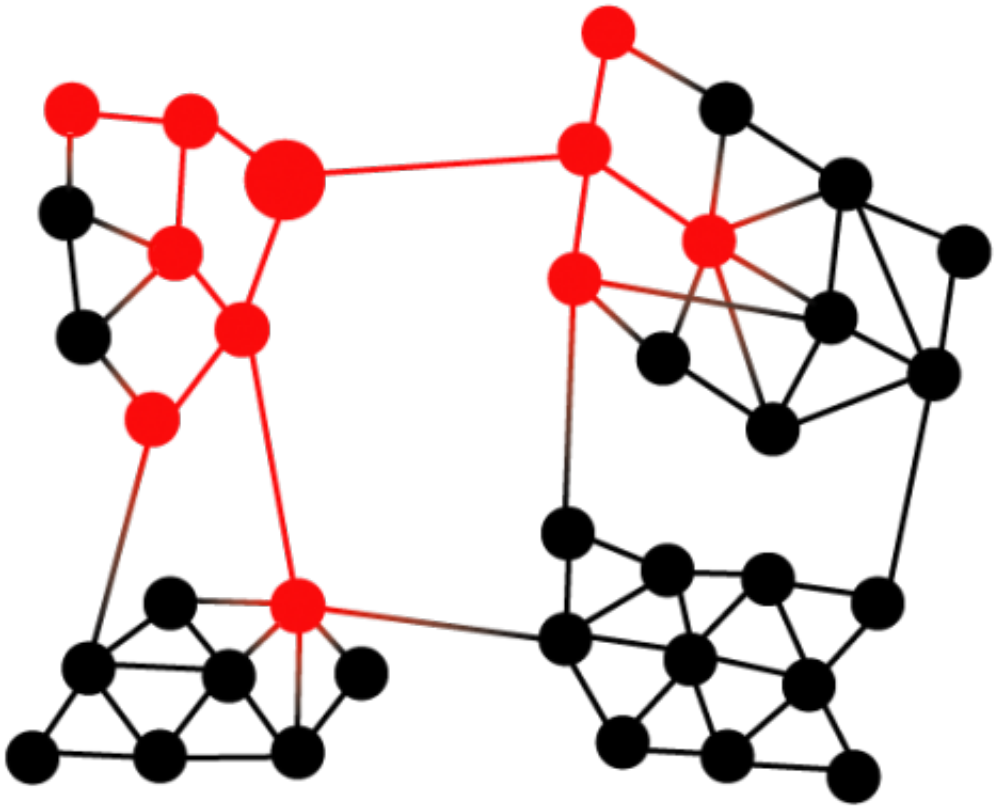
# A multiscale approach to Ebola response

September 22 2014



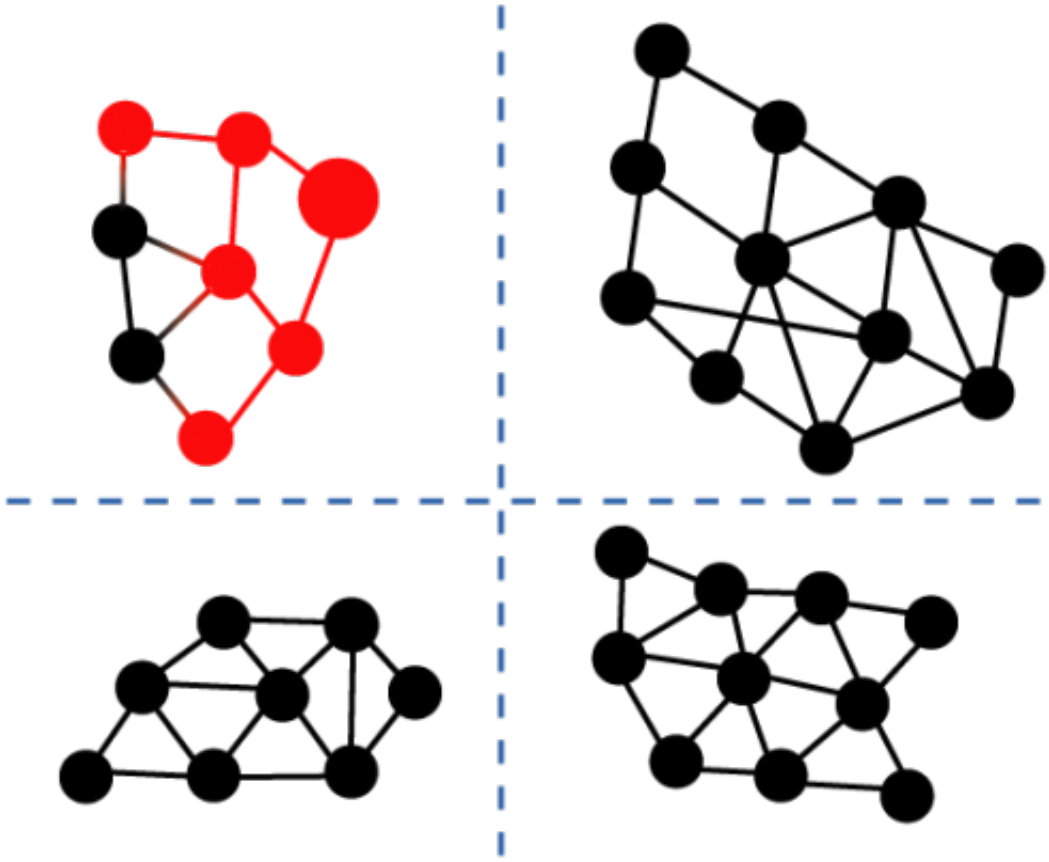
Unregulated contact between networks allows infection to spread quickly from one infected individual (large red node).

The Ebola outbreak in western Africa continues to spread uncontrolled, affecting thus far five countries. On September 16th, President Obama spoke at the Centers for Disease Control and Prevention headquarters in Atlanta and pledged a dramatically higher involvement: funding,

providing supplies and beds and a military command center in Liberia. 3000 military personnel will be on the ground to help train and coordinate thousands of healthcare workers. However, treating patients is not enough. The success of this, or any, intervention depends on stopping the spread of the disease.

The key to stopping the disease is dramatically reducing the likelihood that one case leads to others. The standard approach is to find and isolate infected individuals, check on those they have been in contact with and monitor them to see if they contracted the disease. Finding all those who are infected in impoverished urban populations, and tracing all of the people they have been in contact with is difficult or impossible. Missing even one can have devastating consequences as the disease spreads and then spreads again.

In addition to focusing on isolating sick individuals, we should reduce the number of contacts that are happening. A particularly effective strategy is preventing the spread of disease to groups that are not already infected. This can be done by introducing selective boundaries between regions and enforcing checks at those boundaries. Like the use of quarantines before the age of modern medicine, this is a very effective strategy when treatment doesn't stop a deadly disease from spreading. A complex systems analysis shows why—-decreasing the connectivity between strongly connected parts of a system dramatically decreases contagion. Instead of just thinking about individuals that are sick or not, we need to think about groups and regions that are affected or not.



Restricting interactions between exposed and unexposed populations prevents additional transmission.

One example of such a strategy already in use is checking people for symptoms when they board airplanes. When the incubation period is 21 days this is not enough, but it is a start. Boundaries between city neighborhoods and between parts of a country that require extra checks or delays can dramatically reduce the rates of infection by preventing contagion from spreading to entire areas of the country. Then the healthcare workers identifying individuals who are infected can focus on those areas that have infections in them. The disease can be eradicated by progressively isolating it to smaller and smaller regions, exactly the opposite of the current dynamic of spreading to larger and larger areas.

Even the healthcare workers may make matters worse rather than better in some contexts. Despite taking many precautions, healthcare workers are often infected or can carry infected materials from one place to another, leading to new cases. Contact with and among healthcare workers should have tight restrictions. As few people as possible should be in direct contact with infected individuals and those who have to be in contact with them.

Implementing a response in West Africa faces a number of significant challenges. The limited healthcare infrastructures of several countries have collapsed under the strain of Ebola. Any new system must involve new facilities, supplies and the training of local workers.

Even the question of how to train the workers requires careful thought. The current plans according to President Obama would involve training a reported 500 new health workers per week. But this linear increase in the number of workers may be overcome by an exponentially growing number of cases. The only way to ensure that an exponentially growing number of cases are treated is by an exponentially growing number of workers. This means that a fraction of every cohort of new trainees must become trainers themselves so that the number of trainers grows and the number of trainees grows accordingly.

With 40 percent of all infections having occurred in just the past few weeks, this epidemic has outpaced all existing response efforts. Any proposed solution must be enough to contain the infection not as it is now, but as it may become in the time needed to implement the solution. When exponential growth is in effect, under-response is effectively no response at all. The World Health Organization's estimated cost as of Sept 16 is $1 billion, just a couple of weeks after it cited $600 million. Surely much more than "just enough" should be allocated because failure to contain would mean the number of deaths will continue to grow exponentially, and the economic and social costs would continue to grow

to require many fold the current level of effort.

The Ebola outbreak is complex and deadly. Those in the West like to think they are safe; and policymakers are striving to prevent panic by reassuring them. But even if the virus remains in the developing world, allowing its spread to continue unchecked will have profound global consequences. A rapid response is needed, but it must also be a deliberate one if it is to do any good.

**More information:** M. Hardcastle and Y. Bar-Yam, "Effective Ebola Response: A Multiscale Approach." New England Complex Systems Institute (Sep 19, 2014).

Provided by New England Complex Systems Institute