Vaccine Storage in Remote Areas

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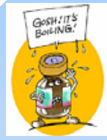
Outline

- Background
- Vaccine potency and the cold chain
- Temperature requirement
- Remote areas of Developing countries
- Two options widely available
- Photovoltaic refrigeration

Background

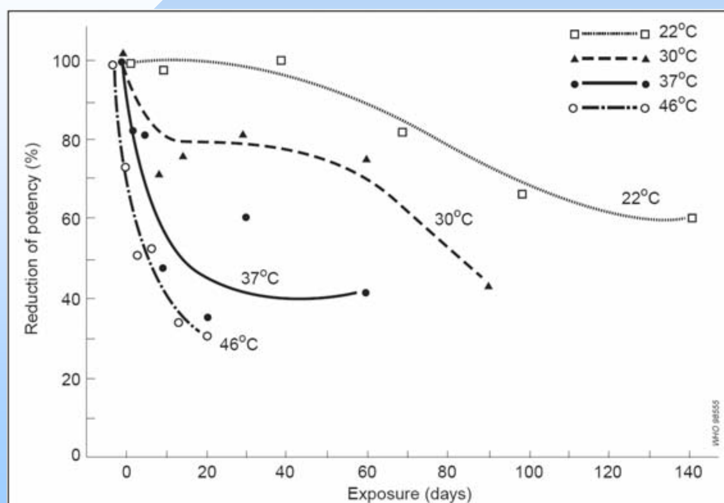


(http://www.unicef.org/immunization/images/immunization_cartoon.jpg)

- A quarter of all children born every year - 34 million infants - are not protected against diseases for which there are inexpensive vaccines (Practical Action Consulting 2006).
- An estimated 2.1 million people around the world died in 2002 of diseases preventable by widely used vaccines (WHO 2005).
- 27 million children worldwide were not reached by DTP3 in 2003, including 9.9 million in South Asia and 9.6 million sub-Saharan Africa (WHO 2005).
- 50 % of transported vaccines are wasted through spoilage, lack of electricity is the reason for spoilage (Woodyard *et al*. 1995).

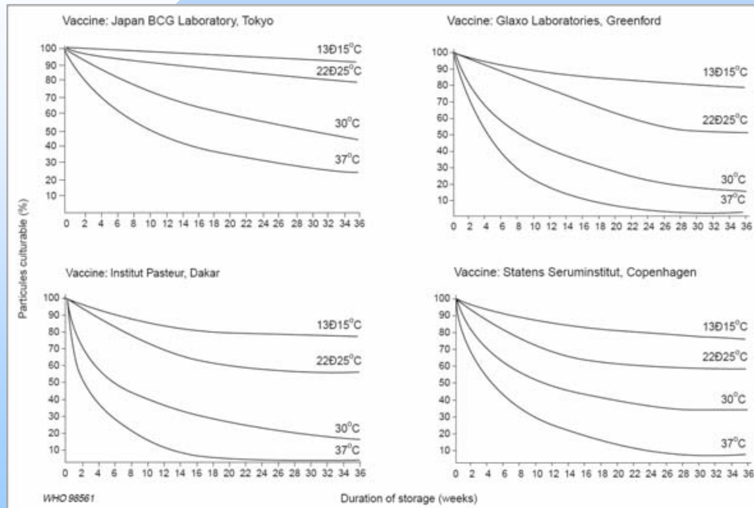
Loss in potency of pertussis component of DTP vaccine

(Source: Galazka *et al*. 1998)

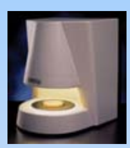


Viability of four BCG vaccines

(Source: Galazka *et al*. 1998)



Vaccine potency



(http://www.nature.com/nature/journal/v424/n6951/images/424975a-i2.0.jpg)

- All vaccines are thermo-sensitive and need to be properly stored and distributed within an efficient cold chain system.
- The stability of vaccines varies considerably (Galazka *et al*. 1998):
  - Diphtheria and tetanus toxoids and hepatitis B vaccine showing the highest thermostability,
  - Freeze-dried measles, yellow fever and BCG vaccines occupying the middle position and
  - Oral poliomyelitis vaccine being the most fragile.

Heat sensitivity
(Source: WHO 1998)

(http://ehs.uky.edu/classes/bloodborne/Pics/HBV%20Vaccine.gif)

- Live oral polio vaccine (OPV) — Most sensitive
- Measles (Lyophilized) *
- Pertussis and Mumps (Lyophilized)
- Hepatitis B
- Adsorbed Diphtheria-Pertussis-Tetanus vaccine (DPT)
- Adsorbed Diphtheria-Tetanus vaccine (DT, Td)
- BCG (Lyophilized) *
- Tetanus Toxoid (TT) — Least sensitive

* Note: These vaccines become much more heat sensitive after they have been reconstituted with diluent.

The cold chain system

- The cold chain refers to the system (personnel, equipment & procedure) used for keeping and distributing vaccines in good condition.
- The cold chain system, when implemented properly, can help overcome the challenge of the delivery of quality vaccines.
- The cold chain system can enhance the on-going quality, safety and efficacy of an immunization programme.

A typical cold chain
(Source: WHO 2002)

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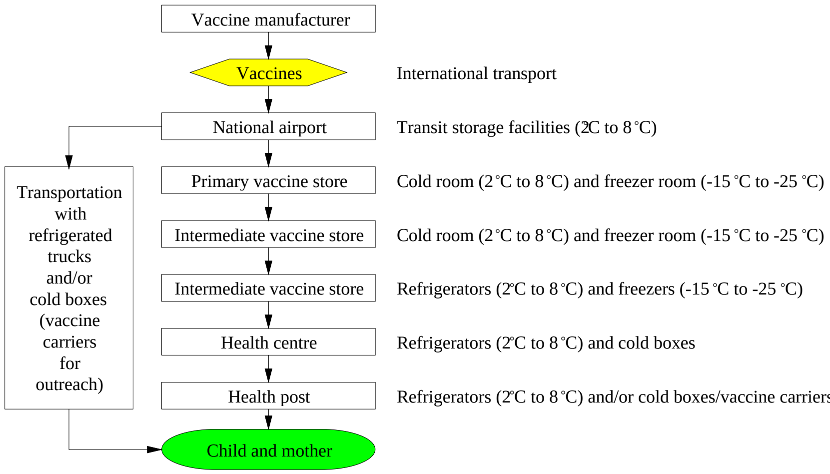

Bolivia cold chain monitoring study; March–May 2005
(Source: Nelson *et al.* 2006)

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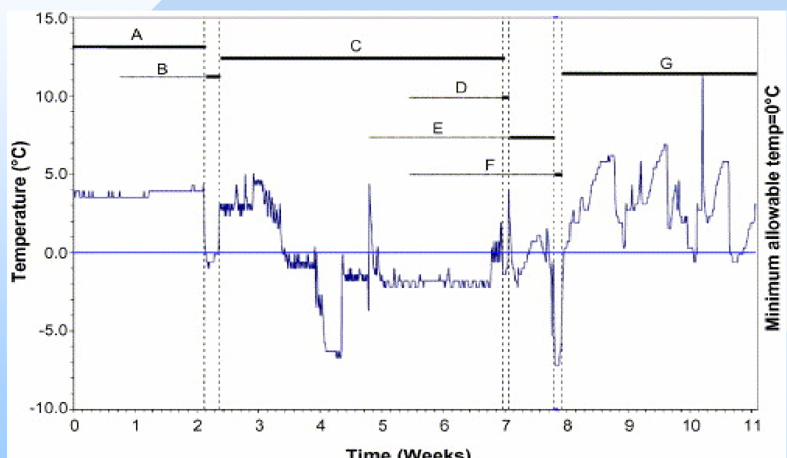
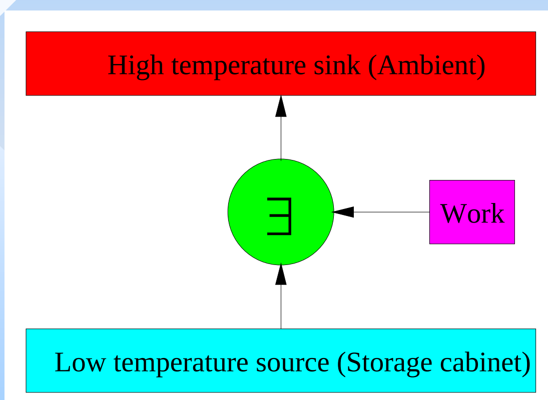
(A) Central stores, (B) transport 1, (C) Santa Cruz (province), (D) transport 2, (E) Cordillera Camiri (district), (F) transport 3, (G) Charagua (health center)



Remote areas in Developing countries

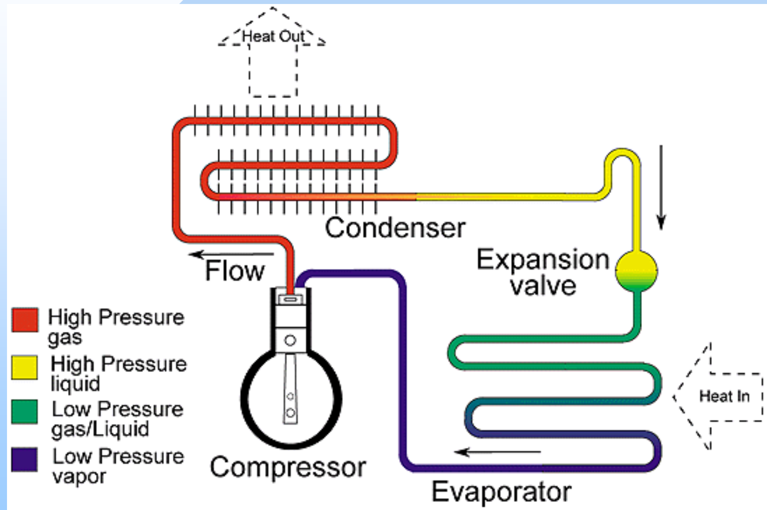
- ~2.5 billion people live in rural areas of developing countries.
- Adequate electrical power and refrigeration are often lacking in developing countries.
- Storage, handling and the heat stability of vaccines are consequently matters of great concern in these areas.
- Most of these rural areas lie in hot and humid climate and have abundant sunshine.

Fundamental of refrigeration

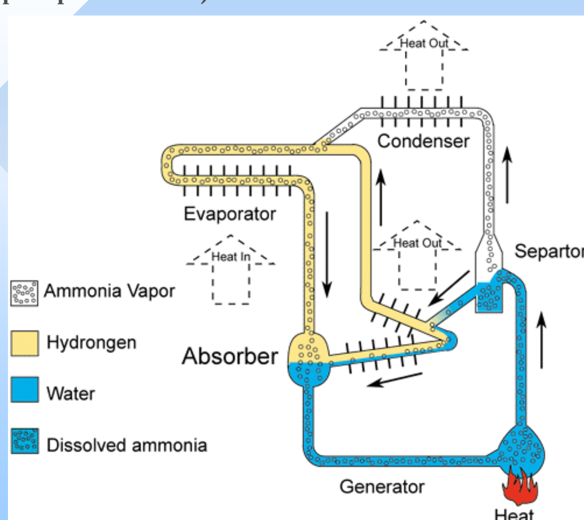


To transfer heat from low temperature region to high temperature region requires work input to the device (refrigerator or reverse engine)

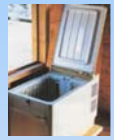
Vapour compression system
(Source: www.polarpowerinc.com)



Absorption system
(Source: www.polarpowerinc.com)

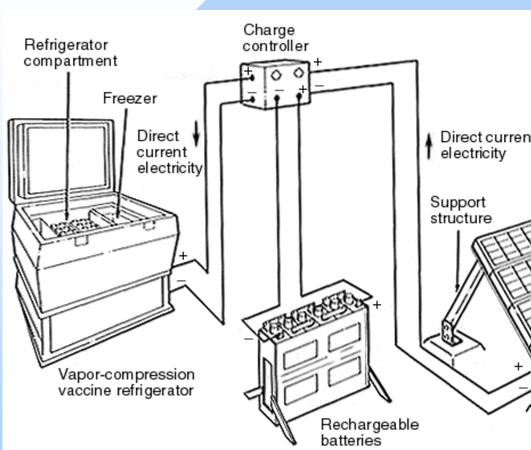


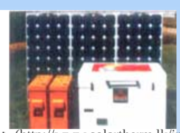
Comparative data



(http://www.lasersunenergy.com/products/refregerator.jpg)

Parameter	PV Refrigerator	Typical Kerosene
Net vaccine capacity (Litres)	100	100
Initial capital cost ($)	4500	500
CIF and installation ($)	1500	800
Fuel costs ($/day)	-	0.70
Maintenance costs ($/year)	150	100
Life time (Years)	15	5
Availability (% time in service)	95	50
(Source: Derrick & Durand 1986)		





(http://www.solartherm.lk/image1/medical%20fridge.jpg)

Vaccine Refrigerator Powered by a Photovoltaic System

(Source: www.polarpowerinc.com)

Performance specification

(Source: WHO 1998)

- The design of the system shall permit a minimum of five days continuous operation when the battery set is fully charged and the photovoltaic array is disconnected.
- In continuous ambient temperatures of +32°C and +43°C the internal temperature of the refrigerator, when stabilized and fully loaded with the standard vaccine load, shall not exceed the range of 0°C to +8°C.

Typical Medical-use PV Refrigerators

- Storage volume: 27 to 100 L
- Freezing volume: 5 to 60 L
- Energy consumption: 300 to 500 Wh/day
- With freezing of ice pack: 700 to 1200 Wh/day
- System cost: US$ 3000 to 5000 (ITDG 2000)
  - PV arrays 28%
  - Refrigerator 37%
  - Batteries 24%
  - Accessories 11%

PV Vaccine storage

Advantages	Limitations
Elimination of fuel problems	Possible component failure
(Electric vapour compression systems – Diesel generator; Absorption systems – Kerosene fridges)	System sizing and performance are site specific Better user training required

IDTC has developed a performance prediction and system components sizing software tool for small-scale photovoltaic refrigeration system (SSPVRS).

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