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Landscaping the structures of GAVI country vaccine supply chains and testing the effects of radical redesign

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ABSTRACT

Background: Many of the world's vaccine supply chains do not adequately provide vaccines, prompting several questions: how are vaccine supply chains currently structured, are these structures closely tailored to individual countries, and should these supply chains be radically redesigned?
Methods: We segmented the 57 GAVI-eligible countries' vaccine supply chains based on their structure/morphology, analyzed whether these segments correlated with differences in country characteristics, and then utilized HERMES to develop a detailed simulation model of three sample countries' supply chains and explore the cost and impact of various alternative structures.
Results: The majority of supply chains (34 of 57) consist of four levels, despite serving a wide diversity of geographical areas and population sizes. These four-level supply chains loosely fall into three clusters [(1) 18 countries relatively more bottom-heavy, i.e., many more storage locations lower in the supply chain, (2) seven with relatively more storage locations in both top and lower levels, and (3) nine comparatively more top-heavy] which do not correlate closely with any of the country characteristics considered. For all three cluster types, our HERMES modeling found that simplified systems (a central location shipping directly to immunization locations with a limited number of Hubs in between) resulted in lower operating costs.
Conclusion: A standard four-tier design template may have been followed for most countries and raises the possibility that simpler and more tailored designs may be warranted.

1. Introduction

Many countries across the world may be outgrowing their current vaccine distribution systems [1–6]. Designed in the 1970s, these vaccine supply chains (i.e., the series of steps, processes, locations, vehicles, and personnel involved in getting vaccines from initial delivery into a country all the way to the people) have long provided life-improving and life-saving vaccines to the world's populations, thus preventing countless disease cases and deaths and saving health care costs and productivity losses [7–16]. However, all innovations eventually require updating. Are the same supply chain designs applicable today or are they outdated with continuing population growth, expanded target populations, and new vaccine introductions (NVIs) to different countries' World Health Organization (WHO) Expanded Program on Immunization (EPI) schedules? Indeed, evidence suggests that supply chain limitations are preventing many mothers and children from getting vaccinated [17–21]. This situation could grow worse throughout this decade, dubbed the "Decade of Vaccines" by Bill and Melinda Gates for an unprecedented number of planned NVIs which have led to development of the Global Vaccine Action Plan (GVAP). Delivery problems also waste significant resources that have been invested in developing and manufacturing vaccines.

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