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Infection Control in Nursery Schools and Schools Using a School Absenteeism Surveillance System

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Infection control in nursery schools and schools is important for community health and the health of children. In Japan, caregivers of children or students usually report the absence due to illness to their attending nurseries or schools, including symptoms and diagnosed diseases. The (Nursery) School Absenteeism Surveillance System, (N)SASSy, covers about 60% of schools and 40% of nurseries in Japan. In this paper, we evaluated the benefits of (N)SASSy as an infection control measure by a public health center. Mito Public Health Center (MPHC) covers 58 nurseries and 186 schools, as of May 2015, and called the nurseries and/or schools to confirm the situation, in case of aberration detected through (N)SASSy. The outcome was defined as the proportion of cluster avoidance by advice from MPHC. A cluster was identified, when the number of patients at the same facility with the same symptom or diagnosed disease was greater than ten during the prior seven days. During the study period (April 2015-March 2016), MPHC advised 85 times, and clusters were avoided 82 times (96.5%). The proportion of cluster avoidance was 100% for fever, enterohemorrhagic *Escherichia coli* infection, respiratory syncytial virus infection, or streptococcal pharyngitis infection. The proportion of cluster avoidance for diarrhea, vomiting or gastroenteritis infection, mumps, hand-foot-mouth disease (HFMD), and influenza was 78.8, 50.0, 20.0, and 6.7%, respectively. In conclusion, advice from a public health center given by phone based on information from (N)SASSy will be helpful for reducing the number of clusters of infectious diseases, except for HFMD and influenza.

Keywords: Absenteeism Surveillance System; cluster; infectious disease; nursery school; public health center
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Introduction

For control of infectious diseases and for preventing and minimizing clusters, early detection and response are extremely important. Particularly, infection control in nursery schools and schools is quite important for community health and the health of children.

Syndromic surveillance is conducted as a powerful method to support earlier disease detection (Buehler et al. 2003; Henning 2004). It can provide information before visiting a doctor or diagnosis and can thus greatly contribute to public health. Electronic medical records have been anticipated for use as an information resource (Lazarus et al. 2002; Wu et al. 2008). In Japan, such information had been examined for use in monitoring outpatient symptoms (Ohkusa et al. 2006). However, because patients of a particular age or disease severity might not visit a doctor (Sugawara et al. 2005), some information from organizations other than medical institutions, such as ambulance transfer (Shimatani et al. 2015), over-the-counter drug sales (Ohkusa et al. 2005), and prescriptions (Sugawara et al. 2012b), had been used for syndromic surveillance in Japan. Particularly, prescription surveillance contributed to the monitoring of an influenza pandemic in 2009 (Sugawara et al. 2011); data were used by prefecture offices to control the spread of the disease. The system has continued to the present day to report outbreak situation nationwide through the web. However, this prescription surveillance has remained limited to monitoring of influenza and varicella or herpes zoster because there are specific medicines to treat

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patients with these diseases. The system cannot monitor diseases that have no specific medicines.

Many surveillances activities conducted worldwide have assessed school absenteeism (Schmidt et al. 2010; Cheng et al. 2012, 2013; Kom Mogto et al. 2012; Fan et al. 2014). However, they monitored total absenteeism or only related to influenza. In Japan, on the other hand, caregivers of children or students usually report the reasons for absence from nursery schools or schools about illness, symptoms, and diagnosed diseases to attending nursery schools or schools. The (Nursery) School Absenteeism Surveillance System, (N)SASSy, is a real-time surveillance system and has used this virtue to provide the systematic information that is helpful for monitoring all symptoms and diagnosed diseases (Ohkusa et al. 2011; Suzue et al. 2012; Sugawara et al. 2012a; Sugawara and Ohkusa 2013; Matsumoto et al. 2015, 2016; Watanabe et al. 2016).

Having the information from caregivers of students who were absent from nurseries or schools because of infectious diseases, school nurses or responsible teachers provide information to (N)SASSy through the internet. Even though the timing of data entry at each nursery or school was not limited by (N)SASSy, the Ibaraki prefectural government has recommended them to enter the data into the system until noon, and almost all nurseries and schools followed the requirements. When data were entered by each nursery or school, (N)SASSy updates the situation to share the data among participants immediately. Accordingly, the public health centers in Ibaraki usually check (N)SASSy twice in a day, before noon and afternoon, so as to recognize situations and find out aberration timely. If the public health centers in Ibaraki found some aberration, they immediately called the involved nursery and/or school, in which aberration was detected, so as to know the situations in detail and advise them if necessary.

As of the end of 2016, (N)SASSy covered approximately 37,000 schools, including 10,000 nursery schools, or about 60% of all schools and 40% of all nursery schools in Japan. In all, on a daily basis, the system monitors the health conditions of about five million children younger than 18 years old as of the end of 2018. The (N)SASSy information is utilized in nurseries and schools themselves to recognize the situation of the surrounding areas and inform teachers, students, and caregivers, thereby promoting precaution if some outbreaks were found in the surrounding areas but not at their nurseries or schools. Information from (N)SASSy is also shared among nursery and school doctors, educational boards, local government offices for nursery schools, the public health center, and the local medical association. The shared information encourages earlier awareness of infectious diseases, which leads to prompt responses to the initial stage of outbreaks in nursery schools and schools. Moreover, having such a large set of data related to children's health promotes large epidemiological studies (Matsumoto et al. 2015).

When it comes to public health, Japan has a unique school system. According to the School Health and Safety Act, at all levels of schools except for nursery schools, when students are diagnosed as defined infectious diseases such as influenza, varicella, mumps, and others, schools should not allow students to attend classes. This practice is designated as "attendance prohibition due to infectious disease." A student, who has a defined infectious disease, cannot attend class. However, such an absence does not count officially as an absence. Caregivers must notify the school if their children are diagnosed with a defined infectious disease. Moreover, even if the children have not visited a doctor or have not been diagnosed with any defined diseases, caregivers usually call the school and report the child's symptoms, e.g., fever, vomiting, or diarrhea. In these cases, schools do not apply "the attendance prohibition due to infectious disease." No other country has a similar system.

Nursery schools, however, are not classified as education institutions but as welfare facilities. The School Health and Safety Act do not apply to nursery school children; namely, the attendance prohibition due to infectious diseases is not applicable to them, even if they were diagnosed as a defined infectious disease in the law. Even if such a disease is not diagnosed or the children did not visit a doctor, caregivers of nursery school children usually report children's health condition to their nursery schools. Of course, the law does not require doing so, but almost all nursery schools require caregivers to report based on the guideline from the Ministry of Health, Labour, and Welfare (MHLW). Additionally, the culture, custom, or rule among schoolchildren's caregivers might affect caregivers' behavior because nursery school children might be younger siblings of schoolchildren.

In short, all information related to children's health conditions is integrated in nursery schools or schools. The (N)SASSy computerized system comprises a network of information sharing among concerned organizations and individuals. We can therefore use (N)SASSy as a form of syndromic surveillance in Japan. The system can be a powerful public health tool for use during mass gatherings or important political events (Shimatani et al. 2015), such as the G7 summit meeting. In fact, it will even be utilized during the 2020 Tokyo Olympic Games.

(N)SASSy was developed by a research group headed by Dr. Ohkusa, one author of this paper, and had been funded by the MHLW since 2007. It has retained its copyright to the present day. Currently, it is operated by the Japanese Society of School Health.

Ibaraki prefecture, located near Tokyo, had 2,907,912 populations in April 2016. It introduced (N)SASSy to schools in 2009 and started to activate it at nursery schools in 2012. Every day from that time until 2014, public health authorities have been able to control influenza, measles, and rubella by monitoring the infectious diseases of children aged 0-18 years who attend nurseries or schools (Watanabe et al. 2016).

This paper presents the activities at a public health center undertaken to mitigate the incidence and effects of infectious diseases at nursery schools and schools. This study has demonstrated the system's effectiveness at avoiding clusters. Similar activities have been reported (Matsumoto et al. 2015), in which only the number of advisories from public health centers was described. Subsequently, Kurita et al. (2018) described reduction effects of (N)SASSy by comparing the incidence in prefectures where (N)SASSy has been introduced with the incidence in other prefectures. In this paper, we present a proposed procedure with (N)SASSy for infection control and evaluate its effect. This is the first time to examine quantitatively the effect of public health intervention using (N) SASSy on cluster of infectious diseases.

Methods

The Mito Public Health Center has jurisdiction over Mito city and five smaller cities in Ibaraki prefecture. The area had population of 466,713, including 76,165 children younger than 18 years old as of April 1, 2016. In that jurisdiction in May 2015 there were 58 nursery schools, 49 kindergarten and kodomoens (hybrid nursery schools and kindergartens), 73 elementary schools, and 35 junior high schools, in addition to 21 high schools and 8 special needs schools. The number of children attending nursery schools was 5,327, and those attending schools were 55,803. The study period extended from April 2015 through March 2016.

After Mito Public Health Center verified the situation on (N) SASSy, they notified the involved nursery schools or schools, in which some aberrations were detected automatically in (N)SASSy, to confirm the situation and to advise them so as to control. The system adopted C1 in the Early Aberration Reporting System (EARS), which was developed by the U.S. Center for Disease Control and Prevention. Currently EARS is supported by the National Center for Infectious Diseases, Bioterrorism Preparedness and Response Program (Hutwagner et al. 2003, 2005) and is widely used as a standard procedure in syndromic surveillance (Chen et al. 2010). EARS has three indicators, C1, C2 and C3, to detect aberrations. Of the three indicators, C1 is the timely indicator with highest sensitivity. It defines aberration if the number of absences in a class with the same symptoms today was higher than the average in the prior seven days by three times of the standard deviation of the prior seven days. For instance, more than three absences are judged as an aberration if a class had one absence with the same symptoms in the prior seven days.

The outcome was defined as the proportion of avoidance of cluster attributable to advisories from the Mito Public Health Center. A cluster was inferred if the number of patients at the same facility with the same symptom or diagnosed disease was greater than ten during the prior seven days, applying corresponding notices from MHLW related to reports of clusters at a welfare facility issued on February 22, 2015. Cluster avoidance was defined as the number of patients at the same facility where the public health center had given advice, with the same symptom or diagnosed disease during seven days, was not greater than ten. The cluster avoidance rate (%) was defined as $100\ \{1 - z / (x + z - y)\}$: x is number of events, in which Mito Public Health Center recognized aberration and advised the involved nursey schools or schools about infection control even before the aberration was identified as a cluster; y is number of clusters emerged after advice from Mito Public Health Center; and z is the sum of the number of clusters emerged after advice from Mito Public Health Center (the same number shown as y) and the number of clusters emerged before advice (see Table 1). Thus, $(x + z - y)$ means that total number of events. Because y is also included in z, we have to delete y from $(x + z)$. For example, when a cluster had occurred before the public health center recognized aberration and called to a nursey school or school, such a cluster was included in z but was not included in x or y, even if the public health center called to the involved nursey school or school after the onset of cluster. On the other hand, when a cluster occurred after the public health center had advised the involved nursey school or school, such a case was included in x, y, and z.

Each of x, y and z was defined as the number of events or clusters, and each event is defined as series of patients with the same symptom or disease during the period from initial few cases to cessation, but is not defined as number of phone calls. The equation of $z / (x + z - y)$ indicates proportion of clusters over total number of events. There might be some events, with only one patient in total or ceased before (N)SASSy identified aberration. We excluded these cases with very small number patients in total from the considered events.

Ethical considerations

(N)SASSy collects the number of patients reported as having each disease, with no personal information such as a name or address. These are anonymous data. For that reason, the "Ethical Guidelines for Medical and Health Research Involving Human Subjects" in 2014 are not applicable to this study. No ethical issue exists in relation to the use of these data for this study.

Results

Mito Public Health Center called the nursery schools and/or schools where (N)SASSy detected some aberration automatically 85 times; about three minutes were needed per call. Mito Public Health Center called to nursery schools or schools due to the detected aberration through (N)SASSy in diarrhea, vomiting or gastroenteritis infection (GI), fever, enterohemorrhagic *Escherichia coli* (EHEC) infection, mumps, hand-foot-mouth disease (HFMD), respiratory syncytial (RS) virus infectious, streptococcal pharyngitis infectious, influenza, and head lice (Table 1).

Despite 70 cases of intervention by phone calls for diarrhea, vomiting or gastroenteritis infection (GI), we were unable to prevent the onset of three clusters of infection (Table 1). Thus, among 85 events, the onset of clusters was avoided 82 times (96.5%). The proportion of cluster avoidance for fever, EHEC infection, RS virus infection, streptococcal pharyngitis infection, and head lice was 100%, with total 11 phone calls. Proportion of cluster avoidance was 78.8% for diarrhea, vomiting or GI, 50.0% for mumps, 20.0% for HFMD, and 6.7% for influenza. Notably, there were four clusters of HFMD and 28 clusters of influenza, but Mito Public Health Center intervened in these diseases only once and twice, respectively.

Table 1. Effects of advisement from Mito Public Health Center on the number of clusters detected during April 2015-March 2016.

Symptom/Disease	Number of events in which Mito Public Health Center intervened (x)	Number of clusters emerged after advice from Health Center (y)	Total number of clusters emerged (z)	Cluster avoidance rate (%)
Diarrhea, vomiting or GI	70	3	18	78.8
Fever	5	0	0	100.0
EHEC infectious	3	0	0	100.0
Mumps	1	0	1	50.0
HFMD	1	0	4	20.0
RS virus infectious	1	0	0	100.0
Streptococcal pharyngitis infectious	1	0	0	100.0
Influenza	2	0	28	6.7
Head lice	1	0	0	100.0
Total	85	3	51	61.7

A cluster was identified, when the number of patients at the same facility with the same symptom or diagnosed disease was greater than ten during the prior seven days. The cluster avoidance rate (%) was defined as $100 \{1 - z / (x + z - y)\}$, as detailed in Methods. Second column (x) shows the number of events, in which Mito Public Health Center advised the involved nursey school or school about infection control even before the aberration was identified as a cluster. Third column (y) shows the number of clusters emerged after Mito Public Health Center had given advice. The total number, shown in fourth column (z), represents the sum of the number of clusters emerged after advice (y) and the number of clusters emerged before advice from Mito Public Health Center.
GI, gastroenteritis infection; EHEC, enterohemorrhagic *Escherichia coli*; HFMD, hand-foot-mouth disease; RS, respiratory syncytial.
Note: In the jurisdiction of Mito Public Health Center, as of May 2015, there were 58 nursery schools, 49 kindergartens and kodomoens (hybrid nursery school and kindergartens), 73 elementary schools, 35 junior high schools, 21 high schools, and 8 special needs schools.

Discussion

Results demonstrated that advices from public health center given by phone can avoid clusters for many symptoms and diagnosed diseases aside from HFMD and influenza. Infection control at nursery schools and schools for HFMD was well known to be extremely difficult because its virus shedding period is very long, longer than one month (Sioofy-Khojine et al. 2018). Moreover, many patients were not absent from nursery schools or schools for such a long time. On the other hand, the incubation period of influenza is short, 2-4 days; moreover, almost half of all infected children are therefore asymptomatic (Hsieh et al. 2014; Ip et al. 2017). For that reason, controlling these diseases in nursery schools or schools is difficult. Although the avoidance rate of mumps is much better than that of influenza, a high proportion of misdiagnosed cases (Falk et al. 1989) of mumps might worsen the avoidance rate. If 'fever' and 'influenza' were treated in the same category as 'fever and influenza,' then the avoidance rate would be raised to 20%, comparable to that of HFMD.

Although results show that the avoidance rate for EHEC was 100%, it makes no sense at all that it was the result of advice given by phone. Primarily, the occurrence of more than ten patients with EHEC in a nursery school or school is apparently very rare; it can be regarded as a catastrophic event. EHEC is a severe disease, but might not be a common disease. Therefore, even a few patients with EHEC should demand a response of the public health center in timely manner. For that reason, this perfect avoidance in EHEC might not reflect the results of advice from the public health center.

Our obtained results were apparently consistent with those reported from an earlier study (Kurita et al. 2018), which showed that prefectures with (N)SASSy had fewer patients with influenza, varicella, HFMD, mycoplasma pneumonia, aseptic meningitis, and herpangina. For example, influenza patients in the (N)SASSy prefectures were 53% lower than those in the non-(N)SASSy prefectures. However, the earlier study only compared some differences in incidence between (N)SASSy prefectures and non-(N)SASSy prefectures. In this sense, how (N)SASSy functioned remains ambiguous. By contrast, the present study examined specific methods of intervention. Results show that advices by phone calls might reduce incidence of certain diseases. However, we do not know whether we can extend the obtained results to other areas or not. Confirmation of the same effects as the obtained results in other areas is anticipated as the next challenge. Moreover, some results were not consistent between the two studies. The present study found no substantial effect on influenza or HFMD, although the earlier study found substantial and significant effects (Kurita et al. 2018).

The present study has several limitations. First, we cannot set up a control group. Control groups for this study should be areas where public health centers did not intervene in nursery schools and schools. However, if (N)SASSy is activated in an area, then the public health centers cannot help intervening in nursery schools and schools where an aberration is detected. Conversely, if (N)SASSy is not activated in an area, then a public health center cannot intervene in nursery schools and schools. For such areas, the situation of infectious diseases was unknown at all. For that reason, control group cannot be set up a for this study. Because of this limitation, we cannot separate the avoidance rate into effects of advisories from the public health center and natural containment without advice. Thus, we must acknowledge that our obtained avoidance rate might be an overestimation.

The second limitation is the robustness of the results. This report described the results obtained for an area in one year. The results might differ in other areas or other years. For example, influenza virus sometimes shifts and causes larger outbreak. Outbreaks of mumps, HFMD, and varicella in an area typically occurred at intervals longer than one year. Therefore, the avoidance rate for a symptom or diagnosed disease can be expected to change area by area and year by year. We must check the robustness of our findings. We accept that task as the next challenge for research in this field.

The third limitation was characteristics of school type. We particularly examined how the proportion of aberrations avoids clustering irrespective of the type of (nursery) schools. However, some diseases have clear age pattern. For example, incidence of influenza patients usually was the highest in elementary school, whereas the incidence of HFMS was typically higher among preschool children. However, in general, high schools are larger than nursey schools. For that reason, infection control in nursery schools and schools might be different by the type of schools. Therefore, the possibility of developing a cluster might differ by the type of symptoms or diseases and by the type of schools. Those analyses by type of schools also remain as the future research.

In conclusion, advice from a public health center by phone call based on information from (N)SASSy is helpful for reducing the number of clusters of infectious diseases, except for influenza and HFMD.

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Conflict of Interest

The authors declare no conflict of interest.

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