Measles outbreak in Qassim, Saudi Arabia 2007: epidemiology and evaluation of outbreak response

Saulat Jahan1, Abdullah Mohammed Al Saigul2, Mohammed Ahmad Mohammed Abu Baker3, Ayman Osman Alataya3, Shamandy Abdul Rahim Hamed3
1Health Education and Training Department, Primary Health Care Administration, Qassim, Saudi Arabia
2Primary Health Care Administration, Qassim, Saudi Arabia
3Preventive Medicine Department, Primary Health Care Administration, Qassim, Saudi Arabia
Address correspondence to Saulat Jahan, E-mail: saulatjahan@hotmail.com

ABSTRACT

Background Worldwide efforts for measles elimination are made possible due to the availability of a highly effective measles vaccine. In spite of highly vaccinated population, a measles outbreak occurred in Qassim province of Saudi Arabia, during January–August 2007.

Methods An outbreak investigation was conducted to describe the epidemiology of outbreak. An audit of performance of control measures taken by the Primary Health Care team was done according to World Health Organization standards.

Results Of 230 cases reported, more than one-third (37.8%) patients were 0–4 years of age. Children aged 6–11 months accounted for 51.7% cases amongst 0–4 years age group. The performance indicator targets of ≥80% for outbreak control measures were achieved regarding investigation of cases within 48 hours, and blood sample extraction within the optimal period. However, 66.8% cases reported within 48 hours of rash onset and only 16.4% of laboratory test results were received within 7 days of receipt of the specimen in laboratory.

Conclusion This outbreak demonstrates the increased susceptibility of unvaccinated children aged 6–11 months. To prevent future outbreaks, community awareness, review of measles vaccination schedule, enhanced surveillance and measles ‘catch-up’ mass immunization campaign to interrupt chains of transmission, are required.

Keywords epidemiology, measles, outbreak, Qassim, surveillance

Introduction

Measles is a highly contagious childhood disease with high morbidity and remarkable mortality. During the pre-vaccination era, measles was endemically present in human population with epidemics of increased activity every 2–3 years.1 With the establishment of immunization programs, the disease frequency and its complications have markedly declined and its epidemiologic picture changed. Outbreaks are less frequent and generally affect older age groups.2

Measles vaccine was introduced in the Kingdom of Saudi Arabia in 1974. It had low coverage until 1982, when a royal decree had made vaccination compulsory for issuing a birth certificate. The impact of this royal order was major for this disease and other childhood disease immunization.3,4 Notified measles cases had come down from 46 115 cases in 1980 to <1000 cases per year in 2001.5 Measles vaccine was initially given to susceptible children at 1–9 years, while in 1983 it became routine for all infants at 9 months.

In 1991, measles vaccine was further advanced to 6 months with a dose of MMR given at 12 months. In 2001, two MMR-dose schedules were implemented, with the first dose at 12 months and the second dose at preschool age.

In 1997, the Saudi ministry of health decided to implement measles elimination strategies. These strategies include strengthening the surveillance system, laboratory confirmation of cases, conducting catch-up and follow-up campaigns. A campaign was conducted targeting 6–18-year-old school children in the year 1998–2000. Since then, confirmed
measles cases have declined, and the proportion of cases among young adults increased. According to measles elimination strategies, a follow-up campaign had to be conducted every 3 years to prevent possible outbreaks and to decrease virus circulation in the community. With high immunization coverage, the number of susceptibles gradually builds up and outbreak may strike in longer cycles and with different epidemiology.

During the previous 5 years (2002–2006), on an average 18 (SD, 11) cases of measles per year were reported to Preventive Medicine Department, Primary Health Care Administration, Qassim, Saudi Arabia. In March 2007, an increase in measles notifications was noted, mainly from Ar Rass and Dikhnah health sectors of the province. By the end of March, the increase was also noted from adjoining sectors. The outbreak response was conducted as per Ministry of Health guidelines.

We conducted an outbreak investigation to describe the epidemiology of the outbreak, review measles surveillance in the province and evaluate the surveillance steps and control measures practiced by Primary health care teams in response to notified cases.

**Methods**

**Outbreak investigation**

Qassim, located in the northern part of the centre of Kingdom of Saudi Arabia, covers an area of 78 500 km² with a population of 1.016 million during the year 2004.6 During early months of the year 2007, an excess number of measles cases were notified to the Preventive Medicine Department, Primary Health Care Administration, Qassim province.

In response to the increased notified measles cases, active surveillance of measles was initiated, using the World Health Organization (WHO) case definition.7 All cases were investigated using standard Ministry of Health notifiable disease form and were subjected to laboratory confirmation by taking blood samples within the defined period of 28 days from onset of symptoms. Investigation forms were completed by the nearest Primary Health Care Centre staff and reviewed by the surveillance team. Information collected included patient name, place of residence, age, gender, date of reporting to the health facility, date of symptoms onset, date of rash onset, vaccination status and epidemiological linkage to a known case. Vaccination status was determined by history and/or review of the immunization card. Daily fax notifications were sent to the regional surveillance office about all suspected cases. Blood samples were sent to the central laboratory at Riyadh for Measles IgM antibodies. Results were either faxed or mailed back. Tests of oral fluid samples to look for viral DNA and IgG were not done, as they are not conducted routinely for suspected measles cases in Saudi Arabia.

Field visits and meetings with concerned staff were conducted early in the outbreak and as needed. Health authority, community leaders and media were informed. A press release was issued notifying the public of measles outbreak, public health and medical communities received regular updates and enhanced surveillance for rash illness in the general population was established.

Outbreak control activities included isolation at home, vaccination of contacts and case finding of the suspected cases among contacts.

**Evaluation of outbreak response**

An audit of performance of case investigation and control measures taken by the Primary Health Care team was done according to WHO standards.8 The performance indicators evaluated were percentage of cases notified within 48 hours of rash onset, percentage of cases investigated within 48 hours of notification, percentage of laboratory tests undertaken in cases with adequate specimen, percentage of laboratory test results received within 7 days of receipt in laboratory. According to WHO standards, all these indicators should be ≥80%. The percentage of cases whose contacts were vaccinated within 48 hours of notification, were also assessed.

**Statistical analysis**

Data collected were entered and analysed by Epi Info 3.4 software. Frequencies, proportions and age specific rates were calculated to describe the epidemiology of outbreak.

**Results**

**Outbreak**

Between 15 January and 25 August 2007, 230 cases of measles were reported. The incidence rate was 37 per 100 000 population. Forty eight (20.9%) cases were laboratory confirmed, by detection of measles IgM. The outbreak peaked in April 2007, when 110 cases occurred with 58 cases being reported during the second week of that month (Fig. 1).

Cases were reported from 15 of the 16 health sectors of Qassim (Fig. 2). One hundred and twenty two (53%) cases were reported from two sectors (Ar Rass and Dikhnah). Sector-specific attack rates ranged from 0 to 253 cases per 100 000 population. The patients ranged in age from 2 months to 52 years (median: 8.7 years). More than one-third (37.8%) of the patients were 0–4 years of age.
Children aged 6–11 months accounted for the highest number of cases. Of the 55 cases reported among infants, 45 (81.8%) occurred in 6–11 months age group (Fig. 3). The age-specific incidence was highest for children aged 1 year (433.9 per 100 000 population), and was higher for children aged 1–4 years (52.9 per 100 000 population) and 5–14 years (36.0 per 100 000 population) than for persons aged 15–44 years (27.4 per 100 000 population).

Two hundred and twenty patients (95.7%) were Saudis. One hundred and twenty three cases (53.5%) were females. Vaccination status was known for 219 (95.2%) reported cases; of these, 136 (62.1%) were vaccinated (Table 1). The number of administered doses was reported for 129 (94.8%) vaccinated persons; out of which 45 (34.9%) were vaccinated with single dose. Amongst the age group ≥15 years, who developed the disease, 53.2% had been vaccinated against measles.

History of epidemiological linkage was given by 212 (92.2%) patients. Out of these, 68 (32.1%) cases gave history of contact with suspected measles case. Probable sites of exposure to measles cases were schools [31 (45.6%) cases], home [29 (42.6%) cases] and other settings [8 (11.8%) cases]. No deaths, hospitalizations, or other major complications were reported among our patients in this outbreak. The source of this outbreak is unknown.

During the outbreak 226 (98.3%) cases had their serum samples tested for measles specific IgM. Of these, 48 (21.2%) were positive for IgM antibodies against measles virus, 154 (68.1%) negative, 5 (2.2%) indeterminate, while in 19 (8.4%) cases, results were not received.

**Evaluation of outbreak response**

At the termination of the outbreak, an evaluation of performance of case investigation and control measures was conducted. The data regarding date of rash onset and blood sample extraction were available for 205 cases; in 189 (92.2%) cases, the blood sample was taken within 72 hours of the appearance of rash. However, there was no statistically significant difference between the mean number of days interval of positive and negative laboratory results.

Out of the data available for 197 cases, 66.8% were reported within 48 hours of rash onset. From the information available for 198 cases, 93.5% cases were investigated within 48 hours of reporting. The analysis of data of
140 cases showed that 16.4% of laboratory test results were received within 7 days of receipt of the specimen in laboratory. Records of 50 cases were randomly selected to assess the percentage of contacts vaccinated within 48 hours of notification of the case. Information could be traced for 47 (94%) cases. In 89.4% cases, the contacts were vaccinated within 48 hours.

## Discussion

Outbreak investigations are important for improving strategies for measles prevention, as they help to understand patterns of measles virus transmission – including who is susceptible and in which settings the disease spreads.

### Main findings

The median age of cases in our study is lower than the median ages reported in other outbreak reports, from Saudi Arabia. The highest age specific rate in our study is in 0–1 year age group, which can be attributed to the waning of passive immunity in early infancy. The source of infection for infants could have been school-aged infected siblings, as a substantial proportion of reported cases belong to 5–14 years age group, corresponding to school age. Schools

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**Table 1** Age distribution of notified measles cases according to vaccination status: Qassim, January–August 2007 ($N = 230$)

<table>
<thead>
<tr>
<th>Age group</th>
<th>No. of cases</th>
<th>Vaccinated</th>
<th>Not vaccinated</th>
<th>Unknown vaccination status N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Single dose</td>
<td>Two doses</td>
<td>Three doses</td>
</tr>
<tr>
<td>&lt;6 months</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6–11 months</td>
<td>45</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1–4 years</td>
<td>32</td>
<td>21</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>5–9 years</td>
<td>30</td>
<td>10</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>10–14 years</td>
<td>36</td>
<td>1</td>
<td>31</td>
<td>3</td>
</tr>
<tr>
<td>15–19 years</td>
<td>36</td>
<td>7</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>20–24 years</td>
<td>16</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>&gt;25 years</td>
<td>25</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>230</td>
<td>45</td>
<td>71</td>
<td>13</td>
</tr>
</tbody>
</table>

*Age = 1 year (first dose of measles vaccine is given at 12 months age as per National EPI program).
were also the most common site of exposure to measles infection.

An appreciable proportion of cases had a history of vaccination and approximately one-third (33.1%) of immunized cases had received a single dose of measles vaccine.

No complications, hospitalizations or deaths were reported due to measles in our study. This can be attributed to high vaccination coverage and good nutritional status of the community.

The majority (92.2%) of blood samples were taken during the first 3 days and less than a quarter of laboratory tests were positive for measles IgM. The samples were taken so soon according to Ministry of Health protocol, blood test of suspected measles cases should be taken on first contact with the health care provider.

The control measures adopted during this outbreak included: increasing the awareness on measles as a possible differential diagnosis by circulating a case definition of measles to the health care facilities, enhanced surveillance for cases by daily telephone calls to health care facilities to obtain reports on patients with acute fever and rash, immediate follow-up of cases to identify contacts and immunization of the contacts. The measles vaccine was administered irrespective of previous measles immunization.

What is already known

Measles outbreaks have been reported from different regions of Saudi Arabia including Najran (1996–1997),10 Riyadh [(1996–1997)11 and 200412] and Madinah provinces (2003).13 During these outbreaks, 35 cases (incidence: 23/100 000 persons) were reported from Najran, 482 cases from schools of Riyadh in 1996–97 and 204 cases in 2004, while 355 cases (incidence: 24/100 000 population) from Madinah. The highest age specific rate in Madinah was in 5–14 years age group, while it was 10–14 years age group in Riyadh outbreak.

The maternal antibodies undergo an exponential clearance (half-life of 35–40 days), after birth.14 Nicoara et al.15 showed that by 9–12 months of age, only 5 of 58 (8.6%) Swiss infants were antibody positive for the measles virus. In Saudi Arabia, a serosurvey conducted for evaluation of measles antibodies found that at 6 months of age, 64% infants had negative measles antibodies.16 Moreover, it is also documented that women who have vaccine-induced immunity provide a relatively short period of passive immunity to their infants.17–20 With an increasing proportion of women with vaccine-induced immunity, the passive immunity in infants is expected to last for a shorter duration. Studies among well-immunized populations in many countries have shown evidence to suggest increasing susceptibility of infants to measles after 6 months of age.21–23

In relatively closed populations such as schools, measles can be transmitted despite high levels of immunity. In these settings, an outbreak can be sustained because of repeated exposures.24–26

Several outbreaks have occurred in highly vaccinated population groups and many of the cases had been previously vaccinated.27–29 Measles vaccine is highly effective; most studies have shown that at least 90% of vaccine recipients are protected and many studies indicate a protection level of 95% or higher.30–31 However, since the vaccine is not 100% effective, there will always be some proportion of vaccinees (10% or less) who remain susceptible to the disease. Vaccine failures account for outbreaks in children and young adult populations with high vaccine coverage.32–34

The reasons for vaccine failure include factors involving the vaccine, vaccine handling, administrative procedures, the host, and the environment.35 In our study, the high proportion of vaccinated cases may be attributed to vaccine failure. In addition, mostly the vaccination status was recorded from case history, so it is difficult to be confident about robustness of evidence for vaccination.

Measles outbreaks in areas with high coverage with a single-dose strategy have been reported in Sri Lanka,36 Latin American countries37 and in Romania.38 It is mentioned in the literature that at least 95% coverage with two doses of measles-containing vaccine will achieve sufficient population immunity to stop measles virus from spreading within a population.39

A study in Guinea-Bissau showed that measles cases who had been vaccinated had milder infection and lower infectivity as compared with those who were not vaccinated.40 Poor nutritional status has also been associated with an increased risk of complications and death following measles.41,42

It is an established fact that in the first 72 hours after rash appearance, up to 30% of tests for IgM may give false negative results.43

What this study adds

The greater susceptibility of unvaccinated 6–11 months age group requires a review of measles vaccination schedule in the country. In order to control measles outbreak, suspected cases must be reported promptly, an accurate diagnosis must be made, and outbreak response measures must be implemented swiftly. Evaluation of our outbreak response revealed that two indicators are not up to WHO standards and require improvement. We lag behind the international standard of ≥80% for reporting of cases within 48 hours.
of appearance of rash (66.8%). To improve this indicator, awareness regarding importance of immediate reporting of rash illnesses, should be created in the community. The delayed receipt of laboratory results may be explained by the fact that there was concurrent measles outbreak in other provinces of the Kingdom. As the blood samples have to be processed in the central laboratory in Riyadh, the delay might have occurred because of excessive work load.

**Limitations of this study**

Our study has some limitations. Some rash and fever illnesses may have been misclassified as measles, and there may be over diagnosis of measles during the outbreak period. The data collection depended on routine surveillance system. The surveillance systems have their own limitations and are considered as imperfect. It was also difficult to assess the vaccine efficacy, as all children and teenagers, have been covered by routine expanded program of immunization. All school children are given a shot of MMR as a pre-requisite for school enrolment. Moreover, most young adults had been vaccinated at school during 1998–2000 campaign. However, it was difficult to trace these documents as campaign was conducted at schools. History alone could not be trusted.

**Conclusion**

The study concludes that the most common age group affected during this outbreak is 6–11 months, which is the unvaccinated group with waning immunity. To prevent future outbreaks, surveillance should be enhanced to closely monitor the accumulation of susceptible persons. In addition, measles 'catch-up' mass immunization campaign should be conducted to interrupt chains of transmission and prevent outbreaks. The catch-up campaign is envisaged to reduce transmission of measles to very low levels, thereby protecting infants as they lose maternal antibodies. A national campaign targeting all children of 9 months to 18 years of age was immediately followed up after this outbreak.

**Acknowledgments**

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**References**


