VACCINE DELIVERY SYSTEMS:
A SEARCH FOR OPTIMIZATION IN LOW-INCOME NATIONS

Introduction to Vaccine Delivery Systems

In the words of Bill Gates, “health is an enabler.” [1] meaning that through improving global health, nations and the individuals within them can attain their full potential. In industrialized nations, healthcare is regarded primarily as an issue of cost, but in low-income nations, factors as fundamental as accessibility and storage prove to be major pieces in a healthcare system that is not easily attained. A specific piece of the health care puzzle that needs to be improved is the vaccine delivery system. When regarding these systems, industrial engineers have the specific skills necessary to optimize relevant factors and minimize costs in order to promote and create efficiency. Given major problems faced by current vaccine delivery systems in the areas of delivery, infrastructure and human resources, and financing, industrial engineers and other experts in this field are working to create better vaccine delivery systems in low-income nations across the globe. Through the use of mathematical models, new and developing technologies, and cost and benefit analysis, these systems are constantly under improvement, always being optimized to find the most efficient design. The vaccine delivery systems that will be discussed represent a major and essential piece of global healthcare. Through improving these systems in low-income nations, benefits will be reaped in health, societal, and economic facets of life for people. With continued improvement and analysis of these systems, there is hope that one day all people will have consistent access to vaccines.

Sustainability

Optimized vaccine delivery systems will improve quality of life because they will prevent mortality, especially in children, making the improvement of vaccine delivery systems a sustainable process. countries. Other important aspects of sustainability have to do with economic and social benefits, which contribute to a better quality of life as well. Economically, prevention of disease creates higher life expectancies and more savings. Prevention of disease can be difficult when it comes to cost. Although traditional vaccines are typically low in price, only costing about $1 per vaccine, 20 million infants died because they did not receive the third dose of either diphtheria, pertussis, or tetanus. Vaccines are also becoming more expensive as they become more advanced. GAVI’s Financial Sustainability Plans estimate “the cost of fully immunizing a child to increase from $10 to $20” [17]. With help from donors and organizations such as the Bill and Melinda Gates foundation, these costs can be minimized so children can receive their vaccines and quality of life can be extended. Bill and Melinda both note that people in high-income nations do not realize that there are people dying because of lack of access to vaccines, and that is why they have donated seven billion dollars towards the improvement of these systems.

Problems and Solutions to Major Factors in Vaccine Delivery Systems

<table>
<thead>
<tr>
<th>Problems</th>
<th>Solutions</th>
<th>Problems</th>
<th>Solutions</th>
<th>Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccine Delivery Systems</td>
<td>Delivery systems of routine, regularly available vaccinations versus short, targeted campaigns of vaccination</td>
<td>Infrastructure and Human Resources</td>
<td>Positive correlation between number of vaccination sites and number of vaccines delivered</td>
<td>Financial Mechanisms</td>
</tr>
<tr>
<td>Vaccine Delivery Sites</td>
<td>Delivery locations such as schools, healthcare centers and a combination of the two</td>
<td>Vaccine Distribution Chain of Care</td>
<td>Integrating aspects of vaccine delivery systems into existing supply chain systems</td>
<td>Vaccination Costs</td>
</tr>
<tr>
<td>Vaccine Storage</td>
<td>Updated equipment capable of adjusting to growth in demand</td>
<td>Vaccine Demand</td>
<td>Low-cost secure and smaller amount of missed wages by workers constitute concrete economic benefits</td>
<td>Vaccine Funding</td>
</tr>
<tr>
<td>Vaccine Storage</td>
<td>Need to reduce reliance on the “cold chain”</td>
<td>Vaccine Demand</td>
<td>Increase of available jobs and human capital in the long run</td>
<td>Vaccine Funding</td>
</tr>
</tbody>
</table>

Applying Industrial Engineering Techniques

A huge way that engineers are currently working to solve the issue of vaccine delivery systems is through systems modeling. A mathematical model has been created to optimize the vaccine delivery system to low-income countries. This figure encompasses only one tenth of the entire model, but it is a good representation of the complexity and variables the model entails. The main goal of this model is to give vaccines to all first-year children in all locations of the poorest countries. The first objective of the mathematical model will give the correct amount of doses of each vaccine in each specific delivery. If there is space leftover for more vaccines that might not necessarily be in demand at the time, there will still be extra vaccines sent in case of spoilage or delivery problems. This objective will optimize space and ensure that demand will be met, because the time of delivery, demand could change.

The next part of the mathematical model lists some constraints of the storage devices. The model accounts for space taken up by other substances in the fridges, such as diliems. The model will calculate exactly how much of a vaccine can be stored in each refrigeration device, ensuring no vaccinations are wasted from the delivery to the storage step.

Meeting demand is an essential part of the vaccine delivery system, and this mathematical model accounts for this. The model is based on data of specific populations and their demand for a specific vaccine. To ensure demand is met properly, the delivery process and storage steps must be efficient. The model ensures that the volume of a vaccine will not exceed the storage capacity of a transfer vehicle. Once the vaccine is delivered, the mathematical model accounts for space in vaccine refrigeration devices. Finally, and most importantly, the model accounts for every child who needs a vaccine and ensures they receive it.

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The Future of Vaccine Delivery Systems

It is tremendously clear that the complex and multi-faceted nature of vaccine delivery systems makes them a very difficult puzzle to solve. Every step in the chain is unique, and comes with its own individual set of problems and solutions. By examining each step in the chain and looking for solutions through the use of mathematical models, graphs, analysis and countless other methods, vaccine delivery systems are slowly becoming improved and redesigned step by step. As healthcare continues to evolve, the system that distributes and manages vaccine delivery will need to be adapted right along with the changing healthcare system. Industrial engineers will be on the forefront of these continued changes, improving vaccine delivery systems in low-income nations throughout the globe. The quest for a perfectly efficient vaccine delivery system will never end, and industrial engineers will continue to solve these issues, piece by piece.

Vaccine Delivery Costs

Funding Gap for Vaccinations