VAXXWAGON: An Innovative “No Ice, No Electric” Active Refrigeration System for Last-Leg Vaccine Transportation

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Most vaccines, such as those for measles; mumps; and yellow fever, must be kept between 2°C and 8°C at all times. This can be logistically challenging during transport to remote locations where refrigeration is unavailable. I designed, constructed and tested a ground-driven refrigeration system called VAXXWAGON, capable of being powered by a human or pack animal. This design was supported by calculation of heat flow into an insulated chamber, 4.5 Watts in this case, and thermodynamic modeling of R-134A refrigerant and thermal storage in a Phase Change Material (PCM). Testing was performed by powering the system from a treadmill. Data collection included temperatures of the condenser, evaporator, vaccine chamber, and PCM as well as high and low side pressures of R-134a refrigerant in a vapor compression system. To simulate proper storage and transportation of vaccines, a water bottle was loaded at 5.7°C and placed in the vaccine cold chamber. The cold chamber temperature was maintained in the 2-8°C range by the refrigeration system during six hours of motion, and by the thermal storage of the phase change material for an additional four hours stationary. The pulling force was 1.4 Newtons for a power of 5 Watts which can be easily supplied by a human. These results support the further development of VAXXWAGON as a cost-efficient means to deliver life-saving vaccines to remote locations throughout the world.

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