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Measles in Healthcare Facilities in the United States during the Post-elimination Era, 2001- 2014

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Abstract

Between 2001 and 2014, 78 reported measles cases resulted from transmission in U.S. healthcare facilities and 29 healthcare personnel were infected from occupational exposure, of whom 1 transmitted measles to a patient. The economic impact of preventing and controlling measles transmission in healthcare facilities was $19,000–$114,286 per case.

Keywords

measles transmission; vaccine failure; economic; healthcare personnel; healthcare facilities

Background

Measles is an acute febrile rash illness that is transmitted by direct contact with infectious droplets or by airborne spread. Approximately 8% of measles case-patients experience diarrhea as a complication, 7–9% develop otitis media, 1–6% acquire pneumonia, and 1–2 per 1000 case-patients develop encephalitis[1]. Death occurs in 1–3 per 1000 cases.

Measles was declared eliminated (defined as the interruption of continuous transmission lasting ≥12 months) from the U.S. in 2000 due to high two-dose measles-mumps-rubella (MMR) vaccination coverage, improved measles control in the World Health Organization Region of the Americas, and intensive and rapid public health responses to imported measles cases[2]. However, even in an elimination era, imported cases and limited spread still occur. Due to the severity of measles, it is not uncommon for infected individuals to seek medical care at primary care centers, pediatric offices, emergency departments, or hospitals[3]. Our objectives were to assess during the post-elimination era the frequency of measles transmission in healthcare facilities in the United States, determine the number of healthcare personnel (HCP) infected with measles while at work, evaluate two-dose MMR vaccine failure in healthcare facilities and subsequent spread, and describe the estimated economic burden of measles outbreak responses in U.S. healthcare facilities.

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Methods

We assessed measles surveillance data reported to the National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention (CDC) from January 1, 2001 through December 31, 2014 to determine the number of measles cases transmitted in U.S. healthcare facilities or among HCP. We also searched PubMed from January 2001 through December 2014 using the search terms “measles”, “transmission”, and “vaccine failure” to identify documented instances of individuals with two prior doses of MMR vaccine who became infected with measles and transmitted the virus. We did an additional PubMed search using the search terms “measles”, “economic”, and “health care” to determine the estimated range spent by U.S. healthcare facilities in response to measles case-patients or outbreaks in their facilities. We cross-referenced articles referenced in the above searches that were not captured in the database search.

Results

Between January 1, 2001 and December 31, 2014[1], 1822 measles cases were reported in the U.S. (annual median: 64.5, range: 37–668), of which 504 were imported cases, 1191 were secondary and tertiary cases, and 127 had an unknown source. Of the 1191 secondary and tertiary cases, 78 (6.5%) were transmitted in U.S. healthcare facilities, including 29 cases in HCP who were infected as a result of occupational exposure, of whom 1 transmitted measles to a patient[2] (Table 1). The tertiary transmission from HCP to patient occurred during a measles outbreak in 2008; the vaccination status of the provider was unknown[4]. Of the 29 HCP who were infected with measles, 19 (65.5%) had adequate presumptive evidence of measles immunity which includes: written documentation of vaccination with 2 doses of live measles or MMR vaccine administered at least 28 days apart, laboratory evidence of immunity, laboratory confirmation of disease, or birth before 1957[3][5]. In addition to the 29, there were 5 measles cases among HCP who were either infected outside of work or had an unknown transmission setting. Although we did not include these 5 HCP, they had the potential to pass on measles to their patients or other healthcare providers.

Of the 1822 case-patients, at least 914 (50.2%) sought medical evaluation including clinical diagnosis, supportive care, laboratory testing, or hospitalization, placing HCP and patients at risk for measles exposures. Although some of the case-patients had laboratory specimens collected during home health visits rather than visiting healthcare facilities, these interactions still placed HCP at risk for measles.

Secondary measles transmission from patients to HCP with two-dose MMR vaccine failure has been reported, but has always been a rare event. Often, transmission to a person with two-dose MMR vaccine failure results in modified or inapparent measles. This was

[1]2014 data are through December 31, 2014 and are provisional.

[2]Transmission setting data were available for 1452 (79.7%) of 1822 measles case-patients. Among the 29 HCP who had occupational exposure, data on transmission setting were 100% complete, while among the 5 HCP not included in the analysis, 1 was infected outside of work and 4 had an unknown transmission setting.

[3]For unvaccinated personnel born before 1957 who lack laboratory evidence of measles immunity or laboratory confirmation of disease, healthcare facilities should consider vaccinating personnel with 2 doses of MMR vaccine at the appropriate interval. In outbreaks, 2 doses are recommended for all HCP who do not have other evidence of immunity, including those born before 1957.

described in 2 case studies of modified measles in physicians vaccinated with at least 2 doses of MMR vaccine who were exposed to primary measles cases in 2009[6]. Neither of these physicians had tertiary transmission of measles to their patients. We also did not find any literature describing tertiary measles transmission in healthcare facilities among HCP with two-dose MMR vaccine failure who presented with classic measles symptoms.

The economic impact was described in four U.S. healthcare facilities that implemented a public health response to prevent or control the spread of measles after one or more measles patients sought medical treatment in their facilities. Costs assessed included the number of HCP furloughed, time spent reviewing employee records for evidence of measles immunity, and time spent conducting serologic tests and administering vaccine doses. A healthcare facility in Illinois spent an estimated $19,000 responding to 1 measles case-patient who presented to its emergency department in 2008[7], a medical center in New York spent $63,000 responding to two measles case-patients in 2011($31,500/case)[8], an Indiana healthcare facility spent $113,000 responding to 3 case-patients in 2005($37,667/case)[9], and two Arizona hospitals spent $800,000 responding to 7 measles case-patients in their facilities in 2008 ($114,286/case)[4].

Discussion

Despite being an eliminated disease in the U.S., 1822 measles cases were reported in the U.S. from 2001 through 2014, of which at least 50.2% sought medical evaluation. These cases placed HCP and other patients at risk for measles exposures, and the healthcare facilities at risk for being sites of potential transmission. In recent measles outbreaks, measles was not considered in the differential diagnosis during the patient's arrival at the healthcare facility[4, 6]. Thus, although airborne precautions are recommended when caring for patients with known or suspected measles, which requires placement of suspect or confirmed measles patients into Airborne Infection Isolation Rooms[10], the implementation of these precautions was often either delayed or not done at all. This resulted in the exposure of others in the waiting room, the laboratory, and other common areas in the facility.

Measles is the most contagious of the vaccine-preventable diseases[1]. Patients are infectious 4 days before through 4 days after rash onset. The virus can remain in the air for up to 2 hours after the patient leaves the area. The measles component of the MMR vaccine is approximately 93% effective for 1 dose and 97% effective for two doses[1]. In order to protect HCP against measles, the Advisory Committee on Immunization Practices (ACIP) recommends that all HCP have presumptive evidence of immunity to measles[5]. Documentation of this in the healthcare setting can be facilitated by maintaining accurate HCP vaccination records, particularly electronic records[5]. For additional protection of HCP, ACIP recommended in 2011 that all healthcare personnel caring for patients with suspect or confirmed measles wear respiratory protection at least as protective as an N95 respirator, regardless of presumptive evidence of immunity to measles[5]. This is because transmission has occurred in healthcare personnel who have serologic evidence of immunity or have had two doses of vaccine, although it is a rare occurrence[6, 11].

It has been hypothesized that the absence or reduced severity of measles-related respiratory symptoms, particularly a cough, may result in lower infectivity[12]. Persons with two-dose MMR vaccine failure may be less infectious and transmit less. Some previous investigations have found no evidence that persons with modified or inapparent measles virus infections shed measles virus[12]. Nonetheless, rare instances of secondary or tertiary transmission have been documented in non-healthcare settings among persons with two-dose MMR vaccine failure who have had classic measles symptoms. In New York City in 2011, a two-dose vaccinated theater employee transmitted measles to 4 individuals with presumptive evidence of immunity against measles[13]. In Pennsylvania in 2003, a two-dose vaccinated individual transmitted measles to 2 unvaccinated persons[14]. In Finland in 1989, two-dose vaccinated and unvaccinated primary patients were found to be equally contagious within families[15]. In Wisconsin in 1986, a two-dose vaccinated index patient with classic symptoms transmitted to 13 previously vaccinated (likely 1-dose vaccinated) classmates[16]. These situations are uncommon and do not suggest a need for change in current measles vaccine policy, but they highlight that transmission can occur from two-dose vaccinated individuals.

The U.S. has high population immunity against measles due to the Vaccines for Children Program (a national initiative that entitles uninsured or underinsured children to free vaccine), the 2-dose measles-vaccination schedule, and school-entry vaccination requirements[17]. However, as long as measles remains endemic in many parts of the world, the measles virus will continue to be imported into the U.S. These imports and subsequent exposures have the potential for serious or fatal outcomes in susceptible high risk individuals. There is also the potential to cause significant disruption in healthcare facilities, resulting in substantial response costs. Since many individuals infected with measles seek medical treatment, HCP remain at risk for measles exposures. HCP should be familiar with the signs and symptoms of measles and should obtain a travel history in patients presenting with a rash and fever. Rapid case identification with implementation of airborne precautions, including the use of respiratory protection at least as protective as a NIOSH certified N-95 respirator for patient care[5], is critical.

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Table 1

Measles Cases Transmitted in U.S. Healthcare Facilities, January 1, 2001–December 31, 2014[1]

Year	No. of measles cases transmitted in U.S. healthcare facilities	No. of HCP infected at work	Did HCP transmit measles to patients or other HCP?	Evidence of immunity[2] status of infected HCP
2014	20	11	No	6 had ≥2 MMR doses, 2 had positive titers, 1 had 1 MMR dose, 1 born before 1957, 1 unknown vaccination status
2013	7	3	No	2 had positive titers (1 of whom also had 1 MMR dose), 1 unknown vaccination status
2012	3	1	No	1 had 2 MMR doses
2011	15	6	No	2 had positive titers, 2 were unvaccinated, 1 unknown vaccination status, 1 had 2 MMR doses
2010	1	1	No	1 had 2 MMR doses
2009	9	2	No	2 had >2 MMR doses
2008	13	1	Yes- infected 1 patient	1 unknown vaccination status
2006	1	0	N/A[3]	N/A
2005	3	1	No	1 unvaccinated
2002	4	2	No	1 unvaccinated, 1 born before 1957
2001	2	1	No	1-dose vaccinated
TOTAL	78	29	Yes (Once in 2008)	19 (65.5%) had adequate evidence of measles immunity

[1] 2014 data are through December 31, 2014 and are provisional.

[2] Presumptive evidence of immunity to measles for persons who work in healthcare facilities includes any of the following: written documentation of vaccination with 2 doses of live measles or MMR vaccine administered at least 28 days apart, laboratory evidence of immunity, laboratory confirmation of disease, or birth before 1957 (However, for unvaccinated personnel born before 1957 who lack laboratory evidence of measles immunity or laboratory confirmation of disease, health-care facilities should consider vaccinating personnel with 2 doses of MMR vaccine at the appropriate interval. For unvaccinated personnel born before 1957 who lack laboratory evidence of measles immunity or laboratory confirmation of disease, health-care facilities should recommend 2 doses of MMR vaccine during an outbreak of measles.)

[3] N/A means not applicable.