Sustainable viral load monitoring scale-up: geospatial optimization model for Zambia
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Objective

\begin{itemize}
  \item To design a geospatial optimization model to minimize the cost of a national viral load sample transportation network (STN) in Zambia.
\end{itemize}

Background

\begin{itemize}
  \item Viral load testing is the WHO-recommended method for routine monitoring of HIV infected patients on ART.
  \item In many countries, the expansion of viral load testing has been slow due to cost and a lack of laboratory facilities and blood sample transport networks.
  \item Zambia is rapidly expanding its ART program and anticipates that 1.5 million viral tests will be needed in 2020.
  \item A primary barrier to widespread viral load test access in Zambia is lack of an efficient sample transport network.
\end{itemize}

Method

\begin{itemize}
  \item A model was developed to optimize an STN in Zambia taking into account geography, infrastructure, and district political boundaries. Data incorporated included:
    \begin{itemize}
      \item The location of all 2,500 Zambian health facilities and laboratories
      \item Lab and hub infrastructure and capacity (a hub collects samples for transport to a lab)
      \item Driving distances and times for vehicles
      \item Expected future viral load demand by health facility.
    \end{itemize}
  \item We evaluated the all-inclusive STN costs of two alternative scenarios (illustrated in Figure 1):
    \begin{itemize}
      \item Scenario 1: An optimized, district-based STN, where each district provides its own weekly or daily sample transport for the anticipated viral load volume, as is currently done
      \item Scenario 2: An optimized national borderless STN that ignores district boundaries, provides weekly or daily sample transport, and reaches the same facilities/viral load volumes as Scenario 1.
    \end{itemize}
\end{itemize}

Table 1. Description of district-based and nationally optimized sample transport networks

<table>
<thead>
<tr>
<th>Value</th>
<th>District-based optimization</th>
<th>National optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of facilities reached</td>
<td>800</td>
<td></td>
</tr>
<tr>
<td>Anticipated weekly viral load</td>
<td>29,842</td>
<td></td>
</tr>
<tr>
<td>Total weekly kilometers traveled</td>
<td>96,849</td>
<td>60,675</td>
</tr>
<tr>
<td>Number of vehicles needed</td>
<td>111</td>
<td>57</td>
</tr>
<tr>
<td>Number of motorbikes needed</td>
<td>162</td>
<td>14</td>
</tr>
</tbody>
</table>

Results

\begin{itemize}
  \item Under both scenarios, coverage of viral load testing would increase from 10% in 2016 to 91% in 2020. Figure 1 illustrates
  \item Mean transport cost per viral load is 52% less in the national borderless versus district-based optimization
    \begin{itemize}
      \item $2.10 per test (SD $0.27) for national transport
      \item $4.40 per test (SD $0.70) for district-based transport
    \end{itemize}
  \item When fully scaled-up to the anticipated 2020 volumes, the borderless system would save the government of Zambia $3,541,000 annually (SD $657,000) compared to the district-based system. (Figure 2)
  \item This saving is primarily due to a reduction in the number of vehicles and drivers needed, along with more efficient routes enabled by intra-district routing. (Table 1)
\end{itemize}

Conclusions

\begin{itemize}
  \item An efficient sample transport network that optimizes sample transport on the basis of geography and test volume, rather than political boundaries, can cut the cost of sample transport by more than half.
  \item This provides a rare opportunity for increased efficiency in an era where cost-savings, particularly in HIV care, are increasingly difficult to come by.
  \item This model has the potential to increase the sustainability of ART programs throughout Africa.
\end{itemize}

Figure 1. Map depicting an optimized viral load sample transportation network in Zambia, district-based optimization versus national optimization

Figure 2. The average annual operating cost of an optimised viral load sample transportation network in Zambia, borderless and by district

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