Proper transport, storage, and handling of vaccines are issues that are frequently overlooked when creating or implementing vaccine protocols. Between the time a vaccine leaves the manufacturer’s plant and the time it is injected into an animal, there are many opportunities for inadvertent contamination or inactivation. By being aware of these potential “weak points” in a vaccine protocol, technicians can help ensure that vaccines are not rendered ineffective because of improper handling.

Awareness of vaccine transport, storage, and handling issues is greater in human medicine than in veterinary medicine because of the risk of epidemic diseases such as polio, influenza, and smallpox. By reviewing research on human vaccine protocols, veterinary professionals can learn a great deal about proper vaccine handling.

Typical vaccines used in veterinary medicine include modified-live virus (MLV) vaccines, killed and adjuvanted vaccines, and recombinant vaccines. The different forms of vaccines have different susceptibilities to storage conditions. The term cold chain is used in human medicine to emphasize the importance of keeping vaccines at an appropriate temperature throughout the chain of transport, storage, and administration. Exposure to temperatures outside the recommended range can lead to reduced protection against infectious disease. MLV vaccines require close attention to the cold chain because they tend to be more heat sensitive than other types of vaccines. In general, published guidelines are limited. However, according to the 2006 American Association of Feline Practitioners Feline Vaccine Advisory Panel report, temperatures that are too cold can also adversely affect vaccines. In addition to excessive cold and heat, exposure to light can cause vaccines to be rendered ineffective.

Storage

Virtually all vaccines used in small and large animal veterinary medicine, including lyophilized (freeze-dried) and liquid forms, must be stored in the dark between 35°F (2°C) and 45°F (7°C). A few veterinary vaccines (e.g., some poultry and fish vaccines) must be kept frozen; technicians working with frozen vaccines should contact the manufacturer for specific storage instructions. Vaccines requiring refrigeration must be stored in a designated refrigerator. This should be a standard-size refrigerator with a separate freezer compartment—not a mini dormitory-style refrigerator—to ensure better temperature control. The temperature inside a refrigerator can vary, with warmer temperatures in the door and vegetable bins and colder temperatures near the cold air outlet from the freezer to the refrigerator. For this reason, vaccines should be kept in the center of the refrigerator, far enough from the freezer compartment to prevent them from freezing. Storing jugs of water in the refrigerator may also help prevent temperature fluctuations.

Vaccines should be kept in their original packaging, and boxes should be rotated so that the newest batch (with the latest expiration date) is in the back and is used last. Food and beverages should not be stored in the vaccine refrigerator; doing so violates Occupational Safety and Health Administration regulations. In addition, frequently opening the refrigerator to retrieve food can also lead to temperature fluctuations.

Equally important to keeping vaccines refrigerated is monitoring and logging the refrigerator’s temperature. The clinic should designate a primary person and a backup person to be responsible for the vaccine cold chain. A good-quality thermometer should be kept in the middle of
Tips for Safe Vaccine Transport, Storage, and Handling*–e

**General**
- Designate primary and backup personnel to be in charge of vaccine inventory, storage, and handling.
- Maintain a vaccine inventory log that notes the vaccine’s quantity, manufacturer, brand, lot number, expiration date, date of arrival, and arrival condition.
- When a shipment arrives, check the temperature inside the shipping box and immediately refrigerate the vaccines.
- Use only the diluent supplied with the vaccine.
- Do not reconstitute or draw up the vaccine into the syringe until it is needed.
- Avoid mixing different vaccines in the same syringe unless licensed for that use.
- Properly dispose of syringes and needles in a sharps container.

**Transport**
- Use an insulated cooler to transport vaccines.
- Keep a thermometer in the cooler.
- Maintain the temperature between 35°F–45°F (2°C–7°C).
- Use refrigerated or frozen packs as needed to maintain the appropriate temperature in the cooler.
- Place insulation (e.g., bubble wrap) between the vaccine vials and the frozen pack to prevent direct contact.
- Keep the vaccines in their original packaging.
- To minimize exposure to extreme temperatures, keep the cooler in the interior of the vehicle instead of the trunk or truck bed.

**Storage**
- Keep vaccines in a standard-size refrigerator with a separate freezer compartment.
- Keep a good-quality thermometer in the vaccine storage refrigerator.
- Maintain the refrigerator between 35°F–45°F (2°C–7°C).
- Do not store vaccines in a mini dormitory-style refrigerator.
- Do not keep vaccines in the door, in vegetable bins, against the walls, or against the cold air inlet of the refrigerator.
- Do not overpack the refrigerator.
- Store vaccines in their original packaging.
- Stack vaccines by type, and rotate the stock so that the batch with the earliest expiration date is used first.
- Record the temperature twice daily on a log sheet.
- If the temperature is above or below the recommended range, notify the supervisor and call an appliance repairperson if necessary.
- Store jugs of water in the vaccine refrigerator to help maintain steady temperatures.
- Check the refrigerator seals regularly.
- Make sure all staff members close the refrigerator door tightly after opening.
- Do not store food or beverages in the vaccine refrigerator.
- Mark the refrigerator’s electrical outlet with “do not unplug” signs.

**Power Outage**
- Have a written protocol addressing power outages.
- If the outage is ongoing, consider moving vaccines to a place where they can be maintained at the appropriate temperature.
- Do not open the refrigerator or freezer until power is restored.
- As soon as power is restored, record the temperature in the refrigerator and the duration of the outage.
- Do not discard the affected vaccines.
- Mark the affected vaccines so that they can be easily identified.
- Call the vaccine manufacturer for guidance regarding whether the vaccines may still be used.


the vaccine refrigerator, and the refrigerator temperature should be checked twice daily (i.e., at the start and finish of the business day). The temperature should be recorded in a log book, with the exact time it was checked and the initials of the individual who is monitoring the temperature; if the temperature in the vaccine refrigerator is outside the recommended range (i.e., <35°F [2°C] or >45°F [7°C]), the log provides a visual trigger to take action.

If the temperature goes above or below the recommended range, immediate investigation is required. It should be verified that the door seals are intact and that the door shuts tightly. The thermostat should be adjusted if necessary, and an appliance repairperson should be called if needed. The exact temperature and action taken should be documented in the log book.

In case of a power outage, the refrigerator should not be opened until power has been restored. When power is restored, the temperature inside the refrigerator should be immediately checked and logged, along with the duration of the power outage. Affected vaccines should not be discarded but should be marked and kept separate from unaffected vials. The manufacturers of the vaccines should
be called for guidance. Depending on the duration of the outage and the ending temperature in the refrigerator, the vaccines may still be usable. If a prolonged power outage is anticipated (e.g., because of a hurricane or other natural disaster), the vaccines may be moved off-site to a location that will not be affected.2

Detailed studies of the degradation of veterinary vaccines exposed to inappropriate temperatures have not been published. Storage at room temperature for a couple of hours is most likely insignificant, but it is unknown at what temperature and length of exposure inactivation becomes a concern.7 More detailed studies exist for human vaccines and show that the rate of inactivation varies considerably by pathogen, strain, vaccine formulation, manufacturer, and exact environmental conditions.8 For example, measles vaccines are quite stable in the lyophilized form but are inactivated within hours of reconstitution.8

Transport
Vaccines are frequently transported in large animal practices and in small animal house-call practices. The cold chain must be maintained during transport. Vaccines should be kept in an insulated cooler. Frozen ice packs or refrigerated packs should be used as needed to maintain the temperature between 35°F (2°C) and 45°F (7°C). The temperature in the cooler should be monitored and logged immediately before and after transport. A layer of insulation should be tucked between the vaccine box and the ice packs to prevent direct contact, which could result in freezing temperatures in the vaccine vial. The cooler should be kept in the passenger cabin of the vehicle; temperatures in a trunk or truck bed could get too hot in summer or too cold in winter.9

Handling
For lyophilized vaccines, only the diluent that is provided with the vaccine should be used.5 Generally, diluents do not need to be refrigerated, but it is usually more convenient to keep them in the refrigerator with their corresponding vaccines. A new, sterile syringe and needle should always be used for drawing up and administering a vaccine. Vaccines should not be reconstituted or drawn up into the syringe until needed. Not only may the reconstituted vaccine be more temperature sensitive than the nonreconstituted vaccine, but there is also a risk of bacterial contamination and overgrowth if the syringe is left for a prolonged period. In addition, there is a risk of “mistaken identity” because many vaccines look similar in the syringe.4 The American Association of Feline Practitioners recommends using vaccines within 30 minutes of reconstitution.5

Some veterinary vaccines are available in multidose vials. When using a multidose vial, the veterinarian should ensure that the vial has been thoroughly mixed before withdrawing a dose and take steps to minimize contamination of the vial.10

Standard sharps safety procedures should be followed to prevent accidental needlesticks. This is of particular concern with brucellosis vaccines because the vaccine agent is live and zoonotic.11

Conclusion
Despite greater awareness of the vaccine cold chain in human medicine, there are still gaps in implementation. A 2001 survey of pediatric clinics found that 4% of clinics had a vaccine refrigerator temperature higher than 48°F (9°C), 15% had a refrigerator temperature lower than 34°F (1°C), 10% did not have a thermometer in the refrigerator, and 62% lacked complete temperature logs.6 Although no similar studies exist in veterinary medicine, the numbers may be similar.

Veterinary technicians are a critical link in the vaccine cold chain. Many clinics do not have procedures in place for monitoring vaccine storage temperatures; therefore, technicians have opportunities to help design and implement vaccine storage and handling protocols.

References
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1. Vaccine efficacy can be affected by
   a. excessive cold.
   b. excessive heat.
   c. exposure to light.
   d. all of the above

2. Vaccines should be stored in which temperature range?
   a. 2°F to 7°F (–17°C to –14°C)
   b. 10°F to 20°F (–12°C to –7°C)
   c. 20°F to 32°F (–7°C to 0°C)
   d. 35°F to 45°F (2°C to 7°C)

3. The term cold chain refers to the
   a. precipitate that forms when an adjuvanted vaccine is frozen.
   b. maintenance of proper vaccine temperature throughout transport and storage.
   c. frozen ice packs that can be used in an insulated cooler.
   d. thermometers used to monitor the temperature in the refrigerator.

4. If a clinic experiences a power outage, the technician should not
   a. discard all vaccines that may have been exposed to warm temperatures.
   b. mark all vaccines that may have been exposed to warm temperatures.
   c. record the temperature inside the refrigerator as soon as power is restored.
   d. contact the vaccine manufacturers for advice.

5. Which statement regarding vaccine transport is false?
   a. Vaccines should be kept in an insulated cooler during transport.
   b. The cooler should be kept in the passenger cabin of the vehicle to prevent exposure to extreme temperatures.
   c. The temperature inside the cooler should be monitored with a thermometer.
   d. Frozen ice packs or refrigerator packs should be placed in direct contact with the vaccines to ensure that they are kept cold.

6. In the clinic, vaccines should be stored in
   a. a mini dormitory-style refrigerator.
   b. the vegetable bins of a standard-size refrigerator.
   c. the center of a standard-size refrigerator.
   d. the door of a standard-size refrigerator.

7. Ideally, vaccines should be reconstituted and drawn up into the syringe ________ before use.
   a. immediately
   b. 1 hour
   c. 6 hours
   d. 24 hours

8. If the temperature in the vaccine refrigerator is above or below the recommended range, which of the following steps should be followed?
   a. The door seals should be checked to make sure that they are intact.
   b. The thermostat should be adjusted if necessary.
   c. An appliance repairperson should be contacted immediately, if necessary.
   d. all of the above

9. A refrigerator temperature log book should include the
   a. date and time.
   b. exact temperature.
   c. initials of the individual monitoring the temperature.
   d. all of the above

10. According to ______________ regulations, food and beverages should not be stored in the vaccine refrigerator.
    a. FDA
    b. Centers for Disease Control and Prevention
    c. Occupational Safety and Health Administration
    d. none of the above