Measles Vaccination Coverage and Cases among Vaccinated Persons

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To the Editor: In December 2014, a measles outbreak that had started at Disneyland Park in Anaheim, California, USA, and subsequently spread to numerous states garnered substantial media attention in the United States. In 2014, the US Centers for Disease Control and Prevention reported the highest number of measles cases (644) since the disease had been declared eliminated from the United States in 2000 (1). This number is still relatively lower than the numbers reported from 30 countries of the European Union and the European Economic Area; the highest numbers of measles cases in 2013 were from the Netherlands (2,499 cases), Italy (2,216), the United Kingdom (1,900), and Germany (1,772) (2). There is widespread concern that increasing hesitancy to vaccinate one can derive a simple quantitative relationship between vaccination coverage with \( \alpha \) and vaccine effectiveness of \( \alpha \), the proportion of persons who were susceptible to measles infection is \( 1 - \alpha v \). If all susceptible persons are at the same risk of getting infected, the proportion of vaccinated persons among all case-patients will be \( v(1 - \alpha)/(1 - \alpha v) \). This equation is similar to the screening method that has been used to calculate vaccine effectiveness on the basis of the proportion of case-patients who were vaccinated and vaccination coverage (5). Perhaps somewhat counterintuitive at first, the proportion of vaccinated measles case-patients increases with vaccination coverage (Figure).

We hypothesized that the observed proportion of measles case-patients who had been vaccinated can be used to infer the vaccination coverage in a population at risk (Figure). To this end, we assume a vaccine effectiveness of 99% among persons who had received \( \geq 1 \) doses (3,4). In 2013, countries in the European Union/European Economic Area reported 9,708 measles case-patients for whom vaccination status was known (2). Of those, 11.8% had received \( \geq 1 \) doses of measles vaccine. On the basis of the relationship derived above, this proportion corresponds to an expected vaccination coverage of 93.1% who had received \( \geq 1 \) doses, which is consistent with reported numbers. Switzerland reported 3,850 measles case-patients with known vaccination status from August 2006 through June 2009; of these, 7.0% had been vaccinated with \( \geq 1 \) doses (8). The inferred vaccination coverage of 88.3% is very close to the reported national level of 87.0% for receipt of \( \geq 1 \) doses at 2 years of age (8). In contrast, the most recent numbers from the United States suggest that vaccination coverage for receipt of \( \geq 1 \) doses is still well over 90%.

Various complexities might affect the relationship between vaccination coverage in a community and the proportion of case-patients who had been vaccinated. First, we assume a vaccine effectiveness of 99% among persons who received \( \geq 1 \) doses. Other estimates indicate that...
vaccine effectiveness is 92% for persons who received 1
dose and 95% for those who received 2 doses (9). Assum-
ing that vaccine effectiveness is lower shifts the curve
(Figure) to the left and would result in a lower estimate of
vaccination coverage. Second, different numbers of per-
sons who received 1 and 2 doses complicate the identifi-
cation of overall vaccine effectiveness. Third, vaccination
status is unknown for some measles case-patients. The
proportion of nonvaccinated persons among those case-
patients might be higher than that among those known to
be vaccinated, also leading to a lower estimate of vac-
cination coverage. Finally, nonvaccinated persons might
be clustered together, and their risk for infection could
be higher than that for the general population (10). This
scenario would imply that the estimated vaccination cov-
erage does not reflect the general population but instead
coresponds to a clustered subpopulation among whom
vaccination rates are lower. The effects of these com-
plexities warrant further investigation. However, as the
examples demonstrate, a model ignoring those effects is
in good agreement with empirical data.

Our analysis suggests that the number of vaccinated
measles case-patients should be closely followed through
surveillance programs. A continuous decrease in the pro-
portion of measles case-patients who had been vaccinated
over the years could indicate a decrease in vaccination rates.
Conversely, an increase in the proportion of measles case-
patients who had been vaccinated would demonstrate the ef-
effectiveness of ongoing efforts to increase vaccination rates
and could serve as a benchmark toward measles elimination.

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Lassa Virus in Multimammate Rats, Côte d’Ivoire, 2013

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To the Editor: Lassa fever is a zoonosis caused by
Lassa virus (LASV; family Arenaviridae, genus Lassavi-
rus). The primary reservoir of LASV is the multimammate
rat (Mastomys natalensis), which is found throughout sub-
Saharan Africa. LASV outbreaks among humans occur
only in West Africa in 2 noncontiguous areas: 1 in Guinea,
Liberia, and Sierra Leone; and 1 in Nigeria. Rare cases and
evidence of exposure of humans have been documented
in neighboring countries (i.e., Benin, Burkina Faso, Côte
d’Ivoire, Ghana, Mali, and Togo) (1). LASV RNA has been
detected in only 4 patients: 1 in Germany who had trav-
eled in Burkina Faso, Côte d’Ivoire, and Ghana (2); 1 in the
United Kingdom who had returned from Mali (3); and 2 in