refrigerated if delivery is refused at its destination or not one is available to accept the shipment at the point of delivery.

4. When biologicals are transported in outside temperatures of less than 2°C, transport in a vehicle where temperature is kept higher than 2°C. If this is not possible and biologicals will be exposed to outside freezing temperatures, pack the transport unit with thawed ice packs which have been brought to room temperature.

5. Maintain the cold chain for all biological products returned to the distributor.

D. Refrigerator/Cold Chain Failure

From time to time, during transportation and/or storage of vaccine, cold chain failure may happen. In case of cold chain failure, following process is recommended for Public Health Services offices.

1. Store exposed vaccines in a separate container marked **"DO NOT USE"** in well functioning refrigerator or cold box with a thermometer, until it is determined which products are useable and which must be replaced.

2. Record a complete list of products involved in the cold chain failure, including expiry dates and quantities of each product, and maximum and minimum temperature of the refrigerator or cold box upon discovery of the incident.

3. Document the cause of the failure, the steps taken in response and the last time the refrigerator/cold box temperature was noted within the +2°C to +8°C range.

4. Calculate the total length of time the temperature was outside +2°C to +8°C. If specific time/temperature details are not available assume the refrigerator malfunctioned *immediately* after the last thermometer check and assume the refrigerator took 2 hours to warm or cool to a temperature outside the range of +2°C to +8°C.

5. Complete the Incident Report and submit immediately to the regional CDPC coordinator, M.O.H and the director of Public Health Services by fax.

6. The M.O.H. and regional CDPC coordinator will assess products involved in the cold chain failure and provide advice for use or return of the vaccine.

   Information regarding the stability of vaccine is evolving. It appears that some vaccines keep their potency for varied time after cold chain failure.

7. If information re. vaccine stability is not available in the region, contact provincial CDPC Coordinator and leave an urgent message stating reasons for call.

   CDPC Coordinator will return your call as a priority.

8. Those vaccines appropriate for use after a cold chain failure must be marked in order to identify them in case of a second exposure. Exposed products must be distributed and/or administered before unexposed products, regardless of expiry date.

8. Report a complete list of products involved in cold chain failure, quantities in doses and cost of each product to the provincial Biological Coordinator, and the provincial CDPC Coordinator. Send exposed vaccine in a box clearly marked **"DO NOT USE"** with a copy of products included to Biological Coordinator.

For physicians' offices and institutions:

1. Assess conditions contributing to the cold chain failure to determine if the incident was preventable. Replacement vaccines must not be provided to the site until documentation of actions taken and, when applicable, payment is received by the health department.

2. Calculate the total value of vaccines damaged in the incident. All incidents must be followed up with recommendations, in writing, from the public health service. Include the value of the vaccines lost, along with an invoice for replacement vaccines if the incident was determined to be preventable.

3. If recommended steps for improved conditions are not followed, or an invoice for replacement vaccines not paid, the M.O.H. may revoke the physicians' office/institution access to publicly funded vaccines.

4. A summary record of cold chain failures in physicians' offices and institutions must be maintained at the public health services including: the total number of incidents, the total value of vaccines lost and the total value of costs recovered through invoicing. This summary information must be forwarded to the biological coordinator.

E. Disposing:

Biologicals expiry date is the final working date of the month listed. (E.g. expiry Sept. 98 means Sept. 30/98). To dispose of biologicals:

1. Put damaged, expired or unusable biologicals (that are not eligible for credit) in a separate box.

   If biologicals are not disposed of immediately, label them **"DO NOT USE"** and store in a separate, well defined area outside of the refrigerator to prevent any possible accidental use.

   Return all unused vaccines to Biological Coordinator. Record products returned, destroyed, quantity, lot number, expiry date. Cost will be estimated at the biological desk.

2. Biological products are not hazardous wastes. There is no danger to individuals or the environment if they are spilled. Any spillage should be cleaned up using implements that protect the worker(s) from contact with broken glass and sharp metal, and the soiled area rinsed with water.