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Retrospective study of the change in vaccination rate through the introduction of regular pneumococcal vaccination and a check box

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Abstract

Background：A regular vaccination schedule for the 23-valent pneumococcal polysaccharide vaccination targeting elderly individuals and others has been in effect since October 2014 in Japan. This study mainly examined whether a regular vaccination schedule and introduction of a vaccination status checkbox in electronic medical records increased the vaccination rates.

Methods：Subjects were inpatients and outpatients who received the pneumococcal vaccine in the Department of General Medicine at Juntendo University Hospital between April 1, 2011 and March 31, 2016. The vaccination rates in individuals ≥ 65 years old before and after introducing the regular vaccination schedule and checkbox were investigated.

Results：A total of 365 people ≥ 65 years old were vaccinated. The vaccination rate (1.3%) for individuals ≥ 65 years old after introducing the regular vaccination schedule was significantly higher than the vaccination rate (0.5%) before introducing the schedule ($p < 0.05$). However, the vaccination rate significantly decreased after the introduction of the checkbox to the electronic medical records ($p < 0.05$).

Conclusions：Although the regular vaccination schedule was effective and should be continued., we were unable to show an improvement of the vaccination rate by the introduction of the checkbox to indicate a patient's vaccination status in the electronic medical records. We feel that the introduction of a check box along with other items such as an alert system would be more effective.

Text

1. Background

According to annual estimates by the Ministry of Health, Labour and Welfare in Japan, pneumonia was the third leading cause of death in 2013, accounting for approximately 124,000 deaths.[1] Pneumococcus is the most common cause of bacterial pneumonia, and prevention by vaccination is also implemented at present；both the 23-valent pneumococcal polysaccharide vaccine (PPSV23) and the 13-valent pneumococcal conjugate vaccine (PCV13) have been introduced in Japan. Pneumococcal vaccination is recommended, as it has been shown to reduce the incidence and mortality rates of pneumonia among the elderly

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population.[2] Especially, the rate of pneumococcal pneumonia in individuals ≥ 65 years old has been reduced by approximately 30% due to vaccination with PPSV23.[3] Pneumococcal vaccination is also recommended to provide a significant preventative effect against invasive pneumococcal disease.[4] A partially subsidized routine vaccination schedule for PPSV23 targeting elderly individuals who are ≥ 65 years old in increments of five years（i.e., 65, 70, 75, 80, etc.）and others has been in effect since October 2014 in Japan, and eligible people can be vaccinated only once using the public subsidies.[5]

The national vaccination rate in Japan for the pneumococcal vaccine among members of the elderly population ≥ 65 years old was estimated to be 25.4% as of the end of June 2013.[6] This vaccination rate is low compared with the vaccination rate（59.7%）in the United States, as reported by the Centers for Disease Control and Prevention（CDC）in 2013.[7] To improve the pneumococcal vaccination rate, use of a patient summary sheet in electronic medical records began on March 9, 2015 at Juntendo University Hospital. The patient summary sheet also includes a checkbox for the confirmation of a patient's pneumococcal vaccination status. While there does not appear to be an official target rate for official pneumococcal vaccination in Japan, it should be as high as possible given the effectiveness of the vaccination for prevention of pneumococcal disease. The aim of the present study was to examine whether a routine vaccination schedule and the introduction of a checkbox in electronic medical records to indicate a patient's vaccination status increase the vaccination rate, and to investigate the characteristics of individuals who were vaccinated.

2. Patients and methods

2.1 Subjects and extracted data

Subjects were inpatients and outpatients who were vaccinated with the pneumococcal vaccine in the Department of General Medicine at Juntendo University Hospital between April 1, 2011 and March 31, 2016. The identification numbers of vaccinated individuals were obtained from the Department of Pharmacy, and data were retrospectively extracted from electronic medical records. The total number of inpatients and outpatients attending the Department of General Medicine was obtained from the Medical Professions Division.

The basic information of subjects and the monthly number of patients ≥ 65 years old in the Department of General Medicine between April 1, 2011 and March 31, 2016 were collected. The basic information of subjects included their identification number, date of birth, age, sex, date of pneumococcal vaccination, patient status（inpatient or outpatient）, type of vaccine（PPSV23 or PCV13）, medical history（pneumococcal pneumonia, non-pneumococcal pneumonia, pulmonary tuberculosis, cerebral hemorrhage, cerebral infarction, bronchial asthma, heart failure, cardiomyopathy, liver cirrhosis, chronic obstructive pulmonary disease, renal failure, nephrotic syndrome, diabetes mellitus, influenza, HIV infectious disease, meningitis, sepsis, alcohol poisoning, cerebrospinal fluid leakage）, presence or absence of the spleen, smoking history, history of steroid use, and history of immunosuppressive drug use.

2.2 Definition of study periods

The different periods of the study were defined as follows. The period before the introduction of the regular vaccinations was between April 1, 2011 and September 30, 2014 ; the period after the introduction of the regular

vaccinations was between October 1, 2014 and March 31, 2016 ; the period before the introduction of the checkbox in the medical records was between April 1, 2011 and March 8, 2015 ; and the period after the introduction of the checkbox in the medical records was between March 9, 2015 and March 31, 2016.

The dates that patients were vaccinated were subsequently categorized into three periods (period 1 was between April 2011 and September 2014 ; period 2 was between October 2014 and March 8, 2015 ; and period 3 was between March 9, 2015 and March 2016). The reason for selecting these periods is as follows. We selected period 1 to know the vaccination rate before the introduction of the pneumococcal regular vaccination schedule. We selected period 2 to confirm improvement of the pneumococcal vaccination rate through introduction of the regular vaccination schedule, and period 3 to confirm improvement of the pneumococcal vaccination rate through introduction of the checkbox in the medical records.

2.3 *Checkbox in the electronic medical records*

Use of a patient summary sheet in electronic medical records began on March 9, 2015 at Juntendo University Hospital. The patient summary sheet also includes a checkbox for the confirmation of a patient's pneumococcal vaccination status. The check box consists of three items : vaccinated with pneumococcal vaccine, no vaccination, unknown. Doctors input by checking what is applicable when they see the patients. Although doctors were informed to use checkbox in a conference, it depended on individual discretion.

2.4 *Statistical analysis*

The vaccination rate for individuals ≥ 65 years old was calculated in each period. The rate that individuals with the pneumococcal vaccination had a medical history, etc., was also calculated. The data were analyzed using the χ^2 test (SPSS version 24 ; SPSS Japan Inc., IBM Company, Tokyo, Japan). $p < 0.05$ was considered to indicate statistical significance. The vaccination rate and the rates of each medical history were calculated as follows.

· Pneumococcal vaccination rate (for patients ≥ 65 years old) = number of patients (≥ 65 years old) who had been vaccinated with the pneumococcal vaccine at the Department of General Medicine / number of patients (≥ 65 years old) attending the Department of General Medicine × 100

· The rate of each medical history = number of patients who had each medical history / number of patients who had been vaccinated with the pneumococcal vaccine at the Department of General Medicine × 100

The study protocol was approved by the ethics committee at Juntendo University Hospital (16-023).

3. Results

There were 478 subjects, but we could not confirm the data about 5 people. According to the medical records, 473 people had been vaccinated, and 365 (77.2%) of them were ≥ 65 years old. The median age was 70 years (minimum 22 years, maximum 93 years), and most of those vaccinated received PPSV23 and were outpatients (Table 1). The number of vaccinated people ≥ 65 years old during period 1 and during periods 2 and 3 combined was 180 (38.1%) and 185 (39.1%), respectively. The number of vaccinated people ≥ 65 years old during periods 1 and 2 combined and during

Table 1

Characteristics of participants who received a pneumococcal vaccination between April 2011 and March 2016.

	N（%）or Median（Max, Min）	
Number of people vaccinated	473	
Number of people vaccinated ≥ 65 years old	365	（77.2%）
Age（years）	70	（93, 22）
Sex（male）	246	（52.0%）
Hospital status when vaccinated（Outpatient）	439	（92.8%）
Type of vaccine		
PPSV23	444	（93.9%）
PCV13	29	（6.1%）

Table 2

Number of patients ≥ 65 years old, number of individuals vaccinated with pneumococcal vaccine and vaccination rate.

	Number of patients	Vaccinated individuals	Vaccination rate（%）
Before introducing regular vaccination schedule (between April 2011 and September 2014)	39,632	180	0.5
After introducing regular vaccination schedule (between October 2014 and March 8, 2015)	5,438	71	1.3
After introducing checkbox (between March 9, 2015 and March 2016)	13,997	114	0.8
Total	59,067	365	0.6

period 3 was 251（53.1%）and 114（24.1%）, respectively（Table 2）.

The vaccination rate（1.3%）for people ≥ 65 years old during period 2 was significantly higher than the vaccination rate（0.5%）during period 1（$p < 0.05$）（Fig. 1）. The vaccination rate（0.8%）for people ≥ 65 years old during period 3 was significantly lower than the vaccination rate（1.3%）during period 2（$p < 0.05$）（Fig. 1）.

The medical histories of the individuals vaccinated with the pneumococcal vaccine are summarized in Fig. 2. Diabetes, HIV infectious disease, and non-pneumococcal pneumonia were the most frequent diseases. Seventy-three（15.4%）of the vaccinated individuals had diabetes. Sixty-three（13.3%）of the vaccinated individuals had HIV infectious disease. Thirty-nine vaccinated individuals had a history of non-pneumococcal pneumonia. Their vaccination rate was 8.2%.

4. Discussion

The pneumococcal vaccination rate in individuals ≥ 65 years old significantly increased after the start of regular vaccinations. However, the vaccination rate decreased after the introduction of the checkbox in electronic medical records. The effectiveness of the checkbox in electronic medical records for improving the pneumococcal vaccination rate in individuals ≥ 65 years old could not be confirmed. Diabetes, HIV infectious disease, and non-pneumococcal pneumonia were the most frequent diseases of the individuals who received the pneumococcal vaccine.

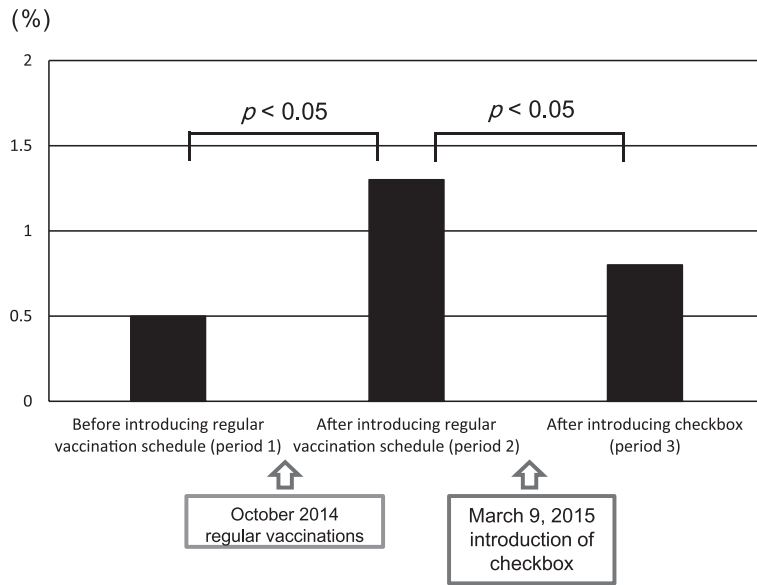Regular pneumococcal vaccinations seemed to trigger improvements in the vaccination

Figure 1

Trends in pneumococcal vaccination rates in individuals $\geq$ 65 years old. The vaccination rate (1.3%) for people $\geq$ 65 years old during period 2 was significantly higher than the vaccination rate (0.5%) during period 1 ($p < 0.05$). The vaccination rate (0.8%) for people $\geq$ 65 years old during period 3 was significantly lower than the vaccination rate (1.3%) during period 2 ($p < 0.05$).
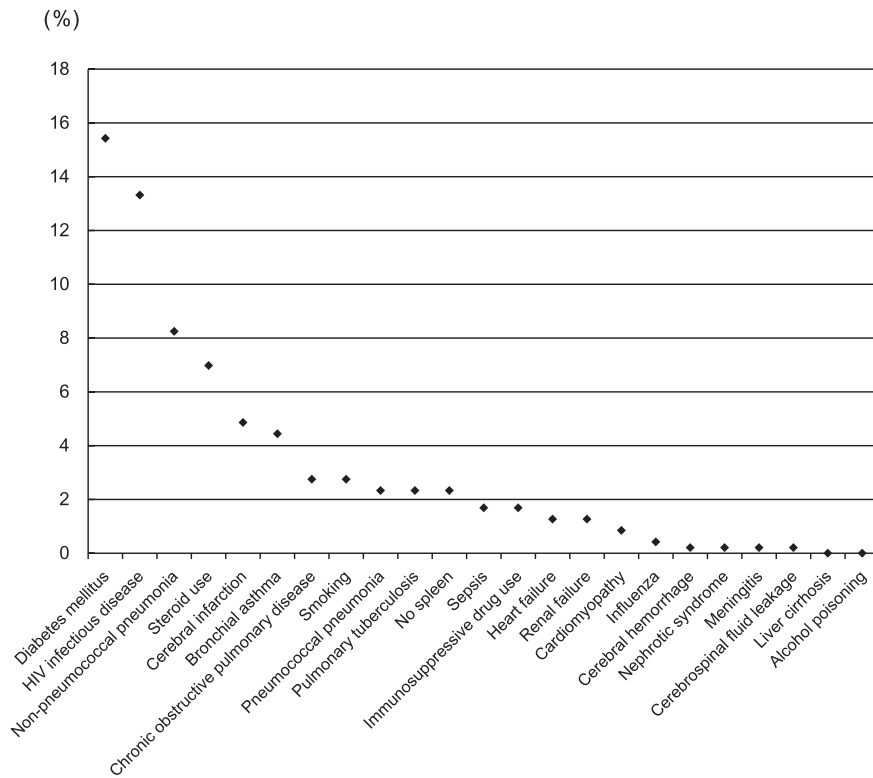

Figure 2

Medical histories among all of the individuals that received the pneumococcal vaccination. Diabetes, HIV infectious disease, and non-pneumococcal pneumonia were the most frequent diseases among those vaccinated.

rate, presumably because the cost burden for targeted patients decreased and because the patient's awareness of the vaccinations improved. A previous study reported that patient financial incentives, patient education, and patient reminders are effective for improving immunization rates in patients.[8] The same trend was seen for the pneumococcal vaccination in Australia. In Australia, pneumococcal vaccines have been subsidized for all adults ≥ 65 years old and others since 2005, and the pneumococcal vaccination rate has been significantly higher since the introduction of the universal funding.[9] As with the results of the present study, the establishment of a regular vaccination schedule appears to be effective for increasing the vaccination rate.

In contrast, the pneumococcal vaccination rate significantly decreased from period 2 to period 3 ($p < 0.05$) (Fig. 1). The pneumococcal vaccination rate calculated by the Ministry of Health, Labour and Welfare in Japan was 38.3% in 2014, but decreased 33.5% in 2015.[10] We assume our decrease of the vaccination rate is associated with the tendency of the national vaccination rate. The introduction of the checkbox to the electronic medical records did not result in an increase in the vaccination rate because its introduction did not go well. Although doctors were informed to use checkbox in a conference, it depended on individual discretion. We assume many doctors did not use the checkbox effectively. Another study reported that the target vaccination coverage could not be achieved by interventions such as inputting the vaccination status in, e. g., electronic medical records, due to patient refusal and missing information caused by doctors who did not complete them in many encounters.[11] Other research reported that an alert system in the electronic medical record improved influenza and pneumococcal vaccination rates.[12] We would like to suggest not only introducing a check box but also the introduction of an alert system to improve the vaccination rate.

Regarding medical histories, diabetes, HIV infectious disease, and non-pneumococcal pneumonia were more frequent in those who received the vaccination. There are several possible reasons for this. First, individuals with a history of pneumonia may tend to be vaccinated with the pneumococcal vaccine because of the primary prevention against pneumonia. A previous study showed that individuals with chronic respiratory disease vaccinated with the pneumococcal vaccine were more likely to have had a bacterial respiratory infection or a pneumococcal respiratory infection within the last year than those without the pneumococcal vaccine.[13] Second, our results might simply reflect the general prevalence of these conditions in elderly people, as elderly people are more susceptible to diabetes and pneumonia.[14],[15] Third, the risk of pneumococcal disease in HIV patients is higher than in non-HIV patients[16], and doctors in charge may be more apt to vaccinate HIV patients with the pneumococcal vaccine due to the Advisory Committee on Immunization Practices (ACIP) recommendation that HIV patients receive the pneumococcal vaccination.[17]

The present study has some limitations. First is selection bias. This study only included individuals vaccinated with pneumococcal vaccine at a single hospital and we did not check vaccinated people at other hospitals, so the vaccination rate may be underestimated and may not reflect the national pneumococcal vaccination rate in Japan. A large-scale, multicenter study with more accurate vaccination histories obtained by conducting thorough interviews with patients is needed in the future.

Second, medical histories that could not be confirmed from the electronic medical records were coded as "not present"(spleen was coded as "present"), and these medical histories might be underestimated. Detailed medical histories should also be obtained via thorough interviews with patients.

5. Conclusions

We think the regular vaccination schedule should be continued because it was associated with an increase in the vaccination rate. However, based on our results, we were unable to show an improvement in the vaccination rate by the introduction of the checkbox to indicate a patient's vaccination status in the electronic medical records. We would suggest not only introducing a check box but also adding other items such as an alert system.

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＜和文抄録＞

肺炎球菌ワクチンの定期接種化やチェックボックスの導入による
ワクチン接種率の変化に関する後方視的研究

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背景：2014 年 10 月から高齢者などを対象とした 23 価肺炎球菌多糖体ワクチンが定期接種化されている。定期接種化や肺炎球菌ワクチンの接種状況を示すために電子カルテに導入したチェック欄によりワクチン接種率が上昇するかを調査した。

方法：対象者は 2011 年 4 月 1 日から 2016 年 3 月 31 日に順天堂医院総合診療科で肺炎球菌ワクチンを接種した者である。定期接種前後やチェック欄導入前後における 65 歳以上の肺炎球菌ワクチン接種率やワクチン接種者の背景などを調べた。

結果：65 歳以上のワクチン接種者数は 365 名であった。定期接種開始後の 65 歳以上のワクチン接種率は 1.3％で開始前の 0.5％よりも有意に高値であった（$p < 0.05$）。ただし，チェック欄導入後に接種率の低下を認めていた（$p < 0.05$）。

結論：定期接種に関しては継続するべきと考えるが，本研究結果からはチェック欄の導入のみではワクチン接種率の改善は確認できなかったが，チェック欄を導入するだけではなく，アラートシステムなどを追加することを提案したい。