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Impact of COVID-19 pandemic on healthcare service use for non-COVID-19 patients in Japan: retrospective cohort study

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ABSTRACT

Objectives We aimed to investigate the impact of the first and second waves of the COVID-19 pandemic on healthcare service use by non-COVID-19 patients.

Design Retrospective cohort study.

Setting Hospital-based claims database from anonymised hospitals in Japan.

Participants Patients (n=785 495) who visited and/or were hospitalised in 26 anonymised hospitals in Japan between January 2017 and November 2020.

Outcome measures We compared changes in the monthly number of hospitalisations (overall or by diagnosis), outpatient visits, endoscopic fibrescopies (EFs), rehabilitations, outpatient chemotherapy treatments, maintenance haemodialysis treatments and outpatient prescriptions between pre-COVID-19 years and the same period in 2020.

Results The overall number of hospitalisations and outpatient visits decreased by 27% and 22%, respectively, in May 2020, of which the most substantial decrease was observed in the paediatrics department (65% and 51%, respectively). The number of hospitalisations for respiratory diseases, circulatory diseases, malignant neoplasms and digestive diseases decreased by a maximum of 55%, 32%, 10% and 26%, respectively, in 2020. The number of hospitalisations for non-COVID-19 pneumonia in patients aged <16 years, patients aged ≥16 years and patients with asthma decreased by 93%, 43% and 80%, respectively, in May 2020. EFs and outpatient rehabilitations decreased by >30%. In contrast, outpatient chemotherapy and maintenance haemodialysis treatments decreased by <10%, if at all. Outpatient prescriptions decreased by a maximum of 20% in 2020, with the largest decrease observed in drugs for obstructive airway diseases and cough and cold preparations.

Conclusions The use of healthcare services by non-COVID-19 patients was most affected during the first wave of the COVID-19 pandemic in May 2020. The number of hospitalisations for respiratory diseases, particularly non-COVID-19 pneumonia and asthma, drastically decreased, while the number of hospitalisations and outpatient chemotherapies for malignant neoplasms or maintenance haemodialysis was less affected.

Strengths and limitations of this study

- We used real-world data to evaluate the impact of the first and second waves of COVID-19 on healthcare service use by non-COVID-19 patients in Japan.
- A wide range of healthcare services has been covered in our cohort of 26 anonymised hospitals, including hospitalisations, outpatient visits, endoscopic fibrescopies, rehabilitations, maintenance haemodialysis and prescriptions.
- The data included not only the diagnoses for hospitalisations but also the purposes of hospitalisations or information pertaining to whether or not admissions were scheduled.
- Because of the anonymised nature of the database, the location of the hospitals and their infection status was unknown.

INTRODUCTION

The global impact of the COVID-19 pandemic on healthcare services is enormous.[1] In Japan, the first case of COVID-19 was reported on 16 January 2020, and on 13 February 2020, the first COVID-19-related death was reported.[2] From 2 March, there was a nationwide school shutdown, and the WHO eventually declared a pandemic on 11 March. Large-scale hospital clusters have emerged since March, some involving >200 people. Many medical facilities postponed nonurgent surgeries and medical check-ups, including cancer screening, to prepare for accommodating COVID-19 patients or tackling hospital clusters. The first state of emergency in Japan was declared on 7 April 2020 and lifted on 25 May 2020 (online supplemental figure 1A). The second wave peaked in August 2020, and the third began in November 2020 and peaked in January 2021, during which a second state of emergency was declared.

The worldwide use of healthcare services, including non-COVID-19 medical admissions, emergency department visits and outpatient visits, drastically declined during the COVID-19 pandemic.[3–7] This decrease was observed for respiratory diseases, including non-COVID-19 pneumonia, asthma and chronic obstructive pulmonary disease (COPD),[3 4 8] as well as for cardiovascular diseases, including acute myocardial infarction (AMI), strokes and acute heart failure.[3 9–11] A study from Italy reported a reduction in emergency department visits across all severity and diagnosis groups and a significant increase in all-cause and cause-specific out-of-hospital mortality related to neoplasms and endocrine, nutritional, metabolic and cardiovascular diseases during the lockdown period.[5] Moreover, reports suggested decreases and delays in identifying new cancers and in delivering treatment for pre-existing patients with cancer.[12–15] Patients with chronic conditions were also affected. In the UK, a decline in diagnosis and monitoring as well as an increase in mortality in patients with type 2 diabetes were reported during the first wave.[16]

Although no hard lockdown was imposed in Japan, the number of hospitalisations and outpatient visits declined,[17] including those for asthma.[18] There was also a substantial decline in acute coronary syndrome[19] and in the proportion of early-stage lung cancer, presumably due to the reduction in cancer screening.[20]

The full extent of the impact of COVID-19 on healthcare service use by non-COVID-19 patients is yet to be elucidated. Moreover, the causes of the decline in hospitalisations are not fully understood. Possible explanations include an actual decline in the incidence of diseases due to changes in people's behaviour, patients' hesitation in visiting hospitals because they fear contracting COVID-19, raised thresholds for hospitalisations, and reduced capacity of hospitals to accept non-COVID-19 patients because of hospital clusters or conversion to COVID-19 wards. Despite an ageing population and early exposure to COVID-19, all-cause mortality decreased in Japan in 2020,[21] suggesting that the incidence of some diseases may, in fact, have decreased.

This study retrospectively reviewed data from January 2017 to November 2020 obtained from a hospital-based database covering 26 hospitals in Japan to gain a more detailed picture of the impact of COVID-19 on healthcare service use by non-COVID-19 patients in Japan.

METHODS

Data source and study population

The commercially available hospital-based database from Medical Data Vision (MDV; Tokyo, Japan) contains claims data provided by hospitals using the Japanese Diagnosis and Procedure Combination (DPC) reimbursement system,[22] which has been adopted by >1600 acute care hospitals in Japan.[23] We obtained a dataset from the MDV database comprising claims of patients whose serum creatinine level was measured at least once between April 2008 and November 2020. We analysed data from all the hospitals that contributed to the database between 1 January 2017 and 30 November 2020. This resulted in a dataset comprising details of 785 495 patients who were hospitalised in and/or visited 26 anonymised hospitals (<200 beds, 4 hospitals; 200–499 beds, 19 hospitals and ≥500 beds, 3 hospitals).

The database contains information such as age, sex, diagnostic codes (according to the International Classification of Diseases, 10th revision (ICD-10)), medical procedures and drug prescriptions. Data for the dates of admission and discharge, the purpose of admission, whether or not the admission was scheduled, in-hospital mortality and the severity of some diseases were also available for hospitalised patients. The database also contains a wealth of information regarding diagnoses for hospitalised patients, including the most resource-consuming diagnosis, main diagnosis, admission-precipitating diagnosis and whether each recorded diagnosis was a definitive or a suspected diagnosis at the time of discharge.

Patient and public involvement

We did not actively recruit patients for this study because we used an existing database. No identifying or personal information was obtained. Because of the anonymised nature of the data, the need for informed consent was waived.

Outcome measures

The number of hospitalisations was calculated based on the monthly number of hospital discharges because each hospitalisation record was only created on discharge. As a sensitivity analysis, calculations were made based on the number of admissions from January 2017 to August 2020 instead of the number of discharges, although the number may have been underestimated because no records were available for those who were not discharged by the end of November 2020. We analysed the use of healthcare services by non-COVID-19 patients, excluding hospitalisations where suspected or definitive diagnosis of COVID-19 infection was recorded as either the most resource-consuming diagnosis, main diagnosis or admission-precipitating diagnosis. Of the excluded data, the monthly number of hospitalisations with definitive COVID-19 diagnosis was counted. The number of outpatient visits was tallied based on consultation fees.

We classified hospitalisations according to the most resource-consuming diagnosis because information on cause-specific in-hospital death or the severity of some diseases was available for this diagnosis. Diagnoses were classified alphabetically based on the first letter of the ICD-10 code (see online supplemental materials for details). Although we included patients with suspected diagnoses, definitive diagnoses and diagnoses where the records did not indicate whether they were suspected or definitive at the time of discharge in the main analysis, we only included those with definitive diagnoses at the time of discharge in a sensitivity analysis.

The ICD-10 codes for each disease are described in online supplemental materials. We assessed pneumonia severity in patients aged ≥16 years who were hospitalised for non-COVID-19 pneumonia by calculating their A-DROP (age, dehydration, respiratory failure, orientation disturbance and blood pressure) score (range 0–5).[24] Patients with A-DROP scores ≥3 were defined as severe pneumonia. In-hospital mortality due to the most resource-consuming diagnosis and in-hospital mortality due to any causes were defined as cause-specific in-hospital mortality and all-cause in-hospital mortality, respectively. The proportion of scheduled vs unscheduled admissions was shown in percentages of the total number of hospitalisations in May 2019.

For endoscopic fibrescopies (EFs), upper gastrointestinal (GI) endoscopy was defined as oesophageal EF and gastric/duodenal EF including endoscopic ultrasound-guided fine-needle aspiration, endoscopic mucosal resections (EMRs) and endoscopic submucosal dissection (ESD); lower GI endoscopy as colonoscopy including ESD and EMR; and bronchoscopy as bronchoscopy, transbronchial lung biopsy, endobronchial ultrasound-guided transbronchial needle aspiration and bronchoalveolar lavage. The number of prostate biopsies was calculated based on fees for prostate needle biopsies. The number of rehabilitations was calculated based on rehabilitation fees for one of the following: cardiovascular disease rehabilitation, cerebrovascular disease rehabilitation, disuse syndrome rehabilitation, musculoskeletal rehabilitation, respiratory rehabilitation, rehabilitation for patients with intractable disease, rehabilitation for patients with handicaps, rehabilitation for patients with cancer and rehabilitation for patients with dementia. The number of maintenance haemodialysis treatments was calculated based on fees for artificial kidneys. The number of outpatient chemotherapy treatments was calculated based on fees for outpatient chemotherapy for malignant neoplasms.

The number of outpatient prescriptions was calculated based on prescription claims. Each time that a single medication was prescribed, it was counted as one prescription (eg, if one patient visited twice in a month and was prescribed three types of medications at each visit, six prescriptions were recorded for that month). Prescriptions were classified based on the first three letters of the Anatomical Therapeutic Chemical code (see online supplemental materials for details). We calculated the median length of prescription coverage for oral medications for each month in 2020. Data on the number of monthly COVID-19 cases in Japan were obtained from the open data of the Ministry of Health, Labour and Welfare.[25]

Statistical analysis

We calculated the percentage change in the number of monthly claims in the COVID-19 year (2020) compared with the pre-COVID-19 years (2017–2019). The numbers in 2020 were compared with those in 2019 in the main analysis and with the 2017–2019 average in a sensitivity analysis. We compared the proportion of severe pneumonia cases evaluated by A-DROP scores and the mortality rates in 2020 with those of the same month in 2019 using the χ^2 test. The proportion of scheduled and unscheduled admissions in May 2020 was compared with that in May 2019 using the χ^2 or Fisher's exact test. The median length of prescription coverage was compared between March and April 2020 using the Mann-Whitney U test. The correlation coefficient was calculated using Pearson's correlation. Values of $p<0.05$ were considered statistically significant. All analyses were performed using R V.4.1.1. (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Of the 609 101 hospital discharges recorded between January 2017 and November 2020, 229 had a definitive diagnosis of COVID-19. The monthly numbers of hospitalisations are shown in online supplemental figure 1B and correlate well with the monthly number of COVID-19 cases in Japan (correlation coefficient 0.87, p<0.001).

We analysed the use of healthcare services by non-COVID-19 patients, by excluding 838 hospitalisations from the analysis because of suspected or definitive COVID-19 diagnoses. Thus, 608 263 hospitalisations were analysed. The overall number of hospitalisations decreased by 27% in May 2020 compared with May 2019 and by 7% in October (figure 1A and online supplemental table 1). Strikingly, the number of hospitalisations in paediatrics decreased by 63% in April 2020 and remained below 50% of the number recorded for 2019 through November 2020. The number of hospitalisations in ophthalmology decreased by 47% in May 2020 but increased by 17% in October 2020 compared with October 2019. The number of hospitalisations in internal medicine, surgery, orthopaedics and otorhinolaryngology decreased by 21%, 19%, 25% and 38%, respectively, in May 2020. When classified according to the purpose of hospitalisation, diagnostic hospitalisations decreased by 50% in May 2020 (during the first wave) and 36% in August (during the second wave), while the number of scheduled readmissions for chemotherapy, radiotherapy, etc only decreased by 6% in May 2020 and 12% in June (figure 1B).

There were 10 932 126 outpatient visits by 773 797 unique patients during the study period. The number of overall outpatient visits decreased by 22% in May 2020, with the largest decrease of 51% observed in paediatrics (figure 1C).

We classified hospitalisations according to the most resource-consuming diagnosis. Accordingly, hospitalisations for respiratory diseases decreased by 55% in May 2020 and remained decreased through November. Hospitalisations for circulatory diseases, digestive diseases and injury, poisoning and external causes decreased in May 2020 by 32%, 25% and 22%, respectively. In contrast, hospitalisations for malignant neoplasms only decreased by 6% in May 2020, with the largest decrease of 10% occurring in September (figure 2A).

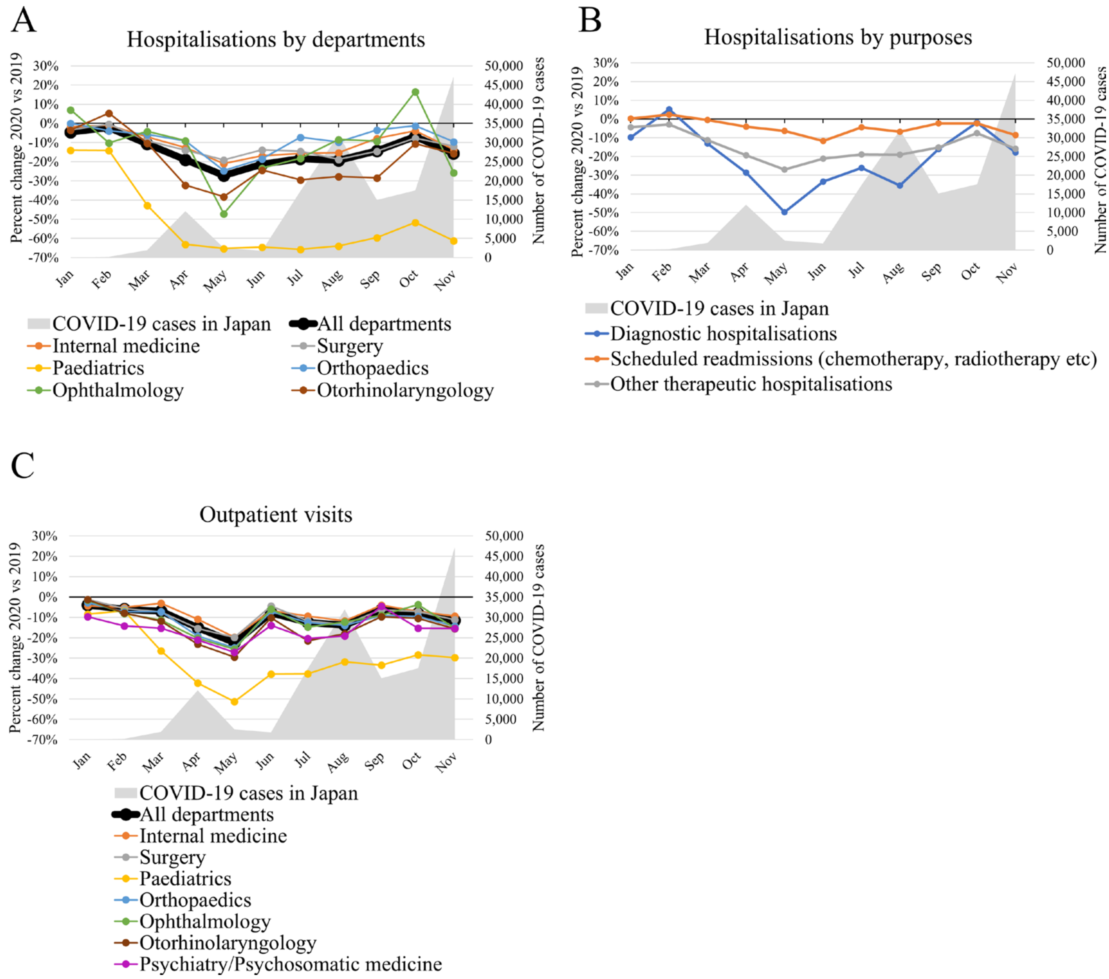

Figure 1 Comparisons of the number of hospitalisations and outpatient visits between 2020 and 2019. (A) hospitalisations by departments, (B) hospitalisations by purposes and (C) outpatient visits.

The number of hospitalisations for respiratory diseases decreased by 43% in May 2020 in the internal medicine department (figure 2B) and by 86% in the paediatric department, where respiratory diseases accounted for 45% of hospitalisations in 2019 (figure 2C). We then analysed changes in the number of hospitalisations for each disease in more detail. For respiratory diseases, hospitalisations for non-COVID-19 pneumonia among patients aged <16 years decreased by 93% in May 2020 and remained decreased by more than 90% through November, while those among patients aged ≥16 years decreased by 43% in May 2020. Hospitalisations for asthma decreased by 80% in May 2020 and remained decreased, correlating with a previous report.[18] Similarly, hospitalisations for acute bronchitis decreased by 88% in May 2020 and remained decreased. Furthermore, hospitalisations for aspiration pneumonia and COPD decreased by 27% and 50%, respectively, in May 2020. Hospitalisations for influenza virus infection had already decreased by 43% in January 2020 (before the COVID-19 pandemic was declared) and remained low through November, although the baseline numbers were low between May and October in 2019 (figure 3A).

Regarding circulatory diseases, while scheduled hospitalisations for angina pectoris decreased by 47% in May 2020, unscheduled hospitalisations only decreased by 12% in the same month. Hospitalisations for AMI, heart failure, cerebral infarction, intracerebral haemorrhage and atherosclerosis decreased by 29%, 17%, 17%, 11% and 46%, respectively, in May 2020 (figure 3B). Concerning malignant neoplasms, the largest decrease in hospitalisations for colorectal cancer occurred in September (−16%), gastric cancer in July (−37%), lung cancer in August (−25%) and breast cancer (−28%) and prostate cancer (−33%) in June (figure 3C). As for digestive diseases, while scheduled hospitalisations for cholelithiasis decreased by 45% in May 2020, unscheduled hospitalisations only decreased by 5%. Hospitalisations for polyp of colon, inguinal hernia, acute appendicitis, paralytic ileus and intestinal obstruction, and diverticular disease decreased by 53%, 43%, 14%, 11% and 26%, respectively, in May 2020 (figure 3D).

As described above, the number of hospitalisations for non-COVID-19 pneumonia substantially decreased (figure 3A). Further analyses revealed that hospitalisations for non-COVID-19 pneumonia decreased in almost

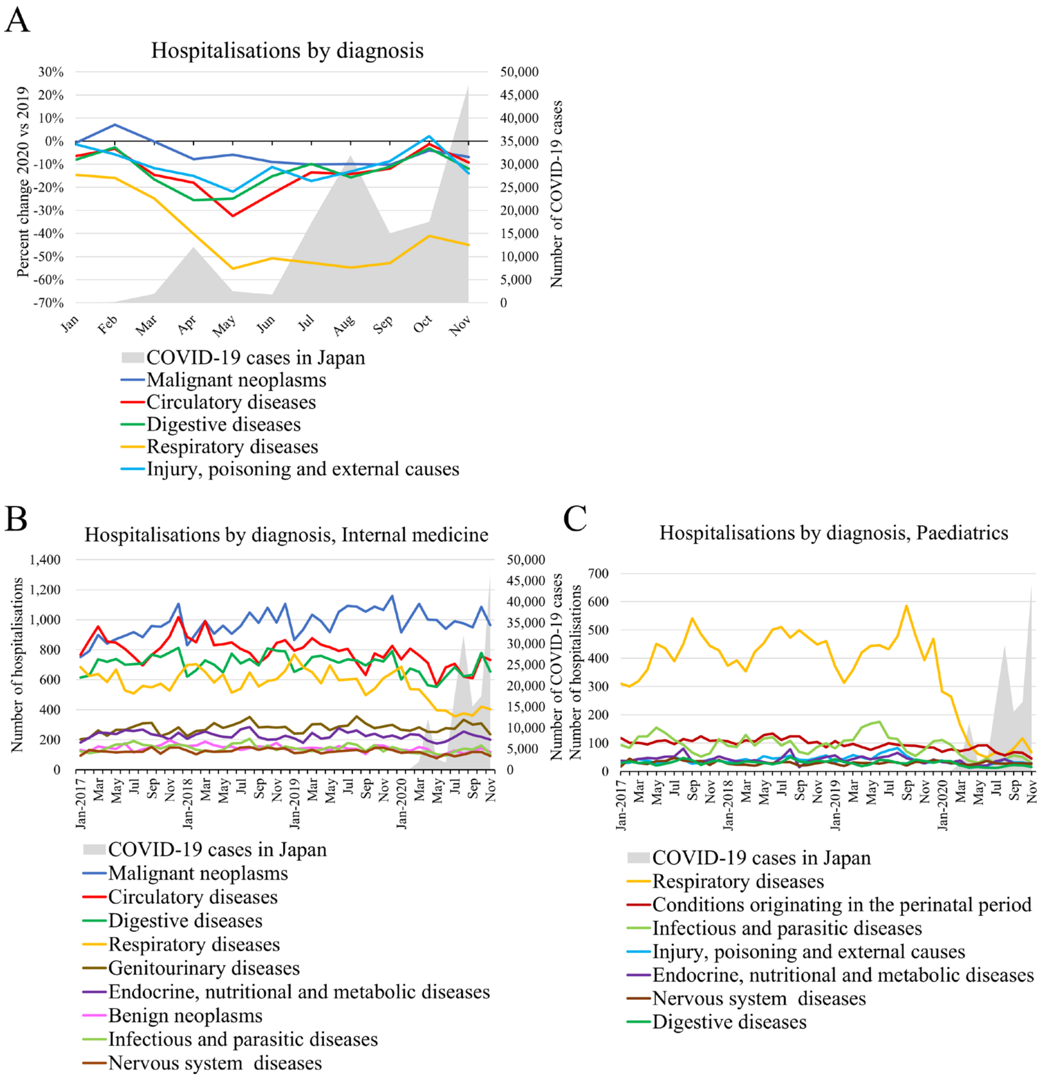

Figure 2 The number of hospitalisations classified according to the most resource-consuming diagnosis. (A) Changes in the number of hospitalisations by diagnosis between 2020 and 2019. (B) The number of hospitalisations by diagnosis in the internal medicine department from January 2017 to November 2020. (C) The number of hospitalisations by diagnosis in the paediatric department from January 2017 to November 2020.

all age groups and was particularly drastic in patients aged <6 years (27% of non-COVID-19 pneumonia hospitalisations in May 2019 vs 4% in May 2020; online supplemental figure 2A). Viral pneumonia was most prevalent in patients aged <16 years and bacterial pneumonia in patients aged ≥16 years. The number of cases of both viral and bacterial pneumonia decreased in 2020 (online supplemental figure 2B,C). Pneumonia severity was evaluated using the A-DROP score for patients aged ≥16 years. While the number of hospitalisations decreased by 43% in May 2020 compared with May 2019, the proportion of cases of severe pneumonia, as defined by A-DROP score ≥3, in May 2020 did not differ from that in May 2019 (27.4% vs 26.9%, p=0.90; online supplemental figure 2D). However, both the cause-specific in-hospital mortality rate (10.6% vs 5.4%, p=0.02) and the all-cause in-hospital mortality rate (15.4% vs 8.7%, p=0.01) increased in May 2020 compared with May 2019 for those hospitalised for non-COVID-19 pneumonia (online supplemental figure 2E,F). With the exception of May 2020, no significant differences in mortality rates were observed from January to November.

We compared the proportions of scheduled and unscheduled admissions among patients who were discharged in May 2020 with those that were discharged in May 2019. The proportion of unscheduled hospitalisations significantly reduced among patients discharged in May 2020 compared with May 2019 in paediatrics, whereas the proportion of scheduled hospitalisations decreased in otorhinolaryngology (online supplemental figure 3A). There were no significant differences in the proportions of scheduled and unscheduled hospitalisations across all departments combined, or within internal medicine, surgery, orthopaedics or ophthalmology. The proportion of scheduled hospitalisations significantly decreased among patients discharged in May 2020 who had been hospitalised for circulatory diseases and digestive diseases, whereas no significant differences was observed among

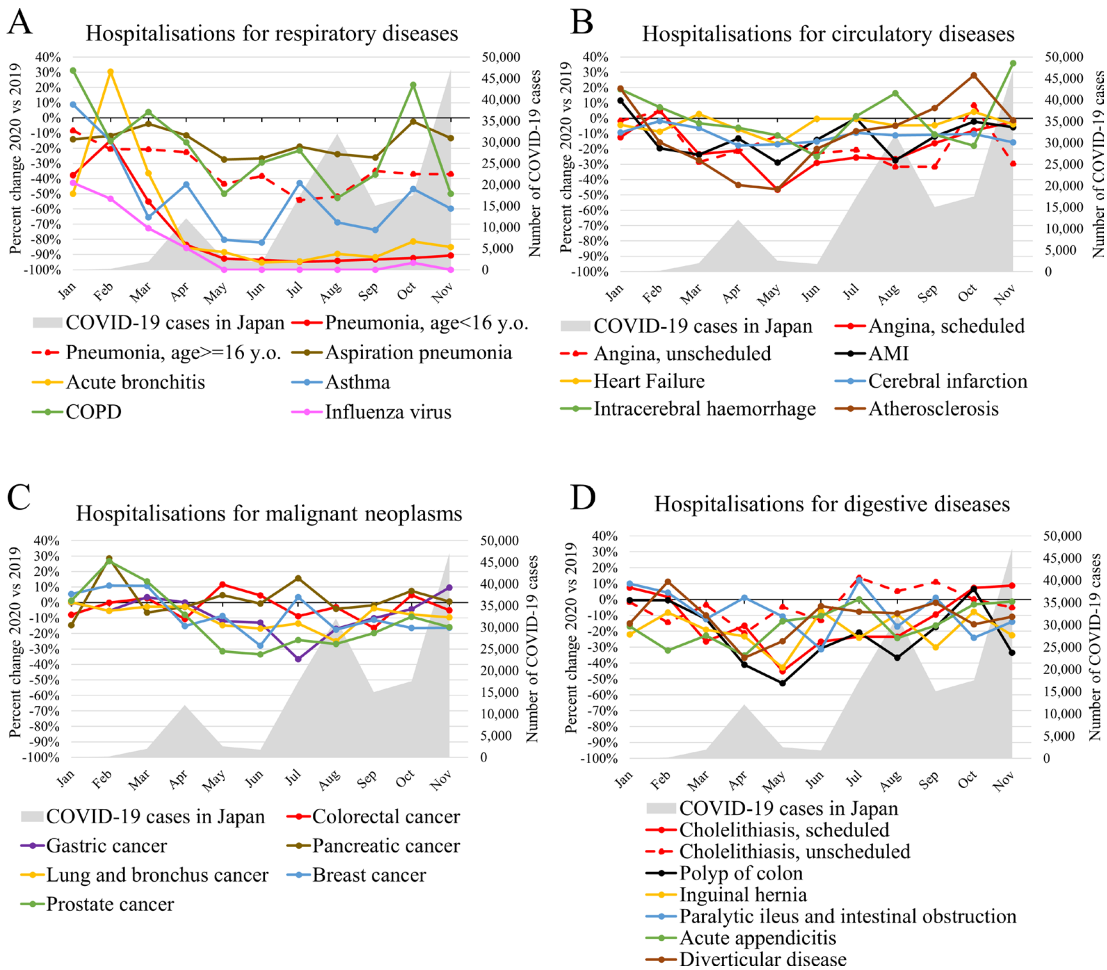

Figure 3 Comparisons between 2020 and 2019 of the number of hospitalisations according to disease type. Changes in the number of hospitalisations for (A) respiratory diseases, (B) circulatory diseases, (C) malignant neoplasms and (D) digestive diseases are shown. AMI, acute myocardial infarction; COPD, chronic obstructive pulmonary disease.

hospitalisations for malignant neoplasms, respiratory disease or injury, poisoning and external causes (online supplemental figure 3B). Among circulatory diseases, the proportion of scheduled hospitalisations for angina was lower in May 2020 than in 2019, as described above. However, the proportion of scheduled hospitalisations for cerebral infarction was higher in May 2020 than in 2019. Most of these patients with scheduled hospitalisation of cerebral infarction had been transferred from another hospital, presumably for chronic-phase treatment and rehabilitation. No significant differences were observed in hospitalisations for AMI, heart failure, intracerebral haemorrhage or atherosclerosis (online supplemental figure 4B). For digestive diseases, the proportion of scheduled hospitalisations was lower among patients discharged in May 2020 who had been hospitalised for cholelithiasis, but not significantly different to May 2019 for those hospitalised for polyps of colon, paralytic ileus and intestinal obstruction, acute appendicitis or diverticular diseases (online supplemental figure 4D). No significant differences were observed in hospitalisations for respiratory diseases or malignant neoplasms, as illustrated in online supplemental figure 4.

The risk of transmission of COVID-19 from aerosols generated during endoscopic procedures has been reported.[26] As expected, the number of upper GI endoscopies, lower GI endoscopies and bronchoscopies decreased by 40%, 46% and 41% in May 2020 (figure 4A). Similarly, the number of prostate biopsies, a diagnostic procedure for prostate cancer, decreased by 44% in May 2020 (figure 4B). Rehabilitation was reported as the most disrupted service during the pandemic because it involves close physical contact.[27] In fact, the number of outpatient rehabilitations decreased by 39% in May 2020, while inpatient rehabilitations only decreased by 11% (figure 4C). In contrast to endoscopic procedures and rehabilitations, changes in the numbers of outpatient chemotherapies and maintenance haemodialysis treatments only decreased by 9% and 5%, respectively, in May 2020 (figure 4D,E).

Finally, we evaluated the number of outpatient prescriptions. Overall prescriptions decreased by 20% in May 2020 (figure 5A). While prescriptions of antineoplastic agents and immunosuppressants only decreased by 8% and 7%, respectively, in May, those of antibacterials for systemic use, drugs for obstructive airway diseases, and cough

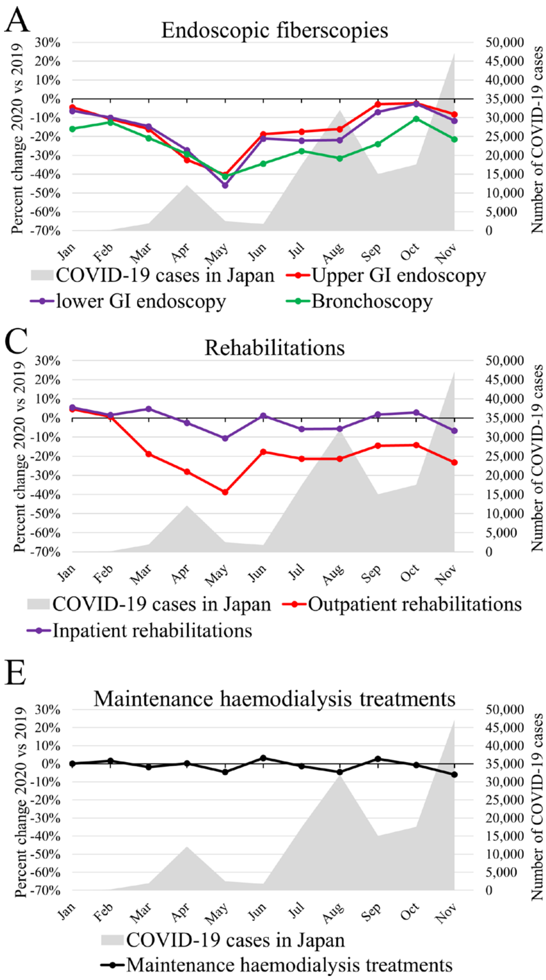

Figure 4 Comparisons between 2020 and 2019 of the number of various procedures and treatments. Changes in the number of (A) EFs, (B) prostate biopsies, (C) rehabilitations, (D) outpatient chemotherapy treatments for malignant neoplasms and (E) maintenance haemodialysis treatments are shown. EFs, endoscopic fibrescopies; GI, gastrointestinal.

and cold preparations decreased by 30%, 40% and 53%, respectively. The median length of prescription coverage for oral medication increased from 30 days (IQR 14–60) in March 2020 to 35 days (IQR 21–63) in April (p<0.001). The median length of prescription coverage for oral medications was increased for drugs used in diabetes (50 days, IQR: 30–63 in March vs 56 days, IQR: 35–64 in April; p<0.001), for psycholeptics (30 days, IQR: 21–30 in March vs 30 days, IQR: 27–30 days in April, p<0.001) and for drugs for obstructive airway diseases (35 days, IQR: 21–60 days in March vs 42 days, IQR: 28–60 in April; p<0.001). In contrast, the length of prescription coverage remained unchanged for antineoplastic agents (14 days, IQR: 14–28 for March and April; p=0.66; figure 5B).

We performed several sensitivity analyses. First, the number of hospitalisations was tallied by admissions instead of discharges (online supplemental figure 5). Similar results were obtained, with the largest decrease of 30% observed in May 2020. Second, the numbers of hospitalisations and outpatient visits in 2020 were compared with the average numbers in the same month for 2017–2019 instead of for 2019 only, and the results were largely similar (online supplemental figures 6–8). Third, only hospitalisations with definitive diagnoses (n=517 412) were analysed (online supplemental figure 9) after excluding 16 260 hospitalisations with suspected diagnosis and 74 591 cases where the records did not indicate whether the diagnosis was suspected or definitive from the cohort of 608 263 hospitalisations. The results were again similar; however, a decrease in the number of hospitalisations for prostate cancer was less evident (−19% in May 2020 in the analysis with definitive diagnoses vs −32% in the main analysis), presumably due to the decrease in prostate biopsies in May (figure 4B).

DISCUSSION

We used a hospital-based dataset to analyse healthcare service use by non-COVID-19 patients during the first and second waves of the pandemic in Japan. The most substantial decrease in the number of hospitalisations occurred in May 2020, which was during the first wave. The decrease in paediatrics was particularly striking, and the number remained low through November 2020 (figure 1A), mainly due to decreased hospitalisations for respiratory diseases (figure 2C). Hospitalisations for

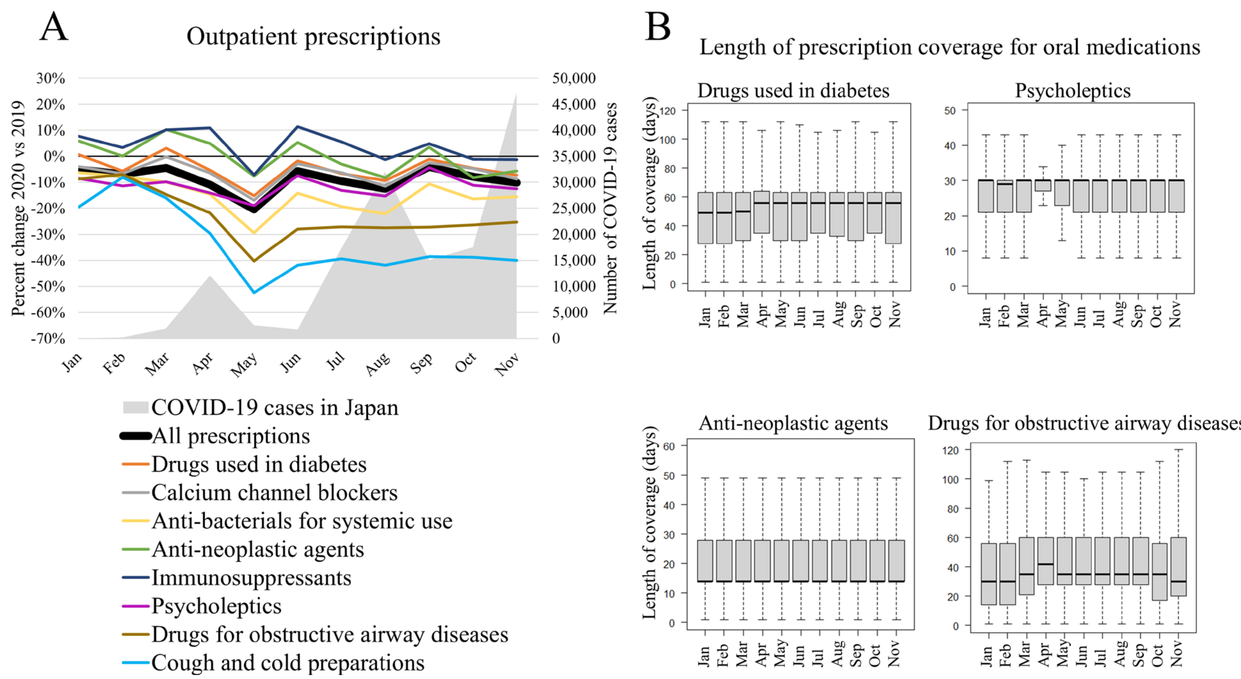

Figure 5 Comparisons between 2020 and 2019 for outpatient prescriptions. (A) Changes in the number of outpatient prescriptions. (B) Median length and IQR of prescription coverage for oral medications used in diabetes (upper left panel), psycholeptics (upper right panel), antineoplastic agents (lower left panel) and drugs for obstructive airway diseases (lower right panel). Outliers (below Q1–1.5 IQR or above Q3 +1.5 IQR) are not shown.

non-COVID-19 pneumonia, asthma, COPD, aspiration pneumonia and influenza virus infection all decreased (figure 3A). While scheduled hospitalisations for angina and cholelithiasis decreased, unscheduled hospitalisations for these diseases were less affected (figure 3B,D). Similarly, diagnostic procedures, such as EFs and prostate biopsies, substantially declined, but outpatient chemotherapy for malignant neoplasms and maintenance haemodialysis were less affected (figure 4).

A substantial reduction in admissions for respiratory diseases, such as asthma exacerbation, was reported during the pandemic.[8 18 28] Furthermore, a decline in admissions for non-COVID-19 pneumonia was also reported,[3] but the nature of this decline was not elucidated. Our study revealed that the number of hospitalisations for non-COVID-19 pneumonia drastically decreased in patients aged <16 years and to a lesser extent in patients aged ≥16 years (online supplemental figure 2B,C). Although the proportion of cases of severe pneumonia as evaluated by A-DROP scores did not differ between May 2019 and May 2020 (online supplemental figure 2D), the rate of all-cause in-hospital mortality and cause-specific in-hospital mortality increased in May 2020 (online supplemental figure 2E,F), suggesting that the decrease in hospitalised cases of pneumonia during the first wave may be, at least in part, because of a higher threshold for hospitalisation (ie, patients with comorbidities at higher risk for mortality were more likely to be hospitalised).We did not observe a significant increase in mortality rates in the following months, even though the number of hospitalisations remained low, suggesting that the incidence of non-COVID-19 viral and bacterial infections had decreased, presumably due to droplet and contact precautions to prevent COVID-19 transmission. In fact, the number of deaths due to non-COVID-19 pneumonia in Japan decreased in 2020 compared with 2019.[29] Our study findings correlated with previous reports[8 18 28] of decreased hospitalisations for asthma and COPD, presumably because exacerbation of these conditions is often triggered by infection.

Previous reports have suggested that delays in cancer screening, diagnosis and treatment might result in an increase in the number of avoidable cancer deaths.[12 13 15 30] Consistent with these reports, we found that diagnostic procedures, including EFs and prostate biopsies, considerably decreased during the first wave (figure 4A,B), possibly delaying the diagnosis of malignant neoplasms. Although the decrease in hospitalisations for malignant neoplasms was less evident compared with other diseases, the nadir was observed later than the first wave (figures 2A and 3C), which may, in part, be due to decreased cancer screening during the first wave. The number of outpatient chemotherapy treatments for malignant neoplasms was much less affected (figure 4D), suggesting that chemotherapy for patients who were already diagnosed at the time of the pandemic was performed without delay. This is in contrast with the studies from other countries reporting that chemotherapy administration services had substantially decreased during the pandemic.[13 31]

Consistent with previous reports, we observed a decrease in hospitalisations for AMI and heart failure (figure 3B). Studies worldwide have reported a significant decrease in admissions for cardiovascular diseases during the pandemic.[11 32 33] While studies from the USA and Europe reported increased rates of in-hospital mortality,[33 34] a study from Japan did not report a notable increase.[19] The exact reasons for this decrease in hospitalisations remain unelucidated.

While scheduled hospitalisations for angina and cholelithiasis decreased substantially in May 2020, unscheduled hospitalisations were less affected (figure 3B,D, online supplemental figure 4), suggesting that conditions requiring urgent treatment were treated without delay and that hospitalisation of patients who could afford to wait was likely postponed. Likewise, while the number of maintenance haemodialysis treatments was unaffected, outpatient rehabilitations were substantially decreased (figure 4).

The number of outpatient prescriptions showed the greatest decrease in May 2020, with drugs used for respiratory diseases the most affected and immunosuppressants and antineoplastic agents the least affected (figure 5A). The number of prescriptions for drugs used in patients with chronic conditions, such as diabetes and hypertension, also decreased in May 2020, following prolongation of the length of prescription coverage in April (figure 5B). This correlates with a report based on a claims database in Japan that showed a temporary decline in physician visits by patients with chronic conditions, although the proportion of days covered by prescribed medication was unchanged.[35]

Even though the second wave was larger than the first, the impact on healthcare service use was more substantial during the first wave. This may be partly because healthcare workers were more adept at dealing with the pandemic situation; therefore, the reductions in services that were required in some hospitals during the first wave were not necessary during the second. Additionally, patients may have been hesitant to visit hospitals while the country is in a state of emergency, which was declared during the first wave but not during the second.

The postponement of elective and preventive procedures as a result of the pandemic may have serious long-term consequences, and the effects of the reduction in healthcare service use remain to be seen. Patients should be encouraged to visit a hospital when they experience symptoms, and to continue with regular check-ups or visits for chronic conditions to prevent complications.

Strengths and limitations

A strength of this study is that it provides an overview of the impact of the COVID-19 pandemic on healthcare service use that covers hospitalisations and outpatient visits for a wide range of services. Second, the most and least affected healthcare services were identified using a single cohort. Third, the dataset contained not only the diagnoses for hospitalisations but also the purposes of hospitalisations or information pertaining to whether or not admissions were scheduled. Therefore, we were able to easily separate cases of the same disease requiring urgent care from those that did not. Moreover, we performed detailed analyses of hospitalised cases of non-COVID-19 pneumonia, including disease severity and in-hospital mortality, providing insight into the possible reasons for the decline.

Our study has several limitations. First, the anonymised nature of the database means that the hospitals' location was not disclosed. Therefore, the infection status of each hospital and their surrounding region are unknown. However, the number of patients hospitalised with a COVID-19 diagnosis shows good correlation with the total number of COVID-19 cases in Japan (online supplemental figure 1B). It is likely that our results reflect the overall situation in Japan. Second, because the dataset that we obtained only included patients whose serum creatinine level was measured at least once, patients with less serious conditions—especially those treated as outpatients—may be underrepresented in our analyses. However, it is likely that most of the hospitalised patients were included. Third, the diagnoses in the database may not be accurate, although diagnoses recorded in the DPC system were reported to have high validity.[36]

Conclusions

Our observations up to November 2020 revealed that the number of hospitalisations, outpatient visits, EFs and outpatient rehabilitations decreased the most in May 2020, which was during the first wave. Paediatric practice was the most affected, mainly due to the drastic decline in respiratory diseases. It is likely that conditions requiring urgent care or already diagnosed malignant diseases were treated without delay, but diagnostic procedures and treatments for conditions that were less urgent were delayed. Future studies are warranted to evaluate the long-term effects of these delays.

Although the second wave was larger than the first, the first wave had a more substantial impact on healthcare service use. Our analysis includes the first and second waves as well as the beginning of the third wave of COVID-19 in Japan. Follow-up studies are necessary to evaluate the impact of the pandemic in subsequent months. At the time of writing, the sixth wave—which peaked in February 2022—is by far the biggest that has occurred in Japan.

Contributors SY, AO, MN and TK conceived and designed the study. SY performed the data analysis. AO, SS, KIK, TY, MN and TK contributed to interpretation of the data. SY and TK wrote the first draft of the manuscript. All authors critically reviewed the manuscript and approved the final version. TK is the guarantor.

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Competing interests SY, AO, KIK and TK are members of the Department of Prevention of Diabetes and Lifestyle-related Diseases, which is a cooperative programme between The University of Tokyo and Asahi Mutual Life Insurance Company. KIK was previously employed by Asahi Mutual Life Insurance Company.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study was approved by the Institutional Review Board of the Graduate School of Medicine of The University of Tokyo (2018030NI). Because of the anonymised nature of the data, the need for informed consent was waived.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. The MDV dataset used in our study is proprietary to Medical Data Vision. As such, it is not publicly available for research purposes but can be purchased from Medical Data Vision.

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