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Economic impact of thermostable vaccines

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ABSTRACT

Background: While our previous work has shown that replacing existing vaccines with thermostable vaccines can relieve bottlenecks in vaccine supply chains and thus increase vaccine availability, the question remains whether this benefit would outweigh the additional cost of thermostable formulations.
Methods: Using HERMES simulation models of the vaccine supply chains for the Republic of Benin, the state of Bihar (India), and Niger, we simulated replacing different existing vaccines with thermostable formulations and determined the resulting clinical and economic impact. Costs measured included the costs of vaccines, logistics, and disease outcomes averted.
Results: Replacing a particular vaccine with a thermostable version yielded cost savings in many cases even when charging a price premium (two or three times the current vaccine price). For example, replacing the current pentavalent vaccine with a thermostable version without increasing the vaccine price saved from $366 to $10,945 per 100 members of the vaccine's target population. Doubling the vaccine price still resulted in cost savings that ranged from $300 to $10,706, and tripling the vaccine price resulted in cost savings from $234 to $10,468. As another example, a thermostable rotavirus vaccine (RV) at its current (year) price saved between $131 and $1065. Doubling and tripling the thermostable rotavirus price resulted in cost savings ranging from $102 to $936 and $73 to $808, respectively. Switching to thermostable formulations was highly cost-effective or cost-effective in most scenarios explored.
Conclusion: Medical cost and productivity savings could outweigh even significant price premiums charged for thermostable formulations of vaccines, providing support for their use.

1. Introduction

While our previous work has shown that replacing existing vaccines with thermostable vaccines can relieve bottlenecks in vaccine supply chains and thus increase vaccine availability [1], the question remains whether this benefit would outweigh the additional cost of thermostable formulations. All World Health Organization (WHO) prequalified vaccines currently require storage in refrigerators or freezers as exposure to higher temperatures may result in the denaturation of the proteins in the vaccine rendering them impotent. However, many vaccine supply chains in low- and middle-income countries have shortages in refrigerated (or even lower temperature) storage and transport capacity to accommodate all of the vaccine doses that must eventually make it to the population [2,3]. Making certain vaccines thermostable would allow these vaccines to be stored outside refrigerators or freezers, thus freeing up space for vaccines that still require cooler or cold temperatures. More vaccine doses reaching the population can protect more mothers and children from infectious diseases, thus saving medical costs and productivity losses. However,

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Table 1
Vaccine characteristics.

Vaccine	Benin					Bihar, India					Niger				
	Doses per person*	Doses per vial*	Packed volume per dose vaccine (mL)†	Packed volume per dose diluent (mL)†	Price per vial (USD)‡	Doses per person§	Doses per vial§	Packed volume per dose vaccine (mL)§	Packed volume per dose diluent (mL)§	Price per vial (USD)§	Doses per person**	Doses per vial**	Packed volume per dose vaccine (mL)†	Packed volume per dose diluent (mL)†	Price per vial (USD)‡
BCG	1	20	1.2	0.7	1.6	1	10	1.2	0.7	0.52	1	20	1.2	0.7	1.6
Measles (M)	1	10	3.5	4	2.8	2	5	5	4	0.83	1	10	3.5	4	2.8
Oral polio (OPV)	4	20	1	0	2.6	5	20	1	0	1.24	4	20	1	0	2.6
Pneumococcal conjugate (PCV)	3	1	12	0	5.52	3	5	5	0	17.1	3	1	12	0	5.52
Pentavalent	3	2	11	0	3.88	3	10	5.3	0	21.86	3	1	16.8	0	2.32
Rotavirus (RV)	2	1	17.1	0	1.88	3	10	3.2	0	10.36	2	1	17.1	0	1.88
Tetanus toxoid (TT)	2	10	3	0	0.8	4	10	3	0	0.21	2	10	3	0	0.8
Yellow fever (YF)	1	10	2.5	6	11.9	–	–	–	–	–	1	10	2.5	6	11.9
Hepatitis B (HepB)	–	–	–	–	–	1	10	3.8	0	0.52	–	–	–	–	–
Diphtheria-tetanus-pertussis vaccine (DTP)	–	–	–	–	–	2	10	3	0	0.41	–	–	–	–	–
Inactivated polio (IPV)	–	–	–	–	–	1	10	2.46	0	10.36	–	–	–	–	–
Japanese encephalitis (JE)	–	–	–	–	–	2	5	3	2.9	0.93	–	–	–	–	–

* *Source:* Benin CMYP [17].
† *Source:* WHO Vaccine Volume Calculator; WHO Prequalified Vaccines Database [18].
‡ *Source:* cMYP Costing Tool 3.6; UNICEF Product Menu [19].
§ *Source:* Personal communications with INCLEN.
** *Source:* Niger cMYP [20].