

varicella than those vaccinated <5 years previously ($p = 0.016$). The annual rates of breakthrough varicella among children aged 12 months–12 years increased significantly with time since vaccination after adjusting for the effects of age at infection, age at vaccination, and year of infection ($p < 0.01$).

Multiple other studies that examined possible reasons for lower vaccine effectiveness did not find age at vaccination (3–5, 111, 114) or time since vaccination (3, 110, 111) to be associated with vaccine failure. An ongoing study is examining these factors and risk for vaccine failure (127). After 8 years of active follow-up of 7,449 children vaccinated at age 12–23 months, results do not indicate an increased risk for breakthrough disease among children vaccinated at age 12–14 months compared with those vaccinated at age 15–23 months. Moreover, a test for trend revealed no change in the rate of reported breakthrough disease for each additional month of age at vaccination (127).

Two outbreak investigations noted an increased risk for breakthrough disease in children with asthma and eczema (109, 113). In these investigations, the use of steroids to treat asthma or eczema was not studied. Steroids have been associated previously with severe varicella in unvaccinated persons (128–130). Only one retrospective cohort study controlled simultaneously for the effect of multiple risk factors, including the use of steroids, and this study demonstrated no association of risk for breakthrough disease with asthma or eczema (125). However, this study documented an increased risk for breakthrough disease if the child had received a prescription of oral steroids (considered a proxy for taking oral steroids when exposed to varicella) within 3 months of breakthrough disease (adjusted RR [aRR] = 2.4; CI = 1.3%–4.4%) and when varicella vaccination was administered within 28 days of MMR vaccine (aRR = 3.1; CI = 1.5%–6.4%).

Evidence of Immunity

ACIP has approved criteria for evidence of immunity to varicella (Box). Only doses of varicella vaccines for which written documentation of the date of administration is presented should be considered valid. Neither a self-reported dose nor a history of vaccination provided by a parent is, by itself, considered adequate evidence of immunity. Persons who lack documentation of adequate vaccination or other evidence of immunity should be vaccinated.

Historically, self-reporting of varicella disease by adults or by parents for their children has been considered valid evidence of immunity. The predictive value of a self-reported positive disease history was extremely high in adults in the prevaccine era although data on positive predictive value are lacking in parental reports regarding their children (131–133).

BOX. Evidence of immunity to varicella

Evidence of immunity to varicella includes any of the following:

- documentation of age-appropriate vaccination with a varicella vaccine
 - preschool-aged children (i.e., aged ≥ 12 months): 1 dose
 - school-aged children, adolescents, and adults: 2 doses*
- laboratory evidence of immunity[†] or laboratory confirmation of disease
- birth in the United States before 1980[§]
- diagnosis or verification of a history of varicella disease by a health-care provider[¶]
- diagnosis or verification of a history of herpes zoster by a health-care provider

* For children who received their first dose at age <13 years and for whom the interval between the 2 doses was ≥ 28 days, the second dose is considered valid.

[†] Commercial assays can be used to assess disease-induced immunity, but they lack sensitivity to always detect vaccine-induced immunity (i.e., they might yield false-negative results).

[§] For health-care personnel, pregnant women, and immunocompromised persons, birth before 1980 should not be considered evidence of immunity.

[¶] Verification of history or diagnosis of typical disease can be provided by any health-care provider (e.g., school or occupational clinic nurse, nurse practitioner, physician assistant, or physician). For persons reporting a history of, or reporting with, atypical or mild cases, assessment by a physician or their designee is recommended, and one of the following should be sought: 1) an epidemiologic link to a typical varicella case to a laboratory-confirmed case or 2) evidence of laboratory confirmation, if it was performed at the time of acute disease. When such documentation is lacking, persons should not be considered as having a valid history of disease because other diseases might mimic mild atypical varicella.

As disease incidence decreases and the proportion of vaccinated persons with varicella having mild cases increases, varicella will be less readily recognized clinically. A recent study demonstrated that only 75% of unvaccinated children aged 12 months–4 years who reported a positive history of varicella were in fact immune (confirmed by serological testing), compared with 89% of children aged 5–9 years and 10–14 years (134). To limit the number of false-positive reports and ensure immunity, ACIP recommends that evidence of immunity should be either a diagnosis of varicella by a health-care provider or a health-care provider verification of a history of disease rather than parental or self-reporting. The above-cited study demonstrated that 99% of persons aged 15–19 years and 100% of those aged 20–29 years who reported a history of varicella were immune (134). Because serologic evidence of VZV infection has been documented in 96%–97% of U.S.-born adults aged 20–29 years and in 97%–99% of adults aged ≥ 30 years tested during 1998–1999 (12), U.S. birth before 1980 is considered evidence of immunity except for health-care personnel (HCP), pregnant women, and