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Science Should Drive Vaccine Policy

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Using agent-based modeling, Sinclair et al[1] have demonstrated the risk that many Texas children face because of their classmates' religious or philosophical exemptions from measles vaccination. In Texas, vaccine exemption rates have increased 28-fold since 2003, and Texas allows for exemptions "for reasons of conscience," which include religious and philosophical objections to vaccinations.[2] Because of these exemptions, others have warned that many Texas cities are at risk of measles outbreaks.[3] Several cities in Texas were previously identified as possible hotspots for outbreaks of vaccine-preventable diseases,[4] including Houston, Fort Worth, Plano, and Austin. The article by Sinclair et al[1] examines just how large these outbreaks could be given current vaccination rates, finding that epidemics of up to several hundred children could occur. Further, they note that while the group that is unvaccinated would have the most cases, bystanders—including those for whom vaccination failed and students who are medically exempt—would also be susceptible, demonstrating the importance of herd immunity to protect those who do not respond to vaccines or who cannot be vaccinated.

Nevertheless, these results must be considered with some caution. Although agent-based models describe heterogeneity well in populations for which highly granular data (eg, individual-level data) are available, these models are prone to assumptions that may not reflect real-world conditions when such data are not available (as noted by Sinclair et al[1] in their Discussion). Further, the authors' choice to use the basic reproduction number (R_O) to run their model likely yielded higher simulated outbreak sizes than would have been estimated if the more appropriate effective reproduction number (R_{Eff}) had been used instead. Unlike R_O, which describes the number of infections that a case will cause in a fully susceptible population, R_{Eff} describes the number of infections that a case will cause in a population that is not fully susceptible (ie, a population in which some fraction has been effectively vaccinated, such as the state of Texas).

However, as partial empirical validation for the modeling method employed by Sinclair et al,[1] Texas has already seen 18 cases of measles in 12 counties from January to mid-July 2019. Indeed, 2019 has been a record year for measles infections in the United States, with 1123 cases reported as of July 11,[5] the largest nationwide annual count since 1992.

What can be done to prevent this outcome? Although the authors did not include interventions in their model, we can consider 2 aspects of prevention: that which takes place in the midst of an epidemic and that which occurs otherwise. During an epidemic, strict public health interventions may be put in place. During outbreaks of measles, cases are typically isolated, and those who have been exposed are subject to quarantine. In New York, New York, these measures were not enough to stop the outbreak that began in October 2018; unvaccinated children were banned from schools, and mandatory vaccination orders for measles were put in place.[6]

An outbreak situation may also encourage individuals to catch up on vaccinations. During Ohio's 2014 measles outbreak in the Amish population, more than 10 000 individuals were vaccinated with the measles, mumps, and rubella vaccine[7]; similarly, more than 50 measles cases in early 2019 led to a 10-fold spike in measles vaccinations in Washington.[8]

The more challenging aspect of prevention is maintaining vaccination rates in the absence of ongoing epidemics, which is complicated by the continued spread of misinformation about vaccines. Texas is an unfortunate leader in this aspect and the current home of Andrew Wakefield, the researcher whose fraudulent 1998 study first erroneously linked the measles, mumps, and rubella

vaccine to autism.[9] Texas is also home to an effective antivaccine lobbying group, Texans for Vaccine Choice, which has worked to curtail any changes in legislation regarding vaccine exemptions in the state.

Countering such antivaccine rhetoric is not a simple task. Research into the factors driving vaccine hesitancy has not led to any easy answers or readily scalable interventions.[10] As such, many in public health are looking to change state laws regarding vaccine exemptions to increase vaccination rates. Mississippi and West Virginia have long allowed only for medical exemptions; religious and/or philosophical exemptions to vaccines are present in other states. California became the third state to eliminate nonmedical exemptions in 2015 with the passage of California Senate Bill 277 following the Disneyland measles outbreak in 2014 to 2015. Because of the 2019 measles epidemic, Maine and New York have similarly modified their vaccine laws, removing nonmedical exemptions. We suggest that studies like Sinclair et al[1] may aid legislators in making these changes proactively, before such outbreaks are experienced.

ARTICLE INFORMATION

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