



The economic burden of sixteen measles outbreaks on United States public health departments in 2011[☆]



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ABSTRACT

Background: Despite vaccination efforts and documentation of elimination of indigenous measles in 2000, the United States (US) experienced a marked increase in imported cases and outbreaks of measles in 2011. Due to the high infectiousness and potential severity of measles, these outbreaks require a vigorous response from public health institutions. The effort and resources required to respond to these outbreaks are likely to impose a significant economic burden on these institutions.

Objective: To estimate the economic burden of measles outbreaks (defined as ≥ 3 epidemiologically linked cases) on the local and state public health institutions in the US in 2011.

Methods: From the perspective of local and state public health institutions, we estimated personnel time and resources allocated to measles outbreak response in local and state public health departments, and estimated the corresponding costs associated with these outbreaks in the US in 2011. We used cost and resource utilization data from previous studies on measles outbreaks in the US and, relying on outbreak size classification based on a case-day index, we estimated costs incurred by local and state public health institutions.

Results: In 2011, the US experienced 16 outbreaks with 107 confirmed cases. The average duration of an outbreak was 22 days (range: 5–68). The total estimated number of identified contacts to measles cases ranged from 8936 to 17,450, requiring from 42,635 to 83,133 personnel hours. Overall, the total economic burden on local and state public health institutions that dealt with measles outbreaks during 2011 ranged from an estimated \$2.7 million to \$5.3 million US dollars.

Conclusion: Investigating and responding to measles outbreaks imposes a significant economic burden on local and state health institutions. Such impact is compounded by the duration of the outbreak and the number of potentially susceptible contacts.

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1. Introduction

Since the elimination of indigenous measles from the United States (US) was documented in 2000, relatively low numbers of cases per year (average of 71 cases, range 37–140) were reported

during this decade [1]. However, in 2011 the country experienced a marked increase in measles cases and outbreaks [2,3]. All initial measles cases in these outbreaks were import-associated [2], defined as meeting one or more of the following criteria, measles cases were imported from other countries, were epidemiologically linked to importations, had viral genetic evidence of an imported genotype, or were epidemiologically linked to an imported virus [2,3]. Outbreaks usually began with susceptible persons infected with measles while staying in countries with endemic circulation and who became ill just prior to or after arriving in the United States [4]. Infected persons may transmit the disease to a number of potentially susceptible contacts in a variety of settings including homes, airplanes or airports [5], schools or daycare centers [4,6,7], university dormitories, refugee camps [8], clinics and hospitals [9,10].

Due to its high infectiousness and the potential severity of complications, a measles outbreak often constitutes a serious public health event entailing a vigorous response from local public

Abbreviations: CDC, the Centers for Disease Control and Prevention; DHHS, Department of Health and Human Services; ID, identification (for outbreaks labels); logs, logarithms; MMWR, Morbidity and Mortality Weekly Report; n/r, not reported; n/a, not applicable; US, the United States.

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health departments and can involve multiple states and counties [2,11,12]. A typical response could involve a range of complex activities, i.e., confirmed cases are isolated, case contacts traced and their disease or vaccination history assessed, potentially susceptible individuals tested for immunity and, if required, vaccinated or quarantined [11–13]. As part of the response to the outbreak, public health departments may need to enhance disease surveillance, plan response efforts, coordinate response activities with healthcare providers, other public health officials, the Centers for Disease Control and Prevention (CDC), and also address public concerns and media attention [11–13]. As a result of the amount of effort and resources reallocated to the outbreak response, the economic toll on these public health departments could be significant [11–14]. In this study, we aim to estimate the economic burden of the sixteen measles outbreaks reported in 2011 on local and state public health departments in the US.

2. Methods

Using local and state public health perspectives, we estimated personnel time for public health departments and costs associated with responding to the measles outbreaks (defined as three or more epidemiologically linked cases) reported in the US in 2011. To do this, we computed average cost and resource utilization data (e.g., wages and salaries, number of personnel hours) from previous studies in the US that estimated the economic impact of measles outbreaks on state and local health departments [11–14], and used these data to estimate the personnel time and costs attributable to the response to the measles outbreaks reported in 2011.

2.1. Cost studies on measles outbreaks

From a review of the literature on the economic impact of measles outbreaks in the US [11–14], we collated data on the reallocation of personnel and resources for the outbreak response (including investigation, contact tracking, screening, laboratory work, emergency response and surveillance) as well as associated costs incurred by local and state public health departments; specifically, we retrieved data on the number of cases reported in these outbreaks, the number of contacts (or exposures to measles

cases) identified, the number of hours allocated by local and state responders, and the main activities performed during the outbreak investigations and response (Table 1). Particular attention was given to studies that reported number of personnel hours allocated to the response by local and/or state health department and associated personnel costs. Using these data, we estimated both the average number of personnel hours per contact and the average cost per contact. All costs were adjusted for inflation to 2011 US dollars using the Consumer Price Index [15].

2.2. Measles outbreak data in 2011

Data on the number of confirmed measles cases reported in each outbreak and the duration of the outbreak were collected from local and state health department reports for 2011 [2,8,16–20]. The duration of the outbreak was defined as the number of days from the first to the last rash onset date reported and assumed this interval was the minimum period during which an active public health response was in place. Additionally, data on the number of identified contacts for each outbreak were collected retrospectively from the affected local and state public health departments (Table 2). Despite efforts to standardized contacts data collection, sites resorted to either documentation, recall, or both definitions of contacts.

2.3. Outbreak size classification and case-day index

Due to the limitations of collecting contact numbers retrospectively, we utilized an indirect approach to define outbreak size scenarios and estimated personnel hours and costs for these scenarios. Specifically, we relied on the number of confirmed measles cases and outbreak duration to build a case-day index (i.e., case-day index = number of cases *times* number of days) for each outbreak, and then classified the size of the outbreak using this index (Table 2 and Fig. 1A). The rationale behind the case-day index approach is that the magnitude of a public health response to a measles outbreak is usually driven by the number of individuals that have been in direct contact with infective measles cases and by the time and effort it takes to respond these outbreaks. Therefore, the magnitude of an outbreak response tends to be increasingly compounded by the number of cases (and contacts), and by the duration of the outbreak (Fig. 1A).

Table 1
Cases, contacts, personnel hours and costs associated with measles outbreaks.

	Iowa and Michigan, 2004 [11]	Indiana, 2005 [12]	San Diego, California, 2008 [13]	Kentucky, 2010 [14]
Confirmed cases	1	34	12	1
Identified contacts	>1000 ^e	500	376	45
Personnel hours				
Local	516	429	1355	n/r ^a
State	1786	1103	390	n/r
Total	2302	1532	1745	387
Hours per contact				
Local	0.5	0.9	3.6	n/a ^b
State	1.8	2.2	1.0	n/a
Total	2.3	3.2	4.6	8.6
Outbreak costs (\$) ^d				
Local	44,558	20,427	116,098	n/r
State	137,121	39,404	13,997	n/r
Total	181,679	59,831	130,095	24,569 ^c
Cost per contact (\$) ^d				
Local	45	41	309	n/a
State	137	79	37	n/a
Total	182	120	346	546 ^c

^a n/r = not reported.

^b n/a = not applicable.

^c Includes some federal personnel expenses.

^d All costs were adjusted to 2011 US dollars using the consumer price index.

^e Estimates of hours per contact and cost per contact used 1000 as the number of contacts for this outbreak.

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