Reviewer's report

Title: Characterizing measles transmission in India: a dynamic modeling study using verbal autopsy data

Version: 0 Date: 05 Jan 2017

Reviewer: Matthew Ferrari

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In this manuscript the authors conduct an analysis of 3 years of measles mortality records to estimate both the CFR and the total burden of measles mortality in India (and specific analyses for UP and Bihar). The authors also make estimates of the number of measles deaths averted by vaccination activities over 2000-2015.

As the authors point out, estimates of measles CFR are woefully lacking in the literature; so this manuscript provides much needed information. While I am sympathetic to the need for this kind of work, and have no fundamental issues with their approach of using spectral density to match model predictions to observations, I have significant reservations about the ability of such short time series (~3 years) to have the power to identify the parameters of a dynamic model — in particular the seasonality.

Measles classically illustrates cycles with an integer-year period (e.g. annual, biennial, etc.). That the authors identify an annual signature is not at all surprising; but it is would be nearly impossible (I believe) for them to identify any other multi-annual signatures from such short time series (e.g. the classic biennial cycles seen in the England and Wales time series would only be observable here as 1.5 cycles). Given the realities of limited data, this does not necessarily disqualify this work, but certainly suggests that the authors illustrate that the methods they are using have the power to discriminate the phenomena they are inferring. I might suggest a simulation approach, where the authors simulate data (cases from a SIR model, and then deaths at some CFR & reporting rate) and take a time series of length equal to the data that they used, and illustrate that they can indeed, reasonably estimate the R0, seasonality, and CFR. With this illustrated, it would be much easier to believe that the relevant measures can be estimated from the spectral analysis of the observed data.

In general, I would like to see some clearer presentation of the methods and the coherence plots (e.g. Fig 4, which will be non-standard for most readers). The methods text suggests that the authors simulated data from a grid of R0 and seasonal amplitudes, and compared the resulting spectra to that from the data — chasing the closest spectra as the "best fit" parameters. The
resulting time series of cases was then compared to the observed time series of mortality to get a CFR. First, I would caution that this implies an observed CFR, as it is possible that deaths were not recorded, and this should be discussed. Second, it is unclear how the reader is meant to interpret the coherence plots (e.g. Fig 4): from the statement in the methods, the coherence should be a function of R0 and the amplitude (as illustrated in Figure 3), its unclear what a relationship between that coherence and CFR is supposed to mean. I also believe that the legend misstates the dashed lines — as it indicates that the red line indicates the "best" CFR, though it is parallel with the CFR axis (the legend in the supplement appears to be correct). Again, given that it appears that only R0 and amplitude directly relate to coherence, I find that these figures are not entirely informative.

While I appreciate the authors' claim to novelty by using mortality records, I wonder if case notification data are not also available for this time period, or perhaps for a longer time period. The argument would be significantly strengthened if the estimates for the dynamic model could be made using longer time series.

Minor points:

1. Please clarify the functional form of the seasonality. Was this a sin function?

2. Please define R0 for your model. It appears that DynaMICE is just a standard SIR model, but without a formal statement it is hard to know how R0 is calculated. Assuming the model is simply an SIR model, then it would be good to give the equations in the appendix so that readers don't have to go to the 2015 Vaccine paper to see the model.

3. What was the mixing matrix used? POLYMOD? homogeneous mixing?

4. In Figure 3, please indicate the Ro and amplitude that has best coherence -- and the confidence region.
Are the methods appropriate and well described?
If not, please specify what is required in your comments to the authors.

No

Does the work include the necessary controls?
If not, please specify which controls are required in your comments to the authors.

Yes

Are the conclusions drawn adequately supported by the data shown?
If not, please explain in your comments to the authors.

No

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