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Note

# Decreased number of inpatients with community-acquired pneumonia during the COVID-19 pandemic: A large multicenter study in Japan

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ABSTRACT

The COVID-19 pandemic has shaped the dynamics of many diseases. This study aims to assess how the pandemic affected community-acquired pneumonia admission of all age groups among Japanese hospitals with various size and availability of COVID-19 wards. Our findings revealed a 44%–53% reduction in community-acquired pneumonia admission among 82 hospitals in Japan, from April through September of 2020, compared to the same period of 2019. Decreases were consistently found among hospitals with and without COVID-19 wards. The most significant decrease was found in the age group <20 years old. COVID-19 preventive measures and personal hygiene are considered to be effective measures to prevent the spreading of this disease. As vaccination progresses and the public gradually become less attentive to infection countermeasures, incidence of community-acquired pneumonia may increase in the coming season. Continued monitoring is required.

## Note

As the coronavirus disease 2019 (COVID-19) pandemic continues in Japan, in order to provide care to patients of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and other non-COVID-19 patients, hospitals have reallocated resources—establishing/adding COVID-19 wards, limiting elective surgeries and hospitalizations, and promoting telemedicine. Meanwhile, preventive measures have been established, such as shortened business hours, telework, school closures, improved personal hygiene, and social distancing. These medical system implementations and individual behavior changes have had impacts on the dynamics of many diseases. Previous studies have revealed a decrease in incidence of respiratory diseases since the 2020 outbreak of the pandemic in Japan [1–4].

Among respiratory diseases, pneumonia is commonly seen in the elderly and children under 5. Pneumonia is caused by a number of infectious agents, including viruses, bacteria and fungi. While some pneumonia cases are non-contagious, such as aspiration pneumonia (commonly seen in weak and elderly populations), pneumonia can be spread via air-borne droplets from a cough or sneeze [5]. Community-acquired pneumonia generally refers to pneumonia occurring outside of a hospital or not related to healthcare-associated pneumonia [6,7]. Japan has approximately 35,000 hospital-admitted pneumonia patients annually [8]. Although reduction in community-acquired pneumonia incidence has been observed since the start of the pandemic, how this reduction affected the hospitalization of different age groups, including pediatric inpatients, has not yet been studied [2]. In addition, whether the reduction occurred only in hospitals with COVID-19 wards or consistently in all types of hospitals remained unknown.

We conducted a survey from December 19, 2020 to February 15, 2021, comparing the monthly number of pneumonia inpatients (non-COVID-19) from April through September 2020, to the same period of 2019. This study was a part of a national project, *The COVID-19 pandemic's impacts on the operation of medical facilities and the effectiveness of government* supports, commissioned by Ministry of Health, Labour and Welfare (MHLW) of Japan. (JPMH20CA2051) Because this national research project was designed with an aim to investigate the effectiveness of government financial support to hospitals, the research timeframe was established as April to September 2020, using the same period of 2019 for comparison. Being part of the national project, this study on community-acquired pneumonia was set according to the same period of time. Study protocols and consent forms were sent to hospitals across Japan. Those who agreed to participate provided written consent for

COVID-19, coronavirus disease 2019 SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

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**Table 1**
Characteristics of studied hospitals (n = 82).

| Classification of hospitals | | Number of hospitals | Average number of hospital beds | Affiliation to universities | | Located in certified high-alarm areas[a] | | No. of pneumonia inpatients (Apr through Sep 2020)[b] |
|---|---|---|---|---|---|---|---|---|
| With COVID-19 wards | Size of hospital | | | University hospitals | Non-University hospitals | High-alarm areas | Other areas | |
| Yes | ≥400 beds | 38 | 607 | 21% | 79% | 71% | 29% | 1579 |
| Yes | <400 beds | 31 | 261 | – | 100% | 81% | 19% | 900 |
| No | ≥400 beds | 0 | – | – | – | – | – | – |
| No | <400 beds | 13 | 241 | – | 100% | 46% | 54% | 164 |

[a] The certified high-alarm areas are determined by the Japanese government to emphasize the efforts required to suppress the spread of SARS-CoV-2 infections, including 13 areas: Hokkaido, Tochigi, Saitama, Chiba, Kanagawa, Gifu, Aichi, Ishikawa, Kyoto, Osaka, Hyogo, Fukuoka prefectures and Tokyo metropolitan.
[b] No. of pneumonia inpatients is defined as no. of new inpatients from April 1 to September 30, 2020 in the studies 82 hospitals in Japan. If patients' hospitalization extended to the next calendar month, when calculating the percentage of pneumonia inpatients during the same period (2020 vs. 2019), these patients were counted in both months.

researchers to utilize their data from the national standard Diagnosis Procedure Combination (DPC), a Japanese system for patient records in acute-care hospitals.

Participating hospitals were classified by their availability of COVID-19 wards and hospital size measured by number of total beds, with 400 beds as the delineation between large and small hospitals [9]. Pneumonia patients with hospitalizations that extended to the next calendar month were counted twice. The monthly inpatients in 2020 as a percentage of the same period in 2019 for neoplasms and circulatory diseases were assessed to examine how the pandemic affected the dynamic of other diseases.

A total of 82 hospitals (with overall 2643 newly admitted pneumonia inpatients from April to September 2020) providing consent were included in this study, with characteristics and geographic distribution shown in Table 1 and Supplementary. Monthly counts of pneumonia inpatients in hospitals with COVID-19 wards and more than 400 beds decreased 50% on average during April through September 2020, compared to the same period of 2019 (Fig. 1-a). 44% and 53% decreases were found in hospitals with less than 400 beds, with or without COVID-19 wards, respectively (Fig. 1-b, 1-c). Decreased inpatients were reported with neoplasms and circulatory diseases during the State of Emergency (April 7 to May 25, 2020), but these inpatients gradually returned to prior levels as the strict quarantine measures were lifted at the end of May.

The most significant drop of pneumonia inpatients occurred among the age group of 0–19 years old. Compared to the same period of April through September, monthly pneumonia inpatients in 2020 were 12.8% (drop of 87.2%) of patients in 2019 for hospitals with COVID-19 wards with >400 beds and 14.6% (drop of 85.4%) for hospitals with COVID-19 wards and with <400 beds. The average percentage for hospitals without COVID-19 wards and less than 400 beds decreased to 3.3% (drop of 96.7%) (Table 2).

A remarkable decrease in the number of inpatients with pneumonia was observed in Japanese hospitals in 2020 (April through September). Unlike the number of inpatients with neoplasms and circulatory diseases, which decreased temperately during the State of Emergency but later went back to prior levels, the number of community-acquired pneumonia inpatients remained low—approximately 50% compared to the same time period in the previous year. Although hospitalization criteria for pneumonia patients might have been stricter, resulting in a possible shift to outpatient care, findings from the national project revealed remarkable reduction of outpatients of respiratory diseases as well (overall drop of approximately 30%). Regarding outpatients with community-acquired pneumonia specifically, monthly counts of outpatients in hospitals with COVID-19 wards and more than 400 beds decreased 21% on average during April through September 2020, compared to the same period of 2019. 16% and 35% decreases were found in hospitals with less than 400 beds, with or without COVID-19 wards, respectively. Thus, causes of reduction in community-acquired pneumonia admission are likely a combination of the following three aspects.

First, COVID-19 preventive measures impact the incidence of communicable diseases. As some types of community-acquired pneumonia are transmitted through contact and/or droplets, interventions aimed against SARS-CoV-2 transmission—self-quarantine, remote work, school closures, large gathering restrictions, and personal hygiene such as mask wearing and hand sanitization—could substantially reduce the incidence of pneumonia as well. Due to similar reasons, the Centers for Disease Control and Prevention in the United States reported a sharp decrease in influenza incidence after the declaration of the COVID-19 pandemic in March 2020, and Sakamoto et al. reported significantly lower occurrences of seasonal influenza in 2019/2020 in Japan as well [10,11].

Second, COVID-19 preventive measures specifically impact pediatric admissions. We found a significant reduction in pneumonia admissions among the age group of <20 years old. A recent multicenter analysis in the Netherlands revealed a maximum 77% reduction in communicable infections among pediatric admissions (April 2020 vs. April 2016–2019) [12]. A similar drop (76%) was reported for pediatric asthma emergency room visits, and hospital admissions in the United States and the United Kingdom [13,14]. These findings suggested that strict measures such as school closures, personal hygiene, and social distancing are effective to prevent pediatric hospital admissions.

Third, utilization of telemedicine has helped parents manage children's symptoms at home [12,14,15]. Parents working from home also makes caring for children at home more feasible.

Community-acquired pneumonia admission decreased among the studied Japanese hospitals. Significant differences were not found among these various hospitals, regardless of their sizes or availability of COVID-19 wards. As COVID-19 vaccination progresses, the Japanese public, including children, may become less attentive to personal hygiene and social distancing. Increased incidence of community-acquired pneumonia may be observed in the coming fall and winter, which may cause new challenges for hospitals while maintaining COVID-19 wards. Continued monitoring is required.

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## Conflict of interest disclosures

The authors declare no competing interests.

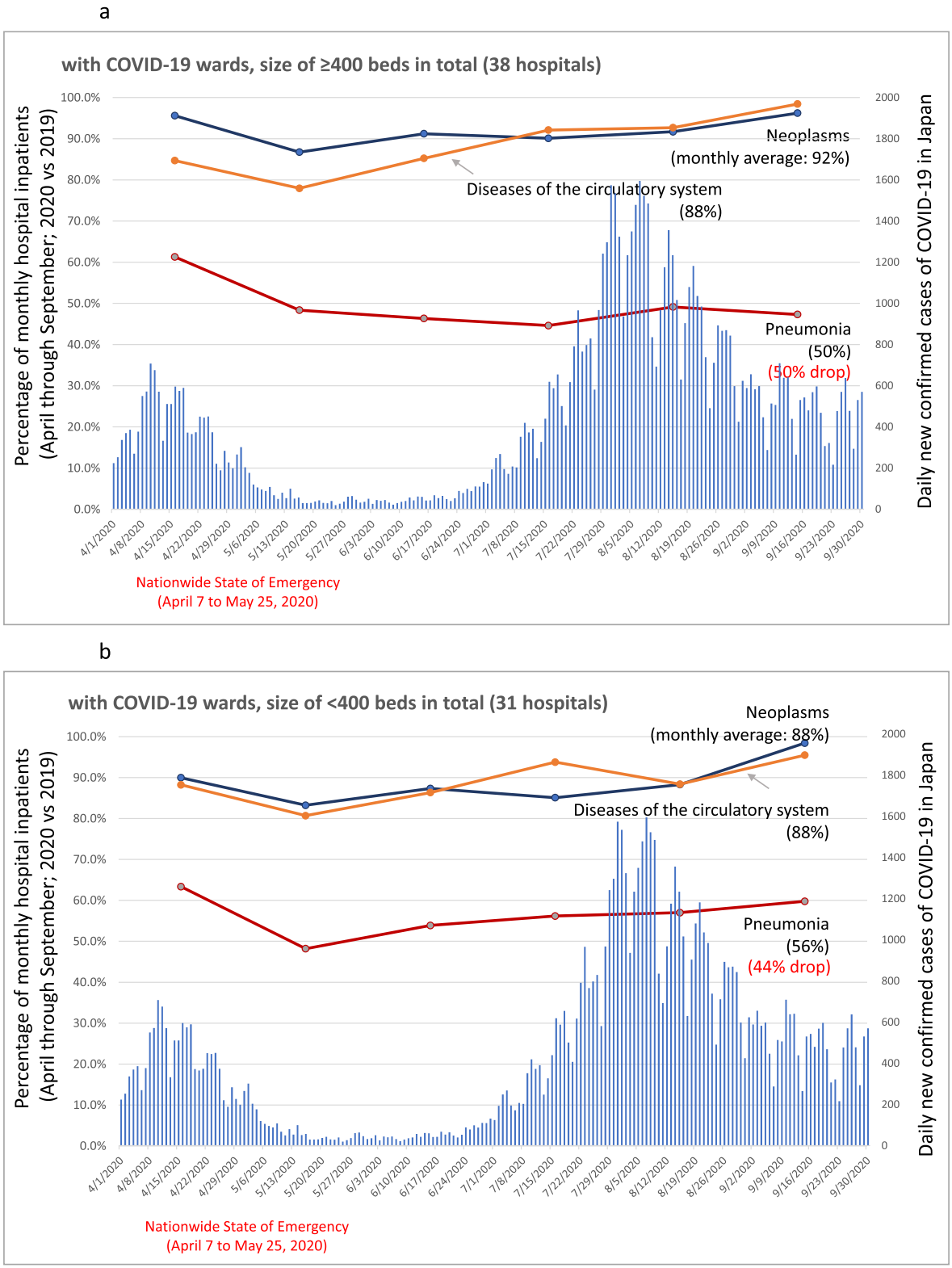


**Fig. 1.** Decreased pneumonia inpatients among Japanese hospitals of various sizes, with and without COVID-19 wards.
Lines in the three panels show the number of inpatients in April through September 2020, as the percentage of the same period in 2019. Pneumonia was compared to neoplasms and circulatory diseases. In addition, daily new confirmed cases of COVID-19 in Japan are shown.
Source: Daily numbers of newly confirmed cases are from the Ministry of Health, Labour and Welfare of Japan. https://www.mhlw.go.jp/stf/covid-19/open-data.html. Last accessed on August 22, 2021. (in Japanese).

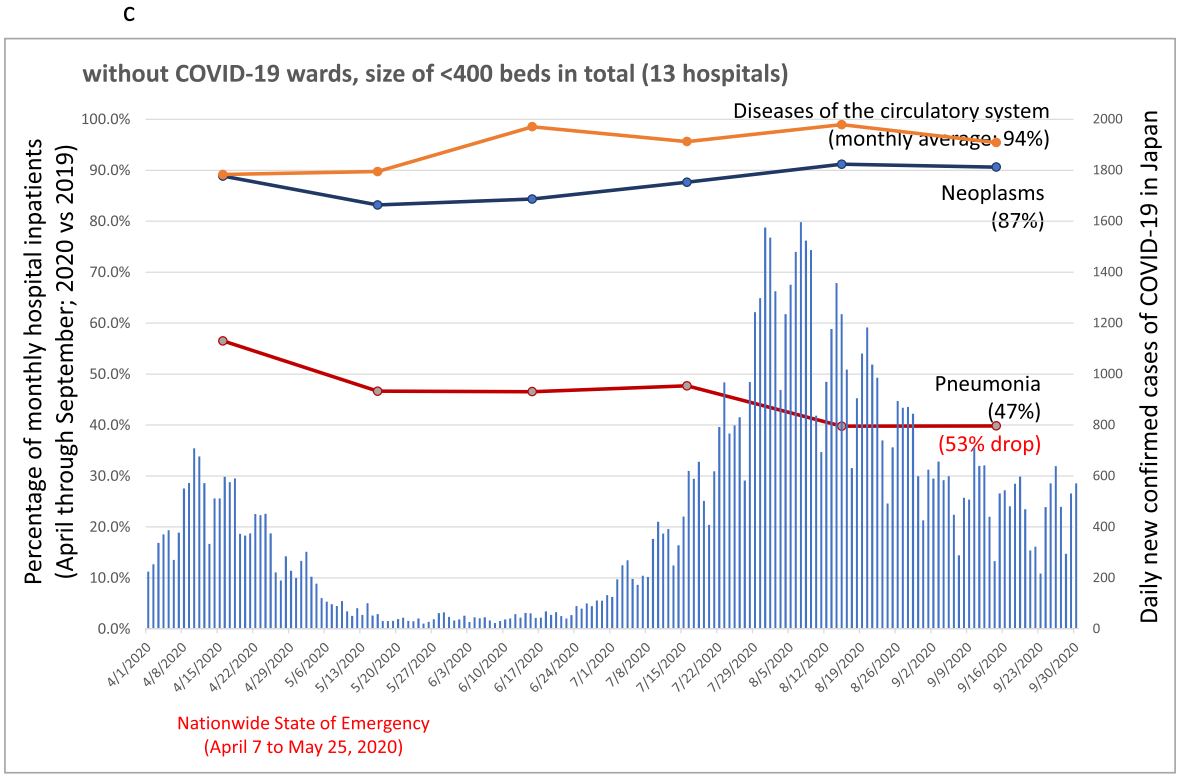


**Fig. 1.** (*continued*).

**Table 2**
Percentage of hospital pneumonia inpatients in 2020, compared to 2019; analyzed by age group and hospital type.

| | Percentage of monthly hospital pneumonia inpatients (April through September; 2020 vs 2019) | | | | | | |
|---|---|---|---|---|---|---|---|
| | April | May | June | July | August | September | Average (Apr through Sep) |
| **0–19 years old** | | | | | | | |
| With COVID-19 wards; ≥400 beds (n = 38) | 23.3% | 7.0% | 9.2% | 15.2% | 10.0% | 11.0% | 12.8% |
| With COVID-19 wards; <400 beds (n = 31) | 29.7% | 9.1% | 15.9% | 17.4% | 11.2% | 5.8% | 14.6% |
| Without COVID-19 wards; <400 beds (n = 13) | 18.2% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 3.3% |
| **20–39 years old** | | | | | | | |
| With COVID-19 wards; ≥400 beds (n = 38) | 104.5% | 51.9% | 32.4% | 46.3% | 42.9% | 47.6% | 51.4% |
| With COVID-19 wards; <400 beds (n = 31) | 57.9% | 31.3% | 71.4% | 54.5% | 80.0% | 100.0% | 62.8% |
| Without COVID-19 wards; <400 beds (n = 13) | 40.0% | 12.5% | 12.5% | 33.3% | 0.0% | 0.0% | 13.5% |
| **40–64 years old** | | | | | | | |
| With COVID-19 wards; ≥400 beds (n = 38) | 76.0% | 52.5% | 49.5% | 47.5% | 60.2% | 58.6% | 56.9% |
| With COVID-19 wards; <400 beds (n = 31) | 67.3% | 54.1% | 45.3% | 45.6% | 71.7% | 87.0% | 58.6% |
| Without COVID-19 wards; <400 beds (n = 13) | 46.2% | 31.3% | 46.2% | 72.7% | 25.0% | 75.0% | 46.6% |
| **65–74 years old** | | | | | | | |
| With COVID-19 wards; ≥400 beds (n = 38) | 62.1% | 52.8% | 52.9% | 51.1% | 62.4% | 74.1% | 58.2% |
| With COVID-19 wards; <400 beds (n = 31) | 76.4% | 39.4% | 59.8% | 56.4% | 82.6% | 90.0% | 64.3% |
| Without COVID-19 wards; <400 beds (n = 13) | 56.7% | 43.2% | 47.1% | 73.9% | 59.1% | 31.3% | 51.9% |
| **75–84 years old** | | | | | | | |
| With COVID-19 wards; ≥400 beds (n = 38) | 71.6% | 63.7% | 62.7% | 59.0% | 71.3% | 71.4% | 66.2% |
| With COVID-19 wards; <400 beds (n = 31) | 59.6% | 45.8% | 63.5% | 66.8% | 61.5% | 75.2% | 60.7% |
| Without COVID-19 wards; <400 beds (n = 13) | 73.3% | 56.7% | 52.2% | 43.6% | 38.6% | 28.9% | 50.1% |
| **≥ 85 years old** | | | | | | | |
| With COVID-19 wards; ≥400 beds (n = 38) | 77.2% | 62.6% | 54.7% | 46.3% | 49.6% | 50.4% | 57.0% |
| With COVID-19 wards; <400 beds (n = 31) | 70.4% | 62.8% | 55.4% | 60.3% | 56.1% | 61.6% | 61.2% |
| Without COVID-19 wards; <400 beds (n = 13) | 51.0% | 50.0% | 49.0% | 46.7% | 47.6% | 71.9% | 50.5% |

Note: 0% indicates no inpatient for the associated month of 2020.

## Author contributions

Prof Naito had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

*Concept and design*: All authors.

*Acquisition, analysis, or interpretation of data:* All authors.

*Drafting of the manuscript:* Yan, Naito.

*Critical revision of the manuscript for important intellectual content:* All authors.

*Statistical analysis:* Tomooka, Tanigawa.

*Administrative, technical, or material* support: Tomooka, Tanigawa.

*Supervision:* Naito, Tanigawa.

All authors meet the ICMJE authorship criteria.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jiac.2022.01.013.

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