New model predicts Ebola epidemic in Liberia could be ended by June 2015

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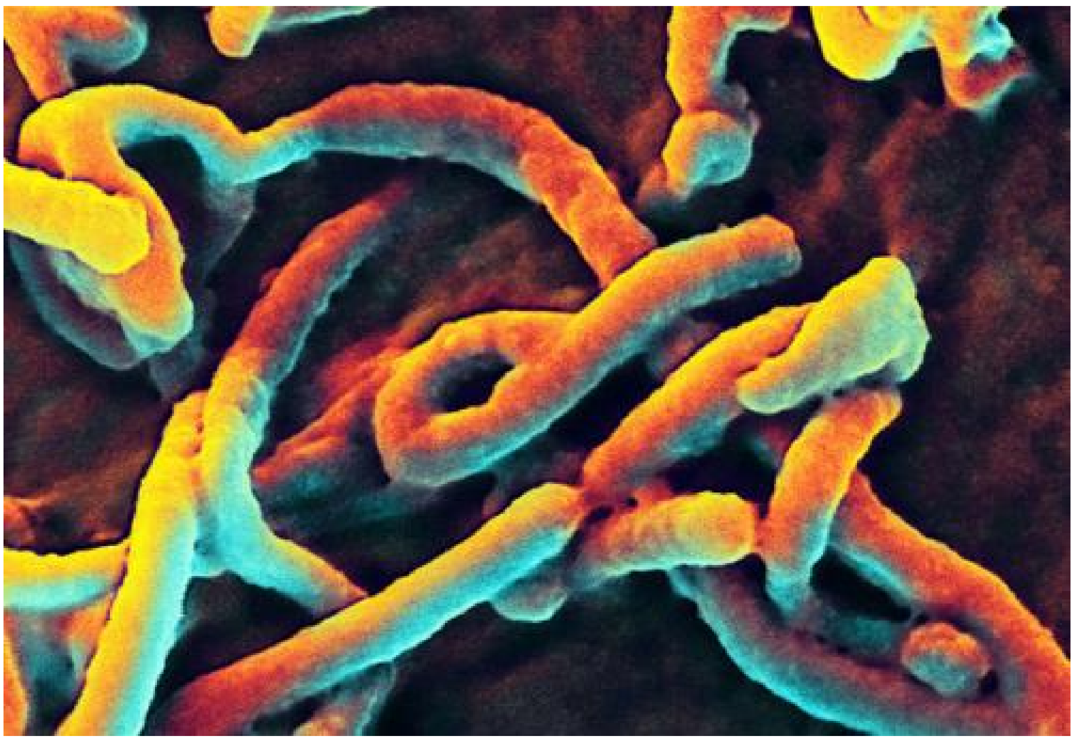

A scanning electron micrograph of Ebola virus budding from a cell (African green monkey kidney epithelial cell line). Credit: NIAID

The Ebola epidemic in Liberia could likely be eliminated by June 2015 if the current high rate of hospitalization and vigilance can be maintained, according to a new model developed by ecologists at the University of Georgia and Pennsylvania State University.

The model includes such factors as the location of infection and treatment, the development of hospital capacity and the adoption of safe burial practices and is "probably the first to include all those elements," said John Drake, an associate professor in the UGA Odum School of Ecology who led the project. The study will appear in the open access journal *PLOS Biology* on January 13.

Drake said that the UGA model should be useful to public health officials as they continue to combat the Ebola epidemic because it offers both general insights and realistic forecasts, something few models are able to do.

The authors ran the model for five different hospital capacity scenarios. For the worst case, with no further increase in hospital beds, the median projection was for 130,000 total cases through the end of 2014; for the best case—an increase of 1,400 more beds, for roughly 1,700 total or an 85 percent hospitalization rate—the median projection was 50,000 cases. After updating the model to include more recent information collected through Dec. 1, the model projected that, if an 85 percent hospitalization rate can be achieved, the epidemic should be largely contained by June 2015.

"That's a realistic possibility but not a foregone conclusion," Drake said. "What's needed is to maintain the current level of vigilance and keep pressing forward as hard as we can."

Epidemic modeling is an important tool that helps public health officials design, target and implement policies and procedures to control disease transmission, and several models of the 2014 Ebola epidemic have already been published. According to Drake, many of these models seek to estimate the disease's reproductive number—the number of new cases that one infected individual can generate.

"This is useful because it says how far transmission must be reduced to contain the epidemic," he said. "Our model does this too, but it does other stuff as well. It aims to be intermediate in complexity—it captures all the things we think to be most important and ignores the rest."

Those important variables include infection and treatment setting, individual variation in infectiousness, the actual build-up of hospital capacity over time and changing burial practices. The researchers used a mathematical formulation known as branching processes—a method for keeping track of all possible epidemic outcomes in proportion to their probabilities—calibrated with newly developed methods.

To build this more complex model, Drake and his colleagues started with information gleaned from earlier Ebola outbreaks. They included data about variables such as the numbers of patients hospitalized health care workers infected, which allowed them to estimate the level of under-reporting; rates of transmission in hospitals, the community and from funerals; and the effectiveness of infection control measures.

Once they had a working model with plausible parameters, they fine-tuned it using data from the World Health Organization and the Liberia Ministry of Health for the period from July 4 through Sept. 2, 2014. This included information about new cases as well as changes in behavior and public health interventions during that time, such as the addition of roughly 300 hospital beds and the adoption of safer burial practices.

Liberia continued to add hospital beds after Sept. 2, so in mid-December, Drake and his team updated the model to include information collected through Dec.1. Using reported data rather than estimates from the earlier version of the model significantly cut down on the range of future possibilities, showing that the response by the Liberian government and international groups had greatly reduced the likelihood of a massive epidemic.

The model should prove useful beyond the current Ebola crisis, Drake said. "We introduced a new method for model fitting—the method of plausible parameter sets—that could be used in future rapid response scenarios."

Plausible parameter sets use recorded data that falls within the range of possibilities generated by the model at least 500 times, meaning that the model "fits" the data closely. This keeps the model's projections in line with observed reality, making it particularly useful for investigating a wide range of realistic potential interventions and accounting for the impacts of human behavior on disease transmission.

More information: Drake JM, Kaul RB, Alexander LW, O'Regan, SM, Kramer AM, Pulliam JT, et al. (2015) Ebola Cases and Health System Demand in Liberia. *PLoS Biol* 13(1): e1002056. DOI: 10.1371/journal.pbio.1002056

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