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Comment

Public health impact of disease–behavior dynamics Comment on "Coupled disease–behavior dynamics on complex networks: A review" by Z. Wang et al.

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In a loop of dynamic feedback, behavior such as the decision to vaccinate, hand washing, or avoidance influences the progression of the epidemic, yet behavior is driven by the individual's and population's perceived risk of infection during an outbreak. In what we believe will become a seminal paper that stimulates future research as well as an informative teaching aid, Wang et. al. comprehensively review methodological advances that have been used to incorporate human behavior into epidemiological models on the effects of coupling disease transmission and behavior on complex social networks [1]. As illustrated by the recent outbreaks of measles and Middle Eastern Respiratory Syndrome (MERS), here we highlight the importance of coupling behavior and disease transmission that Wang et al. address.

In December of 2014, an outbreak of measles arose from a cluster of unvaccinated employees of Disneyland theme parks in California [2]. These infected individuals exposed a large number of people to measles in a short period [2]. This first generation of transmission within the theme park can be modeled with an assumption of homogeneous mixing given the combination of high transmissibility and relatively well-mixed movements of people within the theme park. By contrast, the second generation of infected individuals then disseminated measles as far as Mexico and Canada. Specifically, 15 cases outside California and 11 cases in Mexico and Canada were linked to the outbreak originating from the theme parks [2]. Thus, the spread of infection depended on an interplay between the social network combined with dissemination on a vast geographical scale via by long-distance travel. In this outbreak, the spatial distribution of vaccine refusal led to pockets of unvaccinated regions, which can be enough to spark an epidemic even when coverage is near herd immunity levels overall [3,4]. As the Disneyland outbreak progressed, awareness heightened, shifting perceptions of infection risk in the public and fueling demand for unvaccinated individuals to be vaccinated [5,6]. Conversely, vaccine scares can have the opposite effect in terms of reducing public perceptions of vaccine acceptability, as recently occurred regarding HPV vaccination in Japan. The resulting precipitous drop in coverage will likely have potentially detrimental ramifications for cervical cancer incidence that may be felt for many years to come [7].

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The first case of MERS was reported in Saudi Arabia in June 2012 [8]. Similar to the Severe Acute Respiratory Syndrome (SARS) pandemic in 2003 [9,10], both coronaviruses exhibit super-spreading events in hospital settings [10–12], where super-spreaders are classified as the 20% of the population responsible for 80% of the infections [13]. In these cases, the transmission events for SARS and MERS would be best described using a multiscale network, where edges link hospitals, with individuals interacting within the hospitals. Based on lessons learned from the SARS outbreak, public health officials acted swiftly to reduce the number of MERS super-spreading events within hospitals [14–16]. In this way, the actions of the public health officials, which are themselves based on decision of individuals, are affected by behavioral processes of learning and implementation within the public health sector. Given knowledge acquired from previous experience of substantial SARS transmission within hospitals, control measure were rapidly implemented to contain MERS [17].

These two examples highlight the importance of coupling behavior and disease systems. Coupled disease–behavior network models will also provide insight into the complex interaction of behavior and epidemiology. As suggested by Wang et al [1], directions forward to improve the realism, applicability and public health value of prediction behavioral epidemiological models include using empirical data and inter-disciplinary collaborations with behavioral scientists and epidemiologists. With these collaborations, we can work with public health officials to improve policies and mitigate future outbreaks.

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