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Measles transmission among adults with spread to children during an outbreak: Implications for measles elimination in China, 2014

Chao Ma¹, Shaohong Yan¹, Qiru Su¹, Lixin Hao, Shaopei Tang, Zhijie An, Yulong He, Guangfei Fan, Lance Rodewald, Huaqing Wang*

Chinese Center for Disease Control and Prevention, Beijing, China

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ABSTRACT

Introduction: Following implementation of China's 2006–2012 Action Plan for measles elimination, which led to a nadir of measles in 2012, a resurgence started in 2013 that continued into 2014. Measles typically is a disease that mainly affects children. We investigated a community outbreak in 2014 with measles virus transmission among adults without children serving as virus reservoirs. Our investigation highlights adult susceptibility to measles.

Methods: We conducted a retrospective active case search, and analyzed confirmed case data to describe person, place, and time characteristics of the outbreak. All individuals with measles with onset during the first 2 months of the outbreak were interviewed face-to-face to determine source(s) of infection and transmission route (from whom and to whom).

Results: Among the 280 cases, 220 (77.6%) were among ≥ 20 -year-old adults, 24 (8.6%) were among 8–23 month olds, 22 (7.9%) were among < 8 -month-old infants, and the remaining 14 (5.9%) were among 2–19 year olds. Of the 83 cases in the early stage of the outbreak, 41 (49.4%) were acquired in the community, 24 (28.9%) were acquired nosocomially, 13 (15.7%) were acquired by family contact, and 5 were imported. Among 44 clearly determined transmission linkages, 37 (84.1%) were adult to other age-group (these include 29 adult-to-adult, seven adult-to-child, and one adult-to-infant), six were from infants to adult and children, and one was child-to-child. Outbreak response immunization activities were implemented by non-selective supplementary immunization activities, with 51.3% of targeted 5–19-year-old children and adolescents, and 30.2% of targeted 20–49-year-old adults being vaccinated.

Conclusions: Despite high population immunity among children and adolescents following three rounds of measles vaccine supplementary immunization activities, sustained measles virus transmission still occurred among adults in this community. Adult measles immunity gaps might threaten measles elimination, highlighting the importance targeting susceptible adults during outbreak response immunization.

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1. Introduction

Before licensure of measles vaccine (MV) in 1965, the annual measles incidence in China fluctuated between 10,000 and 50,000 cases per million population [1]. Establishment of the national Expanded Program on Immunization (EPI) in 1978 enabled a one-dose routine MV schedule, with the dose administered at 8 months of age. In 1986, a 2-dose MV schedule was recommended – one dose at 8 months followed by a second at 7 years of age. The

recommended age for the second dose was lowered to 18 months in 2005 [2].

In addition to routine measles vaccination, in 2006 China began closing immunity gaps among children using province-wide, catch-up, supplementary immunization activities (SIAs). These campaigns were followed by a large nationwide SIA in 2010 [3,4]. As of September 2010, every birth cohort between and including the 1995 and the 2009 cohorts have been targeted with an SIA that vaccinated children regardless of their prior vaccination history [5]. Some provincial SIAs targeted cohorts as early as the 1990 birth cohort.

Continuous use of the 2-dose measles-containing vaccine (MCV) vaccination policy for 25 years, coupled with the comprehensive SIA strategy, has led to a marked decrease in measles, so that by 2012, the annual incidence was at its lowest point ever of 4.6 cases

* Corresponding author. Tel.: +86 10 63171724; fax: +86 10 63171724.

E-mail address: wanghq@chinacdc.cn (H. Wang).

¹ Equal contributors.

per million population [6]. However, accumulation of susceptible children in new birth cohorts has allowed a resurgence of measles that started at the end of 2012 [5], reaching 20.4 per million in 2013 [6], and 38.8 per million in 2014.

Measles typically is a disease that mainly affects children; in the pre-vaccine era, over 90% of children had measles by their 15th birthday [7]. With a greater than 99.5% decrease in the incidence of measles during the elimination effort in China, the age distribution of measles case-patients has changed. In recent years, relatively few cases have been reported from age-groups that were targeted by SIAs. Instead, the majority of cases have been occurring among young children <24 months of age and adults [6,8]. Among all reported measles cases, the percentage of cases in the over 15-year-old age group was less than 10% in the early 1990s [9,10], increased to 27% in the first 10 months of 2013 [5], and further increased to over 40% in 2014 [11]. Some provinces have been having measles outbreaks among adults.

One of the stated research needs for global measles elimination is to identify the roles of infants less than 9 months old, adolescents, and adults in measles virus transmission [12]. In our traditional assessment, adult measles is highly correlated with the incidence in children. The great reduction of measles incidence rates in every age-group in 2011 and 2012 – including among children and adults – seems to support this assessment [6,8]. Such an assessment implies that high immunization rates among children will provide adequate herd immunity to prevent measles among adults and infants too young to vaccinate – a key part of the strategy for measles elimination. However, we have seen measles outbreaks among adults without children acting as measles virus reservoirs in recent years in China, raising our concern that susceptible adults could alone sustain measles virus transmission in community settings. We report a typical measles outbreak among adults in China that occurred in 2014, describing a pattern of measles virus transmission from adult to adult and then to children, in Kulun (KL) County. We describe sources of infection and the effect of outbreak response immunization, and we suggest control measures targeting adults.

2. Methods

2.1. Setting

Kulun (KL) County is one of the eight counties in Tongliao prefecture, Inner Mongolia Autonomous Region, a less-developed western province. The county has a population size of 167,200 (5.3% of the total population in Tongliao prefecture, and 0.7% of Inner Mongolia); 2.1% are children less than 2 years of age, and 82.7% are 15 years or older. Three rounds of SIAs had been conducted in KL: a catch up SIA in April 2009 targeting birth cohorts of May 1994 through August 2008 as part of an Autonomous Region-wide campaign; a follow-up SIA in September 2010 targeting birth cohorts between October 2005 and 2009 as part of the nation-wide campaign; and a 2nd round follow-up SIA in 2012 targeting birth cohorts between 2008 and 2011, as part of an Autonomous Region-wide campaign. Thus, all birth cohorts from 1994 through 2011 have been covered by at least one SIA, regardless of target children's prior vaccination histories.

In 2009, there was a large measles epidemic in KL County, with 279 cases reported (52.7% of these were ≥ 15 years old), representing a measles incidence of 152.9 per 100,000 population. After the outbreak, only three cases were reported (in November 2011, and May and June 2013) until another outbreak started in December 2013 that continued into 2014. Over 150 measles cases were reported by March 31, 2014, representing an incidence of 89.7 per 100,000 population; among the cases, >75% were among

individuals 15 years or older. The disease pattern raised our concern about the source(s) of infection and transmission routes (from whom and to whom), and prompted an evaluation of the effectiveness of outbreak response immunization in such an adult outbreak setting. We conducted a field investigation in April, 2014.

2.2. Outbreak investigation and description

In accordance with the Chinese Measles Surveillance Guidelines [13], all suspected measles cases were reported through a computerized, real-time reporting system. Variables obtained included age, sex, address of residence, date of onset, occupation, MCV vaccination history, and measles-specific immunoglobulin (IgM) testing results [14]. A suspected measles case was defined using World Health Organization (WHO) criteria as a person with fever, rash, and one or more of the following symptoms: cough, coryza, or conjunctivitis. All suspected measles cases were classified as laboratory confirmed, epidemiologically confirmed, clinically compatible, or discarded measles cases [13].

During the field investigation, we conducted a retrospective active case search to find additional measles cases; suspected cases found were reported through the measles surveillance system. MCV vaccination statuses were checked by reviewing vaccination certificates and SIA records. Case data were analyzed to describe person, place, and time characteristics of the outbreak.

2.3. Source of infection and transmission chain determination

We evaluated all laboratory and epidemiological-link confirmed measles cases that had onset during the first 2 months of this outbreak (before March 2014) to determine source of infection and early-stage transmission patterns. In-house interviews of all individuals confirmed to have had measles were conducted to gather an activity history from 21 days before their rash onset through 5 days after rash onset, to describe the “incubation period” (7–21 days prior to rash onset, when they get infected) and the “transmissibility period” (5 days before through 5 days after rash onset). Queried activities included contact with other fever and rash illness patients, places visited, and hospitals and clinics visited. A source of measles virus infection was categorized as: (a) an imported measles case, defined as exposure to measles virus outside the KL County during the seven to 21 days prior rash onset in which a thorough investigation of contacts excludes a local source of infection; (b) a family-contact acquired infection, defined as one or more measles cases occurring during their transmissibility period within the same family during the 7–21 days prior to rash onset; (c) a nosocomial measles case, defined as having a clinic/hospital visit during 7–21 days prior to rash onset in which a thorough investigation of contacts excludes other sources of infection; or (d) a community acquired infection, defined as contact with measles cases in the same or neighboring villages, or in schools, workplaces, or other locations outside of healthcare facilities or the home. Cases with a clear, common infection source were epidemiologically linked to each other.

2.4. Ethical considerations

This field investigation did not involve endangered or protected species, and no human subjects' specimens were obtained. Such outbreak investigations are considered by China CDC's Ethical Review Committee to be exempt from IRB review as they are considered public health program evaluation. Individual identifying data were not retained in analytic data sets.

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