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Timeliness of measles surveillance in the Republic of Korea, 2002-2009: Impact of sentinel laboratory surveillance

실험실 능동감시체계 도입에 따른

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Timeliness of measles surveillance in the Republic of Korea, 2002-2009: Impact of sentinel laboratory surveillance

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ABSTRACT

Background: In order to sustain the elimination of measles, timely reporting is important. We analyzed surveillance data in Korea from 2002–2009 to determine the effect of sentinel laboratory surveillance (SLS), which was introduced in 2006, on the timeliness of measles reporting.

Methods: We stratified data by two surveillance periods, (A) before and (B) after 2006, and by clinically-confirmed and laboratory-confirmed cases.

Results: During Period A, 113 suspected cases were reported, and 241 during Period B. There was no difference in the proportion of timely reporting among clinically-confirmed cases between the two periods, whereas the proportion of laboratory-confirmed cases has increased. The mean notification interval in laboratory-confirmed cases was shortened from 39 to 16 days.

Conclusions: In Korea, SLS has enhanced earlier detection of suspected cases that had not been reported, improving the timeliness of measles surveillance. Adopting this new method may improve the timely collection of cases in other countries as well.

Keywords: measles; surveillance; timeliness

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3C – cough, coryza, and conjunctivitis

KCDC – Korea Centers for Disease Control and Prevention

LDH – local department of health

MMR – measles-mumps-rubella vaccine

PHC – public health center

SLS – sentinel laboratory surveillance

WHO – World Health Organization

Introduction

Measles is a highly contagious disease that causes substantial disease burden in children worldwide. The incidence of measles has been declined some countries following the introduction of effective vaccination program [1]. However, measles is still a major public health threat because of its worldwide prevalence and changing epidemiologic pattern in countries where vaccines has been widely used [2, 3]. Although it is rare in South Korea presently, hospitalization for measles and its complications was common before the widespread use of the vaccine [4-6]. Furthermore, severe complications of measles can occur in susceptible subjects; in the 1960s, measles was one of the 10 leading causes of death in Korean children [7]. At the time of the installation of the national surveillance system in 1955, the annual number of reported measles cases ranged from 9,400 to 30,000; the number has been decreasing since the 1960s [8].

The introduction of measles monovalent vaccine in 1965 and the measles-mumps-rubella (MMR) vaccine in 1980 has played an important role in the decline in the number of reported cases. However, occasional outbreaks in cyclic patterns continued to occur every 3–4 years, due to poor routine vaccination coverage [9, 10]. Although 1 dose of MMR vaccine given at 15 months of age was partly introduced into the National Immunization Program in 1985, the outbreak in 1989–

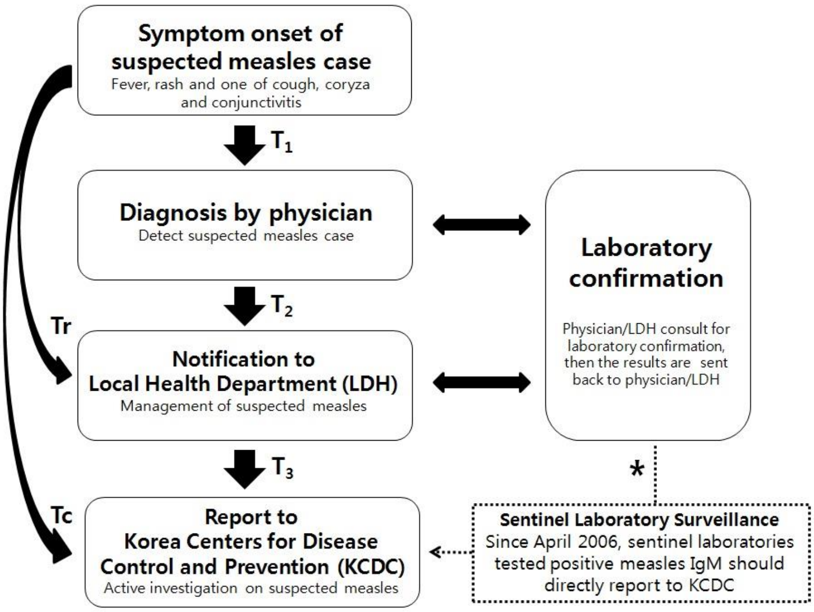
1990, which affected approximately 5,000 patients, prompted the government and academia to take action [11]. During the outbreak, the peak incidence occurred among young children; therefore, since 1994, the Korean Pediatric Society has recommended that a second dose of MMR vaccine should be given at 6 years of age, and the same recommendation was issued by the government 3 years later [11-13]. Following the recommendation, the number of reported cases had decreased to less than 100 cases annually by the late 1990s. However, an unexpected nationwide outbreak involving 55,707 cases and 7 deaths occurred in 2000–2001 [14]. In response, the government instituted the Five Year Measles Elimination Program, which included the following: (1) a catch-up campaign targeting approximately 5 million school-aged children; (2) a keep-up vaccination program that required children to be certified as having received 2 doses of MMR vaccine before they could enter elementary school; and (3) an enhanced case- and laboratory-based measles surveillance system [15]. Following the installation of these programs, the annual measles incidence has declined to less than 1 per 1,000,000 of the population, and in 2006, the Republic of Korea became the first country in the Western Pacific Region (as defined by the World Health Organization [WHO]) to declare measles as eliminated [14, 16].

Despite this achievement, sporadic cases and outbreaks have been detected by the measles surveillance system. With the reduction in the number of children affected by measles, changes in the epidemiology of the disease are to be expected, as has been experienced in other countries [17, 18]. To maintain the elimination status of measles in Korea, ongoing efforts are needed to meet the goals of: (1) high vaccination coverage for 2 doses of MMR vaccine, and (2) building effective measles surveillance strategies [19, 20].

Before the 2000s, surveillance of measles in Korea depended largely on physicians' passive reporting of diagnosed cases. The system was modified in 2001 to include case-based surveillance (cases with fever, rash, and one or more of cough, coryza, or conjunctivitis). The physicians are obliged to notify the diagnosis of suspected measles cases to the regional Public Health Center (PHC) within seven days. In turn, the PHC reports to the Local Department of Health (LDH) within one day then the LDH should report it to the Korea Centers for Disease Control and Prevention (KCDC) within one day. Some, but not all, suspected cases were tested for measles IgM antibodies. The results of laboratory tests are sent back to the physician, who requested the test, then the physician reports the test results to the PHC or LDH; therefore, a delay in communicating this information was inevitable.

In April 2006, to shorten the reporting intervals among laboratory-confirmed cases, sentinel laboratory surveillance (SLS) was introduced, which mandates nationwide sentinel laboratories to send an immediate notification directly to the KCDC when measles serologic testing is positive (Figure 1). When the KCDC receives direct notification from SLS, the investigation team, which is jointly operated by KCDC and LDH, immediately starts an investigation and conducts preventive measures.

Figure 1. Flow-chart of the measles surveillance system in the Republic of Korea, 2002–2009.



*Since April 2006, sentinel laboratory surveillance of measles was established; sentinel laboratories testing measles antibody are mandated to report directly to the Korea Centers for Disease Control and Prevention (KCDC).

To sustain the elimination of measles, a sensitive collection and timely reporting of suspected cases is essential. Efforts to improve the timeliness of reporting must be part of a continuous process to improve the quality of measles surveillance systems [21, 22]. In countries where the incidence of measles is low, a delay in the notification process may occur because clinicians may have less experience in diagnosing measles patients without laboratory confirmation [23]. With this point in view, immediate reporting from laboratories to the public health sector may potentially shorten the information delay.

In this report, we assessed the impact of SLS on the timeliness of measles reporting in Korea during the period 2002–2009. We have focused on the challenges related to the surveillance of measles during the post-elimination phase in Korea. Further, we aimed to describe the public health approaches that have provided the framework for the surveillance of measles that has been operating in Korea between years 2002 and 2009.

Materials and Methods

1. Measles Case-based Surveillance

The routine measles case-based surveillance system is an important tool for monitoring and interpreting the measles control measures in Korea. Since 1995, the mandatory reporting of suspected measles cases (those with fever, rash, and 1 of cough, coryza, and conjunctivitis [3C]) was required from physicians. A suspected case of measles must be reported to the public health centers or directly to the KCDC through the electronic reporting system. The electronic reporting system was established in 2001 to enable timely reporting of suspected cases [24]. In general, the Korean National Notifiable Disease Surveillance System operates a passive surveillance scheme with supplementary case-based investigation performed for all reported cases of measles.

2. Case Definition and Data Collection

We used the surveillance data collected by KCDC from 2002 to 2009 to evaluate the timeliness of measles surveillance in Korea. Suspected measles cases were classified by the WHO case definitions as follows: (1) clinically-confirmed was defined as cases that met the clinical case definition (fever, rash, and one of cough, coryza and conjunctivitis) and for which no adequate blood specimen was taken; and (2) laboratory-confirmed was defined as cases that met the clinical case definition and were laboratory-confirmed (serum measles-specific IgM) [25]. We then analyzed the surveillance data and case investigation reports to identify the demographic and epidemiologic characteristics of suspected measles cases. The source of transmission was identified from epidemiologic investigation case reporting forms. The 'source-identified' case was defined as the measles case patient who had contact with the laboratory-confirmed case at least 7–18 days before onset of rash. The remainder was classified as 'source-unidentified'. The place of residence and seasonality were also analyzed. The analysis presented in this study consisted of only secondary unlinked data analysis; no contact with human subjects occurred.

3. Data Analysis

To evaluate the effect of SLS on the timeliness of the reporting, we first categorized the surveillance period into two periods: (1) Period A from January 2002 to March 2006, during which there was routine case-based surveillance; and (2) Period B from April 2006 to December 2009, during which surveillance was done in conjunction with SLS. For each measles case, we determined the intervals between the dates of symptom onset and diagnosis, physician's notification to the LDH, and LDH reporting to the KCDC (Figure 1). We excluded PHC from the analysis because PHC and LDH were technically notified at the same time through an electronic reporting system. Positive predictive value (PPV) was determined by dividing number of laboratory-confirmed cases by number of laboratory tests performed.

T_1 was defined as the time lag between symptom onset to diagnosis; T_2 as the time from diagnosis to notification of the LDH; and T_3 as the time between taken by the LDH to report to the KCDC. The time limit of each step was defined as 'within one day' and the time limit for $T_1+T_2+T_3$ was defined as 'within three days'.

As reported previously, the area over curve (AOC) represents the sum of time lag for all reports divided by the number of clinical or laboraotyry-confirmed cases in each period [Ref]. The difference between the two AOC indicates the time reduction per cases.

Ref: Yoo HS et al. Epdemiol Infect 2013.

Results

1. Demographic Characteristics

From 2002 to 2009, a total of 354 suspected measles cases were reported to the KCDC; 113 (32%) during Period A and 241 (68%) during Period B. Of the cases reported during Period A, 68% were clinically-confirmed, whereas 90% of cases reported during Period B were laboratory-confirmed (Table 1). During Period A, 60% of cases were male, but the male-to-female ratio was nearly equal during Period B. During Period A, 24% of cases reported were school-age children aged 6–17 years, whereas 7% of cases during Period B were in this age group. PPV during Period A was 10.7%, and during Period B was 29.0%. Unlike the absence of seasonal variability observed during Period A, a majority of cases were reported between April and June during Period B. No cases had their source of infection identified during Period A, whereas 37% of cases that occurred during Period B had an identified source of infection.

Table 1. Demographic and epidemiologic characteristics of reported measles cases, by surveillance periods, Republic of Korea, 2002-2009.

Characteristics	Period A*		Period B*	
	No.=113	(%)	No.=241	(%)
Classification†				
Clinically-confirmed	77	(68.1)	24	(10.0)
Laboratory-tested	337		747	
Laboratory-confirmed	36	(31.9)	217	(90.0)
PPV		(10.7)		(29.0)
Gender				
M	68	(60.2)	122	(50.6)
F	45	(39.8)	119	(49.4)
Age group				
<1yr	25	(22.1)	82	(34.0)
1-5yr	51	(45.1)	121	(50.2)
6-17yr	27	(23.9)	17	(7.1)
≥18yr	10	(8.8)	21	(8.7)
Residence				
Metropolitan cities	61	(54.0)	169	(70.0)
Provinces	52	(56.0)	72	(30.0)
Seasonality				
January-March	30	(26.5)	12	(5.0)
April-June	38	(33.6)	172	(71.4)
July-September	17	(15.0)	46	(19.1)
October-December	28	(24.8)	11	(4.6)
Transmission source				
Source-identified	0	(0)	88	(36.5)
Source-unidentified	113	(100.0)	153	(63.5)

*Period A, from January 2002 to March 2006, under routine case-based measles surveillance; Period B, from April 2006 to December 2009, routine case-based measles surveillance plus sentinel laboratory surveillance.

†Clinically-confirmed measles cases, defined as cases that met the clinical case definition and for which no adequate blood specimen was taken; laboratory-confirmed measles cases, defined as cases that met the clinical case definition and were laboratory-confirmed. Abbreviations; PPV, positive predictive value.

2. Timeliness of Reporting

Table 2 shows the proportion of measles cases reported within the specified time limit. For clinically-confirmed cases, the proportion of timely reported cases was relatively constant between Periods A and B, whereas for laboratory-confirmed cases the proportion for timely reporting at T_1, T_2, $T_{3,}$ and $T_1+T_2+T_3$ increased from Period A to Period B. Among clinically-confirmed cases, timely reporting had decreased from 29% to 21%, whereas timely reporting of laboratory-confirmed cases had increased from 8% to 17%. Overall, among both clinically- and laboratory-confirmed cases, the proportion timely reporting during T_1 and T_2 was higher during Period A, whereas the proportion timely reporting during T_3 and $T_1+T_2+T_3$ was higher during Period B.

Table 2. Proportion of measles cases reported within time limit, by case classification and surveillance periods, Republic of Korea, 2002-2009.

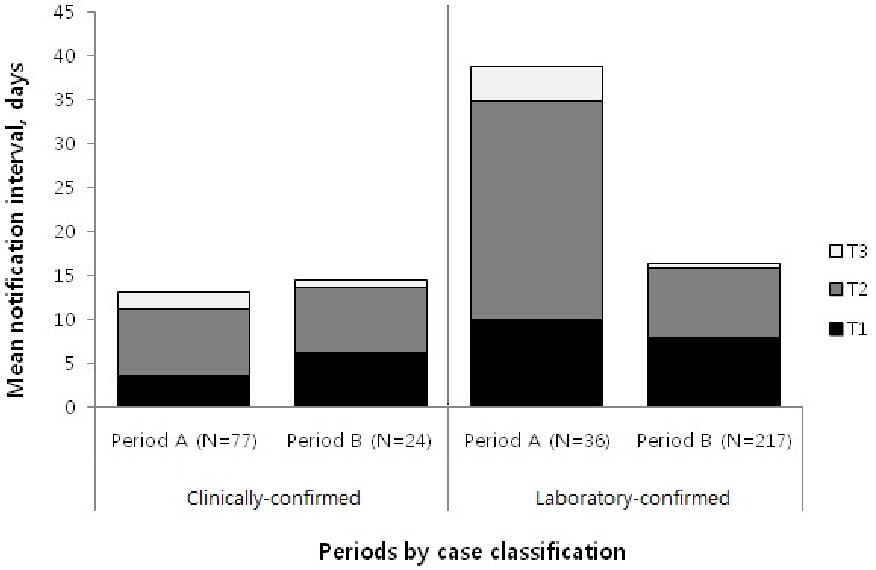
Time limit*	Clinically-confirmed† (%)		Laboratory-confirmed† (%)		Total cases† (%)	
	Period A N=77	Period B N=24	Period A N=36	Period B N=217	Period A N=113	Period B N=241
T_1	28.6	20.8	8.3	16.6	22.1	17.0
T_2	40.3	29.2	22.2	25.3	34.5	25.7
T_3	62.3	79.2	61.1	86.2	61.9	85.5
$T_1+T_2+T_3$	11.7	12.5	0	9.2	8.0	9.5

*Time limit at each step was defined as 'within one day'; time limit for $T_1+T_2+T_3$ was defined as 'within three days'; T_1, time from symptom onset to diagnosis; T_2, time from diagnosis to notification of the Local Health Department (LDH); T_3, time taken for reporting from the LDH to the Korea Centers for Disease Control and Prevention (KCDC); $T_1+T_2+T_3$ indicates the sum of time limits from symptom onset to report to KCDC.

†Clinically-confirmed measles cases, defined as cases that met the clinical case definition and for which no adequate blood specimen was taken; laboratory-confirmed measles cases, defined as cases that met the clinical case definition and were laboratory-confirmed; Period A, from January 2002 to March 2006, under routine case-based measles surveillance; Period B, from April 2006 to December 2009, routine case-based measles surveillance plus sentinel laboratory surveillance.

The mean notification intervals according to case classification and surveillance periods are compared in Figure 2. For clinically-confirmed cases, the overall mean notification interval was similar between Periods A and B; however, the interval from symptom onset to diagnosis (T_1) increased from 3.7 days to 6.3 days, respectively. For laboratory-confirmed cases, the overall mean notification interval decreased from 38.8 days to 16.4 days between Periods A and B, respectively. The most remarkable decrease was found in the interval between LDH and KCDC (T_2), which decreased from 24.8 days to 7.8 days.

Figure 2. Comparative mean notification intervals by case classification and surveillance periods, Republic of Korea, 2002–2009.



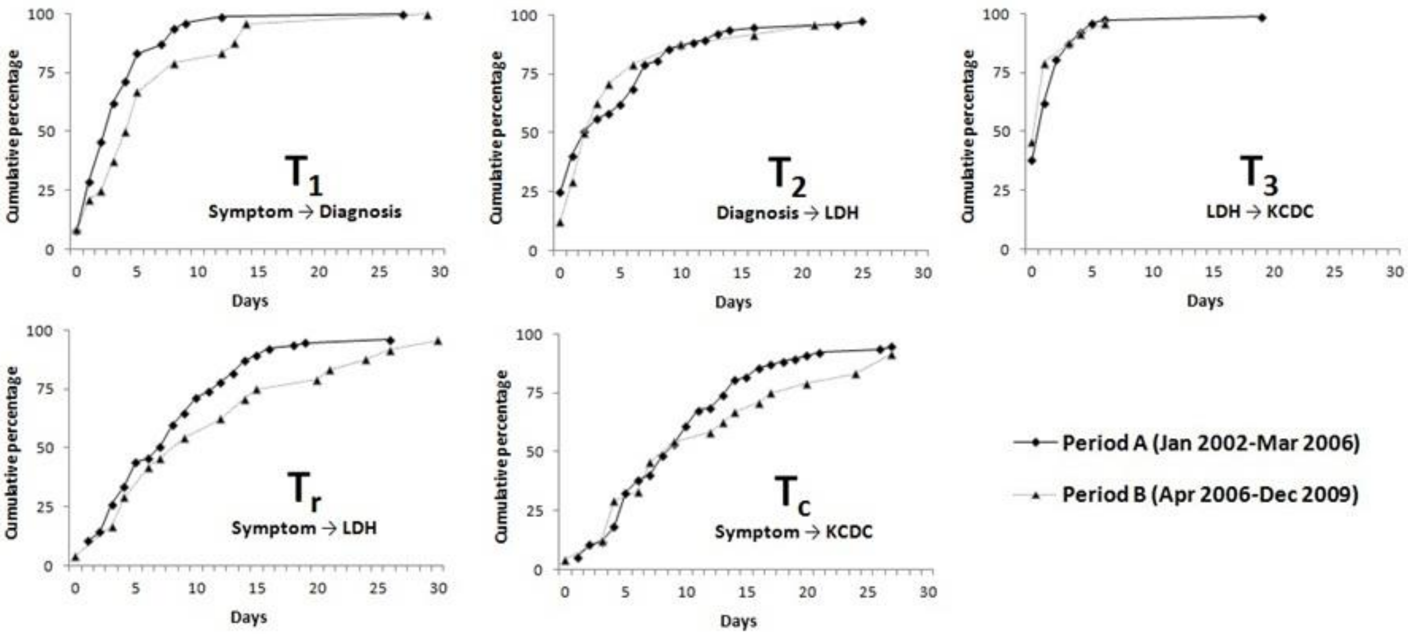
*Period A, from January 2002 to March 2006, under routine case-based measles surveillance; Period B, from April 2006 to December 2009, routine case-based measles surveillance plus sentinel laboratory surveillance.

†Clinically-confirmed measles cases, defined as cases that met the clinical case definition and for which no adequate blood specimen was taken; laboratory-confirmed measles cases, defined as cases that met the clinical case definition and were laboratory-confirmed.

§T_1, time from symptom onset to diagnosis; T_2, time from diagnosis to notification of the Local Health Department (LDH); T_3, time taken for reporting from the LDH to the Korea Centers for Disease Control and Prevention.

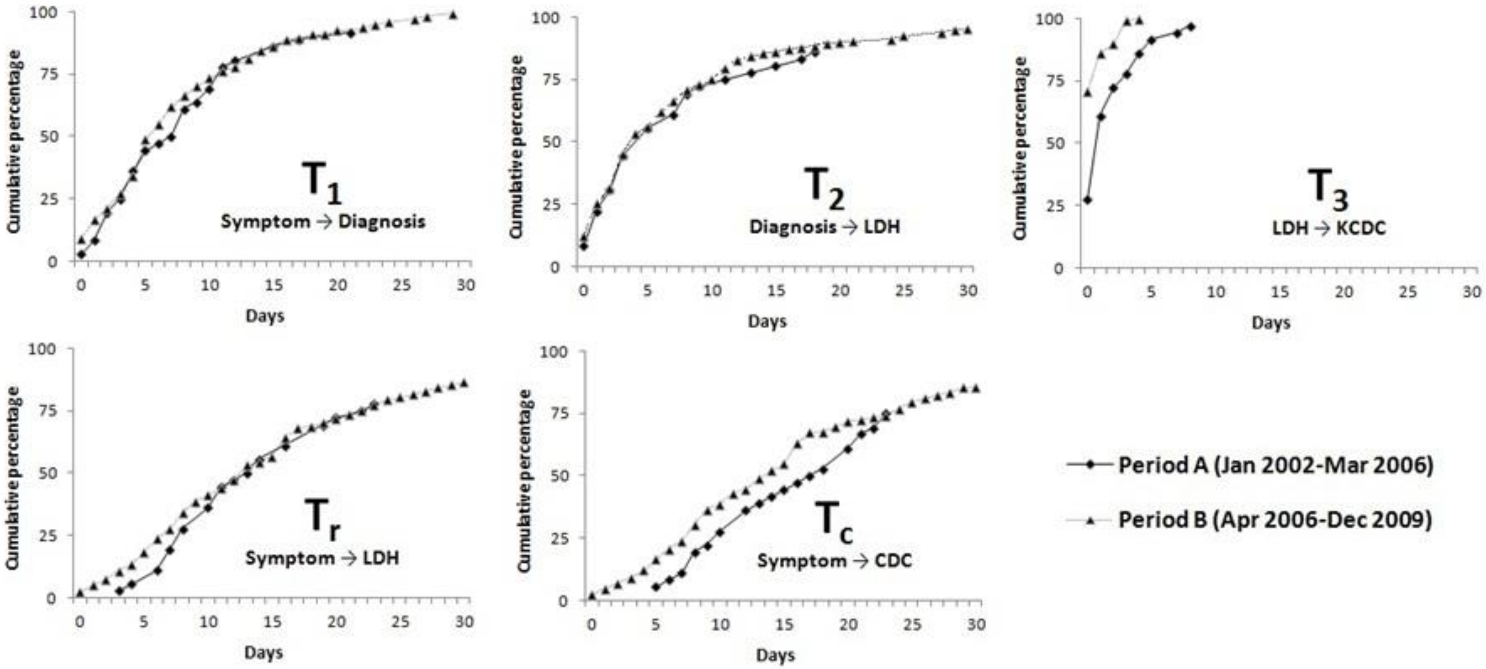
The cumulative distributions of time delay are shown in Figures 3 and 3. The steeper curve indicates a shorter time interval between each step. Among clinically-confirmed cases, there were more time lags observed during Period B compared with Period A (Figure 3). Although the interval difference between LDH and KCDC (T_3) was unremarkable, a reporting delay was observed for the intervals between presence of symptoms and diagnosis (T_1). On the other hand, the differences in T_1 and T_2 were not significant in laboratory-confirmed cases (Figure 4). The intervals between symptom onset to notification of the KCDC (Tc), and from the LDH to the KCDC (T_3) were shorter during Period B. Table 3 describes the time reduction between Period A and B among clinically-confirmed and laboratory-confirmed cases. Among clinically-confirmed cases, time was even more delayed during Period B, ranging -0.2 to -3.0 days per cases. Among laboratory-confirmed cases, the time reduction ranged between 0.4 to 1.8 days per cases.

Figure 3. Cumulative distribution of the time delay in detecting clinically-compatible measles cases (those that met the clinical case definition and for which no adequate blood specimen was taken) during the two surveillance periods, Republic of Korea, 2002–2009



*T1, time from symptom onset to diagnosis; T2, time from diagnosis to notification of the Local Health Department (LDH); T3, time taken for reporting from the LDH to the Korea Centers for Disease Control and Prevention.

Figure 4. Cumulative distribution of the time delay in detecting laboratory-confirmed measles cases (those that met the clinical case definition and were laboratory-confirmed) during the two surveillance periods, Republic of Korea, 2002–2009.



*T_1, time from symptom onset to diagnosis; T_2, time from diagnosis to notification of the Local Health Department (LDH); T_3, time taken for reporting from the LDH to the Korea Centers for Disease Control and Prevention.

Table 3. Distribution of the time reduction in detecting clinically-confirmed and laboratory-confirmed measles cases during the two surveillance periods, Republic of Korea, 2002–2009 (AOC, area over curve)

Timeliness	Clinically-confirmed			Laboratory-confirmed		
	AOC		Time reduction	AOC		Time reduction
	Period A	Period B		Period A	Period B	
T_1 (Symptom->Diagnosis)	3.1	5.5	-2.4	7.9	7.5	0.4
T_2 (Diagnosis -> LDH)	4.6	4.5	0.1	7.7	7.0	0.8
T_3 (LDH->KCDC)	1.5	1.6	-0.2	2.0	0.4	1.6
T_r (Symptom->LDH)	7.8	10.8	-3.0	14.7	14.2	0.5
T_c (Symptom->KCDC)	9.7	11.5	-1.8	16.5	14.6	1.8

Discussion

Our study provides evidence that SLS shortened the time interval between symptom onset to notification, particularly in laboratory-confirmed cases. Among laboratory-confirmed cases, the time intervals for all parameters (T_1, T_2, and T_3) were shortened by 0.4 to 1.6 days per cases, resulting in a higher proportion of measles cases that were reported in a timely fashion. Considering the high transmissibility of measles in a vulnerable population, the reduction in time to report through establishment of SLS was meaningful. Moreover, PPV in Period B was even higher than that of Period A, therefore SLS presumably has not compromised the diagnostic accuracy in clinical reporting of measles, which is worrisome when maximizing timeliness of the surveillance. When utilized in combination with traditional case-based surveillance, SLS improved the timeliness of the identification of measles cases and information flow. This finding extends other reports in which alternative or supplementary surveillance activities have shortened the time delay of disease notification. Assessment of real-time electronic outbreak surveillance for dengue in Latin America showed improved timely notifications of outbreaks occurrences [26]. Another approach, the sentinel case-based surveillance, which was designed to monitor hand-foot-mouth disease from designated sentinel institutions in Hong Kong, was found to provide better timely reporting of suspected cases [27]. Moreover, several studies have shown that SLS reduces the time interval between diagnosis and notification. Through the implementation of electronic laboratory reporting of the hepatitis C surveillance system, an improvement in reporting timeliness was demonstrated in the USA [28]. In the Netherlands, the time delay was dramatically reduced after implementation of SLS for measles and hepatitis A infections [29].

In addition, we also found that the difference in T_1, which depicts that the interval from symptom onset to diagnosis during Period B, was longer than that of Period A. There are two possible main reasons for this difference: first, parents may seek healthcare for only a few children with measles symptoms because the perceived importance of measles would be low in the low-incidence setting; second, physicians are now less aware of measles in an ordinary clinical setting in Korea because measles is now seldom seen, resulting in decreased sensitivity and completeness of measles detection in the primary health care sector during Period B. The measles surveillance system is prone to delays in notification or even under-reporting in disease-eliminated countries, as observed in Germany and Italy [30, 31]. Nevertheless, measles has reemerged in countries that have already declared measles eliminated because new viruses are constantly being introduced from neighboring countries, and there may be ‘pockets’ of susceptible populations with inadequate vaccination coverage. The delay in the diagnosis and notification of measles may provoke an endemic circulation of imported virus; then an outbreak would be expected to occur. Therefore, strengthening surveillance activities through laboratory confirmation and improving timely notification systems are an important aspect of sustaining measles elimination in these countries.

From 2002 to 2009, a total of 354 suspected measles cases were reported to the KCDC. There was a gradual decrease from 2002 to 2005; however, resurgence was observed in 2006 and 2007. The increase in reported cases in each of these 2 years mainly resulted from measles outbreaks. The first outbreak occurred in a preschool in Incheon and involved 15 confirmed cases from 152 exposed students. Among those 15 patients, 14 had received fewer than 2 doses of MMR vaccine, and measles affected 100% of children with no vaccination history [32]. Following the outbreak, the importance of maintaining high 2-dose MMR vaccination coverage and keeping accurate vaccination status records was emphasized. The second incident occurred in 2007, when multiple transmission chains of measles were identified, mainly in hospital settings [33]. Among 180 confirmed measles cases, 81 (45%) resulted from nosocomial transmission in 6 hospitals, mostly located in Seoul and its metropolitan area. More importantly, 124 (69%) cases did not have a history of MMR vaccination. This incident helped to improve the understanding of measles transmission in healthcare settings and how it is related to community transmission; the implication was that nosocomial transmission of measles may precipitate the ongoing spread in the community setting. Although shifts in the epidemiology of infectious diseases are observed following an increase in vaccination coverage, our surveillance data did not show a noticeable age-related-shift among reported cases during the last 10 years.

Measles surveillance ultimately relies on physicians to detect and report cases to the LDH. Because measles is now seen less often in Korea, physicians who began their practices after 2002 may have difficulty in diagnosing the disease. Although obtaining serum specimen is sometimes technically difficult, our data provide evidence that the use of laboratory testing in measles diagnosis is clearly vital when resources permit, especially in disease-eliminated countries.

The benefits of laboratory surveillance include the accuracy and reliability of collected data. On the other hand, the price paid is an additional time delay. The implementation of SLS is one of many efforts to improve the timeliness of laboratory surveillances. Although there is little evidence that laboratory surveillance mitigates the outbreak response capacity, our data suggest that even SLS does not speed up the reporting interval compared with clinically-confirmed cases. Additional efforts to improve the timeliness of laboratory surveillance to one that is as fast as clinically-confirmed cases should be in place in the near future.

Our findings are subject to several limitations. First, because we were unable to obtain data on the source of notification of individual cases (whether it was reported from routine case-based surveillance or from SLS), the time interval of cases reported through SLS was not examined separately. There was no single definition of an ‘SLS-related case’, and we were unable to determine the true number of such events to assess the sensitivity of such surveillance. Further, as observed in the state of Connecticut in the US, the two different surveillance methods may result in a different epidemiology of reported cases of an infectious disease [34]. Second, the change in the epidemiology of measles between Periods A and B may have affected the quality of the surveillance’s performance. Recently, there are fewer school-aged children detected as measles cases and more infants aged less than 12 months are being diagnosed. Suspecting measles and obtaining a serum specimen from this age group may be challenging compared with older children with similar symptoms and signs.

Despite these potential limitations, our observation may well represent an effect of SLS on the timeliness of measles surveillance. Moreover, no other data available match the completeness or cover the same timescale as the national measles surveillance data in Korea. SLS improved the early detection of suspected measles cases that had not yet been reported by physicians, therefore improving the overall performance of measles surveillance. Despite new challenges and increased responsibilities, SLS continues to provide important support for the elimination of measles in Korea.

Conclusion

In conclusion, our data suggest that the SLS in Korea has allowed cases to be captured in a more timely fashion, and adoption of such surveillance measures by other countries may improve the timely collection of measles data that places a burden on surveillance resources.

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국문초록

실험실 능동감시체계 도입에 따른 2002-2009년 홍역 감시자료 적시성 평가

배경: 본 연구는 2002년에서 2009년 사이에 발생한 홍역사례 감시자료 및 역학조사자료를 기초로 우리나라에서 홍역을 퇴치하기 위한 정책 중 실험실 능동감시체계 도입에 따른 적시성의 변화에 대하여 제시하고자 하였다.

방법: 2002-2009년 기간 동안 수집된 질병관리본부에서 확보하고 있는 법정감염병 감시자료 및 2군 감염병 역학조사자료를 취합하여 개별 사례를 세계보건기구 사례 기준에 맞춰 다음과 같이 분류하였다: 1) 임상적 확진; 2) 실험실적 확진. 이후 개별 사례들의 인구학적 분포 및 임상적 특성을 파악학도 전파 경로를 확인한다. 홍역 양 발진 발생일을 기준으로 기간을 일반적 수동 감시체계가 운영되던 2002년 1월부터 2006년 3월(A시기)과 실험실 능동감시체계가 추가적으로 도입된 2006년 4월부터 2009년 12월로 구분한다(B시기). 모든 홍역 확진 사례의 홍역 양 발진 발생일, 의사의 진단 일시, 보건소 신고 일시, 질병관리본부 보고 일시를 파악하여 각 단계별로 1일 이내의 시간이 소요된 경우 적기 신고인 것으로 분류하였다.

결과: A시기 동안 113례의 홍역의사환자가, B시기 동안 241례의

홍역의사환자가 보고되었다. 양 시기 간에 임상적 확진례의 적기 신고 분율은 차이가 없었다. 하지만 B시기의 실험실적 확진례의 적기 신고 분율은 A시기보다 높은 것으로 나타났으며 실험실 능동감시체계는 실험실적 확진례에서의 인지기간을 평균 39일에서 16일로 감소시켰다. 개별 사례별로는 인지기간을 실험실적 확진 사례 당 0.4-1.8일로 감소시켰다.
결론: 우리나라에서 실험실 능동감시체계는 신고가 되지 않은 채 실험실 검사만 의뢰되었던 건수들의 인지기간을 단축시켰으며 전체적인 감시체계의 질을 향상시켰다.

주요어 : 홍역, 감시체계, 적시성

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