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Prevalence and changes of low-value care at acute care hospitals: a multicentre observational study in Japan

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ABSTRACT

Objectives We aimed to examine the use and factors associated with the provision of low-value care in Japan.

Design A multicentre observational study.

Setting Routinely collected claims data that include all inpatient and outpatient visits in 242 large acute care hospitals (accounting for approximately 11% of all acute hospitalisations in Japan).

Participants 345 564 patients (median age (IQR): 62 (40–75) years; 182 938 (52.9%) women) seeking care at least once in the hospitals in the fiscal year 2019.

Primary and secondary outcome measures We identified 33 low-value services, as defined by clinical evidence, and developed two versions of claims-based measures of low-value services with different sensitivity and specificity (broader and narrower definitions). We examined the number of low-value services, the proportion of patients receiving these services and the proportion of total healthcare spending incurred by these services in 2019. We also evaluated the 2015–2019 trends in the number of low-value services.

Results Services identified by broader low-value care definition occurred in 7.5% of patients and accounted for 0.5% of overall annual healthcare spending. Services identified by narrower low-value care definition occurred in 4.9% of patients and constituted 0.2% of overall annual healthcare spending. Overall, there was no clear trend in the prevalence of low-value services between 2015 and 2019. When focusing on each of the 17 services accounting for more than 99% of all low-value services identified (narrower definition), 6 showed decreasing trends from 2015 to 2019, while 4 showed increasing trends. Hospital size and patients' age, sex and comorbidities were associated with the probability of receiving low-value service.

Conclusions A substantial number of patients received low-value care in Japan. Several low-value services with high frequency, especially with increasing trends, require further investigation and policy interventions for better resource allocation.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This is the first study investigating the frequency, healthcare costs and trends of low-value care in Japan.
⇒ We identified and examined 33 low-value services based on a rigorous literature search.
⇒ We used routinely collected claims data across as many as 242 acute care hospitals (accounting for approximately 11% of all discharges in Japan).
⇒ We did not consider other possible inappropriate care; further research investigating more evidence-based low-value care will be needed.
⇒ We did not examine medical facilities other than acute care hospitals, such as outpatient clinics, non-acute care hospitals and nursing homes.

INTRODUCTION

Low-value care or healthcare that provides no net clinical benefit to patients[1] remains a challenge that plagues healthcare systems worldwide.[2 3] Low-value care contributes to increased health expenditures, is potentially associated with iatrogenic harms associated with overdiagnosis and overtreatment and often interferes with the delivery of quality care. Since the American Board of Internal Medicine launched the 'Choosing Wisely' initiative in 2012 to identify low-value care commonly used in medical practice,[4] similar clinical-led initiatives have been introduced in more than 20 countries.[5] To minimise low-value care, it is imperative to identify and directly measure it and, more importantly, to understand the factors associated with providing it.

Despite increased awareness of the importance of identifying low-value care globally, most studies have focused on the magnitude of these practices in North America.[6–10] Outside of North America, studies have been conducted in Australia[11–13] and Austria,[14] but these studies focused only on inpatient services provided in hospitals. There is another study from the Netherlands,[15] but this study evaluated only three diagnostic services. The extent to which low-value care is used in inpatient and outpatient settings remains largely unknown in other countries, including Japan. In Japan, the provision of healthcare services has been strictly

controlled by the government (eg, the scope of healthcare services reimbursed by health insurance, as well as their unit price, are determined by the fee schedule developed centrally by the government) under the social insurance system,[16] and, therefore, it is possible that the utilisation of low-value care may be less common in Japan compared with the USA. This category of social insurance schemes in healthcare, as Japan is classified, includes several states such as Germany, France, South Korea and Taiwan.[16] As there is limited information regarding overuse on a global scale, measuring low-value care in healthcare settings like Japan can extend our knowledge on the factors associated with use of low-value care and inform recent international collaborations to address wasteful clinical care.[5 17]

In this context, we aimed to examine low-value care in inpatient and outpatient settings of Japanese acute care hospitals by using large-scale hospital claims data. We first identified a measurable list of low-value care based on previous studies and recommendations specified by a group of specialists according to independent literature review. We then measured the amount of low-value care and its associated healthcare spending according to algorithms to identify low-value care that could apply to hospital claims data with reasonable accuracy. Finally, we evaluated factors associated with low-value care use.

METHODS

Setting

We first briefly describe the health insurance and payment system in Japan. Japan has achieved universal health coverage in 1961.[18] Japanese residents are legally obligated to purchase one of the health insurance programmes that consist of the employment-based health insurance, residence-based health insurance (for non-elderly self-employed and unemployed people) or age-based health insurance programme (for individuals aged 75 years or older). The scope of benefits covered by these health insurance programmes is standardised among insurers by the government, including inpatient and outpatient care, dental care, physical rehabilitation, home healthcare and prescriptions. Regardless of the healthcare services provided, the coinsurance rate is the same for all insurers (eg, adults younger than 70 years pay 30%) without deductibles, and including a catastrophic coverage provision.[19] The payment method by which insurers pay acute care hospitals differs between outpatient and inpatient care. Outpatient care is reimbursed under the fee-for-service (FFS) system. Among the costs of inpatient care, hospital fees (bed charges) are paid by the insurers under the per-diem reimbursement (a fixed amount per inpatient day, according to diagnosis categories, under a mechanism known as Diagnosis Procedure Combination), although the costs of expensive surgeries and therapeutic or diagnostic procedures are exempted and paid through the FFS system.

Data

We used a de-identified hospital claims database from Japanese acute care hospitals that consented to the data utilisation, built by Medical Data Vision Co (Tokyo, Japan).[20] This available claims database consists of inpatient, outpatient, emergency care and physician prescription claims, covering all the physician and hospital fees and the healthcare spending of drugs prescribed or used in hospitals. Briefly, the database includes information on patients' demographics, the reimbursement codes for provided healthcare services, diagnoses and routes of hospitalisation.[21] The database has been appropriately quality-controlled (see online supplemental method 1) and has been used in previous studies.[21–25] We obtained claims data from 242 continuously observed hospitals that consented to data utilisation from the fiscal year (FY) 2015 through FY2019 (1 April 2015 to 31 March 2020). Our preliminary investigation found that these hospitals had 138 820 discharges in September 2017, which accounted for 11% of all discharges from acute care hospitals in the same month across Japan (n=1.27 million), and the distributions of patients' age, sex and principal diagnosis were comparable to the nationwide estimates, according to the Patient Survey (a triennial survey of patients using nationwide hospitals selected by stratified random sampling) (online supplemental figure 1).[26] We analysed a random 5% sample of patients.

Measures of low-value care

First, we conducted a literature review to identify low-value services (online supplemental method 2). In doing this, we listed up to 68 low-value services identified in previous studies conducted in the USA,[9] in Canada[10] and in Australia,[11] as measured by multiple sources, including Choosing Wisely,[4 27–29] US Preventive Services Task Force 'C' or 'D' recommendations[30] and Royal Australasian College of Physicians EVOLVE initiatives.[31] We also identified 45 low-value services, as defined by robust clinical evidence based on a predetermined literature search method. For this, the members of a selected specialist physicians board (whose specialties are described in online supplemental table 1) proposed candidate low-value services along with clinical evidence, and then several authors double-checked the evidence. After excluding 22 duplicated services (including combining similar services into a single measure) and 58 services that could not be reliably measured using the claims data, we identified a final list of 33 low-value services that could apply to hospital claims data with reasonable accuracy (online supplemental figure 2 and online supplemental table 2). Whether or not the service is 'measurable' in claims data was determined by three authors with sufficient experience in claims data analyses (AM, RI and YTo). For a low-value service to be measurable, we applied the following two criteria:

1. It had to be identifiable in the hospital claims data (healthcare services that are not reimbursed by the Japanese public health insurance system (eg,

preventive medicine services, pregnancy checkups and regular deliveries) are not recorded).
2. It had to be possible to reasonably identify a low-value service with high specificity using the variables in the data (eg, the target area for imaging tests is usually not recorded unless otherwise specified in the Japanese public health insurance claim).

Based on these criteria, we did not include all cancer screening services (eg, prostate-specific antigen testing for men aged ≥75 to screen prostate cancer) and some imaging tests (eg, head imaging for syncope and uncomplicated headache and back imaging for low back pain) as a measurable low-value service.

For each of the 33 selected services, we developed an operational definition of a low-value service using the International Classification of Diseases, Tenth Revision (ICD-10) diagnostic codes[32] and service reimbursement codes, the timing of care, site of care (outpatient vs inpatient), route of admission and demographic information (online supplemental table 3). We did not distinguish between principal and secondary diagnoses when using ICD-10 diagnosis codes because the flag of principal diagnosis in Japanese claims data is unreliable. It should be noted that there is inherent uncertainty in identifying low-value services using administrative claims data because diagnosis and service reimbursement codes do not necessarily map the actual conditions and diagnostic/therapeutic procedures that patients experience. To account for this uncertainty, following previous studies,[7 11] we specified two versions of each measure: a broader definition and a narrower definition. First, we created the broader definition to include all low-value care at the risk of misclassifying appropriate care. By adding some criteria to this broader definition, we next created the narrower definition to minimise the misclassification of appropriate care instead of overlooking some low-value care. Although the gold standard for low-value care was not available in this study, if such a gold standard had been available, the narrower definition would have shown lower sensitivity and higher specificity than the broader definition. Operational definitions followed those used in previous studies and were ultimately determined by multiple authors, each of whom was physician accustomed to data analyses using claims data (AM, RI and YTo).

Analysis

We counted low-value care based on episodes of inpatient care, outpatient care or prescription (online supplemental table 2). For example, we counted a series of intravenous treatments administered over several days during hospitalisation as one episode. Focusing on FY2019 data, we identified episodes in which each service was provided (regardless of whether they were low-value or non-low-value) and calculated the number and percentage of the low-value ones. We also calculated the number of low-value care episodes per 1000 patients who saw physicians at least once and the percentage of patients having at least one of the 33 low-value services in FY2019.[33]

Second, we calculated the healthcare spending associated with low-value episodes. To do this, we used official prices under the public health insurance (constant across regions or types of insurance) at the timing of care, FY2019. Although inpatient services are reimbursed by per diem bundled payment in Japan, we calculated healthcare spending based on an FFS payment following the Guideline for Healthcare Spending-Effectiveness Evaluation in the Central Social Insurance Council.[34] We included related services for calculating healthcare spending (eg, contrast medium administration for imaging studies or all inpatient services on the day of surgeries) (online supplemental table 3). When multiple low-value services were performed in a single hospitalisation, we added up the costs of those services. Aggregate healthcare spending estimates were multiplied by 20 to approximate healthcare spending for the entire population of patients seeking care from 5% samples. We also calculated the proportion of total healthcare spending for services covered under the public health insurance devoted to low-value episodes. The healthcare spending was reported in Japanese yen (110 JPY=1 US$ and 140 JPY=1 British pound on average in 2019).

Third, we examined the overall trends in the number of low-value episodes per 1000 patients seeking care from FY2015 to FY2019. This overall analysis evaluated the aggregated number of 31 out of the 33 identified low-value services that were measurable throughout the period (bone mineral testing became measurable in FY2017 and breast MRI in FY2016). We estimated the annual average percentage change in the number of low-value episodes. Furthermore, for each of the 17 services with the most episodes involving low-value care (based on narrower definition) in FY2019, we separately evaluated the trends in the number of low-value episodes per 1000 patients seeking care from FY2015 to FY2019. We analysed the data from the earliest year for bone mineral testing and breast MRI in which the episodes became measurable.

Finally, we regressed the indicator of whether a patient received at least one of the 33 low-value services in FY2019 on the patient's age (continuous), sex and comorbidities (Charlson's comorbidity score at the first visit of FY2019, 0–1, 2–4 and ≥5) and the size of the treating hospital (small (number of hospital beds <200), medium (200–499) and large (≥500)) by using logistic regression with Huber-White robust standard errors. We focused on adults aged ≥18 because most low-value care measures focused on adults.[6 9 11] We also repeated the analyses focusing on the probability of receiving an individual low-value service at least once rather than the entire 33 low-value medical services. In doing this, we analysed the two services with most episodes involving low-value care (narrower definition) and the two services accounting for the greatest healthcare spending in FY2019. We considered a p value of less than 0.05 to be statistically significant. All analyses were performed using Stata, V.15.1 (Stata Corp).

Patient involvement

Patients and the public were not directly involved in this study. However, patient perspectives have been heavily involved in various international Choosing Wisely campaigns, the recommendations from which are an important input to this study.

RESULTS

Frequency of low-value care

Among the 345 564 patients who saw physicians at least once in FY2019, we identified 39 657 episodes (115 episodes per 1000 patients) as low value according to the narrower definitions of low-value care (table 1). These accounted for 16.3% of all 243 722 episodes involving any of these services. We also found that 4.9% of patients seeking care (n=16 863) received at least one low-value service identified by the narrower definition. Four services (tricyclic antidepressants prescription for children without other psychological disorders, carotid endarterectomy in asymptomatic patients, nasolacrimal probe in infants and electroconvulsive therapy in children) had no low-value episode in our data. According to the narrower definitions, 17 of 33 services accounted for more than 99% of all low-value episodes. Among them, the majority of spinal injection (86.3%), oral betamimetics prescription (100%), intravenous betamimetics (78.7%) and intravenous sivelestat (100%) were considered to be low value (narrower definitions). Meanwhile, the broader definition identified 75 638 episodes (219 episodes per 1000 patients) as low value, accounting for 31.0% of all episodes involving any of these services. Also, 7.5% of patients seeking care (n=25 815) experienced at least one of these low-value episodes.

Healthcare spending due to low-value care

The total healthcare spending on low-value episodes for these 33 services in FY2019 ranged from JPY 5.7 billion (narrower definition) to JPY 12.9 billion (broader definition) (table 2). This was 0.23% (narrower) to 0.51% (broader) of the total JPY 2.5 trillion healthcare spending of all medical services covered under the public health insurance in FY2019 for the analytic 242 hospitals. According to the narrower definition, spinal injection for low back pain accounted for the most significant total healthcare spending on low-value care (JPY 1.7 billion), followed by spinal fusion for lumbar stenosis (JPY 1.0 billion), pregabalin prescription for back pain (JPY 0.6 billion) and vertebroplasty for osteoporotic vertebral fractures (JPY 0.5 billion).

Trends of low-value care

Overall, there was no clear trend in the prevalence of low-value services between 2015 and 2019. The total number of low-value episodes per 1000 patients decreased slightly when using the narrower definition (annual average percentage change, −2.0%; 95% CI, −3.4% to −0.6%; p=0.02) (figure 1 and online supplemental table 4). However, there was no clear trend when using the broad definition (annual average percentage change, +0.6%; 95% CI, −1.6% to +2.8%; p=0.45).

Among the 17 services accounting for more than 99% of all low-value episodes, 6 showed decreasing trends in the number of low-value episodes per patients seeking care from FY2015 to FY2019 regardless of the low-value care definitions, while 4 showed increasing trends (online supplemental table 5). According to the narrower definition (figure 2), for example, low-value antibiotics prescription decreased annually by 11.5% on average (p=0.001); low-value spinal injection decreased by 7.0% (p=0.001) and low-value oral betamimetics prescription decreased by 6.4% (p=0.03). In contrast, low-value serum triiodothyronine (T3) level testing increased annually by 2.0% on average (p=0.02); low-value pregabalin prescription increased by 17.4% (p=0.01); low-value echocardiogram increased by 4.0% (p=0.002) and low-value hypercoagulability testing increased by 4.9% (p=0.01). These patterns were similar when using the broader definition (online supplemental figure 3).

Factors associated with receiving low-value care

After excluding 42 344 patients aged <18 and 10 945 patients with missing data on comorbidities, we analysed 292 275 patients aged ≥18 years. Online supplemental table 6 shows the crude probability of receiving at least one of the 33 low-value services in FY2019. Our multivariable regression model (table 3) found that older adults had a lower probability of receiving at least one of the 33 low-value services in FY2019, while an additional 10-year increase in patients' age was associated with an adjusted OR (aOR) of 0.90 (95% CI, 0.90 to 0.91; p<0.001). A higher probability of receiving low-value care was associated with being female (female vs male; aOR, 1.37; 95% CI, 1.32 to 1.41; p<0.001) and presenting with more comorbidities (Charlson's score ≥5 vs Charlson's score 0–1; aOR, 2.45; 95% CI, 2.29 to 2.63; p<0.001). Patients treated in larger-size hospitals had a lower probability of receiving low-value care (large vs small; aOR, 0.73; 95% CI, 0.69 to 0.77; p<0.001). When focusing on individual low-value services, patient and hospital characteristics were associated with the probability of receiving low-value care. However, the direction of the association varied by service. For example, a low-value antibiotic prescription was more common among younger adults, while low-value serum T3 testing, spinal injection and spinal fusion were performed more frequently among older adults. Patients treated in larger hospitals had a smaller probability of receiving low-value antibiotics prescriptions but a higher probability of receiving low-value serum T3 testing. Furthermore, the association with Charlson's comorbidity scores was inconsistent across services.

DISCUSSION

Using large-scale hospital claims data, we found that patients seeking care in Japan commonly received low-value care, with 1 in 20 patients (16 863/345 564) using at least one low-value service in FY2019, even when applying narrower definitions of only 33 low-value services. Given

Table 1 Frequency of low-value care (LVC) services in 242 acute care hospitals in the fiscal year 2019

Healthcare services	No of episodes	Narrower definition (high specificity)*			Broader definition (high sensitivity)*		
		No (%) of LVC episodes	No of LVC episodes/1000†	% of patients receiving LVC	No (%) of LVC episodes	No of LVC episodes/1000†	% of patients receiving LVC
Antibiotics prescription	60344	8159 (13.5)	23.6	1.8	10164 (16.8)	29.4	2.2
Serum T3 level testing	37620	8061 (21.4)	23.3	0.8	8061 (21.4)	23.3	0.8
Pregabalin prescription	60388	7914 (13.1)	22.9	0.4	35736 (59.2)	103.4	1.6
Spinal injection	5659	4883 (86.3)	14.1	0.4	4948 (87.4)	14.3	0.4
Oral betamimetics prescription	3425	3425 (100)	9.9	0.2	3425 (100)	9.9	0.2
Pulmonary function testing	15920	3287 (20.6)	9.5	0.9	3293 (20.7)	9.3	0.9
Echocardiogram	27017	1436 (5.3)	4.2	0.4	1442 (5.3)	4.2	0.4
Bone mineral density testing	9157	1021 (11.1)	3.0	0.3	5157 (56.3)	14.9	1.3
Hypercoagulability testing	2790	474 (17.0)	1.4	0.04	508 (18.2)	1.5	0.04
Intravenous betamimetics	314	247 (78.7)	0.7	0.1	247 (78.7)	0.7	0.1
Stress testing	4502	160 (3.6)	0.5	0.04	1760 (39.1)	5.1	0.4
Breast MRI	290	96 (33.1)	0.3	0.03	103 (35.5)	0.3	0.03
Intravenous sivelestat	66	66 (100)	0.2	0.02	66 (100)	0.2	0.02
Traction therapy	683	63 (9.2)	0.2	<0.01	74 (10.8)	0.2	0.01
Spinal fusion	378	60 (15.9)	0.2	0.02	65 (17.2)	0.2	0.02
Endoscopy in adults <55	1604	58 (3.6)	0.2	0.02	60 (3.7)	0.2	0.02
PTH testing	6251	53 (0.8)	0.2	0.01	58 (0.9)	0.2	0.01
Electroencephalography	4266	40 (0.9)	0.1	0.01	117 (2.7)	0.3	0.03
1,25-dihydroxyvitamin D testing	474	28 (5.9)	0.1	0.01	28 (5.9)	0.1	0.01
Vertebroplasty	61	27 (44.3)	0.1	0.01	30 (49.2)	0.1	0.01
IVC filters	30	26 (86.7)	0.1	0.01	26 (86.7)	0.1	0.01
Endotoxin apheresis	25	25 (100)	0.1	0.01	25 (100)	0.1	0.01
Artificial liver support	27	18 (66.7)	0.1	0.01	18 (66.7)	0.1	0.01
PAC	295	12 (4.1)	0.03	<0.01	12 (4.1)	0.03	<0.01
Arthroscopic surgery	77	8 (10.4)	0.02	<0.01	40 (51.9)	0.1	0.01
Renal angioplasty	7	6 (85.7)	0.02	<0.01	6 (85.7)	0.02	<0.01
PCI	1660	2 (0.1)	0.01	<0.01	151 (9.1)	0.4	0.04
Intravenous anti-herpes drugs	338	1 (0.3)	<0.01	<0.01	2 (0.6)	0.01	<0.01
Surgery for VUR in children	1	1 (100)	<0.01	<0.01	1 (100)	<0.01	<0.01
Tricyclic antidepressants prescription in children	31	0 (0)	0	0	9 (29.0)	0.03	<0.01

Continued

Table 1 Continued

Healthcare services	No of episodes	Narrower definition (high specificity)*			Broader definition (high sensitivity)*		
		No (%) of LVC episodes	No of LVC episodes/1000†	% of patients receiving LVC	No (%) of LVC episodes	No of LVC episodes/1000†	% of patients receiving LVC
Carotid endarterectomy	22	0 (0)	0	0	6 (27.3)	0.02	<0.01
Nasolacrimal probe in infants	0	0	0	0	0	0	0
Electroconvulsive therapy in children	0	0	0	0	0	0	0
Total	243 722	39 657 (16.3)	114.8	4.9‡	75 638 (31.0)	218.9	7.5‡

*We developed two versions of each measure: a narrower definition (higher specificity and less misclassification of inappropriate use) and a broader definition (higher sensitivity and greater capture of inappropriate use).
†Denominator is the number of patients seeking care at an analytic acute care hospital at least once in the fiscal year 2019 (note that the same individual might be double-counted if he or she visited a different hospital).
‡Totals do not equal sums for the percentage of patients receiving each low-value service because some patients received multiple low-value services.
IVC, inferior vena cava; PAC, pulmonary artery catheterisation; PCI, percutaneous coronary intervention; PTH, parathyroid hormone; T3, triiodothyronine; VUR, vesicoureteral reflux.

the facts that our analytic sample was a 5% sample, and that our analytic hospitals accounted for approximately 11% of all discharges from acute care hospitals in Japan, simple extrapolation indicates that more than 3 million patients experienced low-value care across all Japanese acute care hospitals in a given year. It was also found that at least 11 low-value episodes occurred per 100 patients in the year. The healthcare spending of low-value care accounted for at least 0.23% of the total annual medical healthcare spending across the analytic hospitals. A simple extrapolation to the JPY 44 trillion of Japanese total medical spending in 2019[35] indicates at least JPY 100 billion (approximately US$ 1 billion) of medical overuse every year, suggesting that low-value care consumes considerable resources in the Japanese universal healthcare system.

Overall, our finding that 4.9% of all patients seeking care at hospitals received low-value care was comparable to the figure of 5% reported in Alberta, Canada[10] and 8% reported in the USA,[6] even though making direct comparisons is difficult because not all of the low-value services measured overlap. Our findings extend previous studies by demonstrating that low-value care is an important policy issue as well in Japan and suggesting that there is room for reducing the burden of low-value care even under a universal social insurance system.

As a whole, there was no evidence of a clear decline in the prevalence of low-value services in Japanese acute care hospitals between 2015 and 2019, despite the increasing awareness of low-value care and its associated harms in Japan.[36 37] This is similar to the findings in the USA, which showed that low-value care use remained similar or declined only slightly over time even after the Choosing Wisely campaign,[38–40] although the measurement methods, timing and target population were different.

Consistent with prior studies, trends in the prevalence of low-value care varied by individual service.[11 38] Five services with high frequency and increasing trends (eg, serum T3 level testing and pregabalin prescriptions) should be prioritised for further investigation to understand the drivers behind these increases and the possible solutions to reduce their low-value care use. For 16 low-value services that were already rare (eg, renal angioplasty and arthroscopic surgery for knee osteoarthritis) and 6 services with downward trends, background monitoring will be helpful in identifying changes in trends early. The decreasing trends of oral/intravenous betamimetics use and traction therapy for neck/back pain may reflect changes in recommendations in the Japanese Society of Obstetrics and Gynecology Guideline in 2014[41] and the Japanese Society of Orthopaedic Association Guideline in 2012.[42] Moreover, decreased low-value antibiotic prescribing for the common cold is encouraging, given the growing global and national attention focused on antibiotic stewardship and appropriate antibiotic prescribing. This was in contrast to the stable trend in antibiotic consumption from 2004 to 2016 in Japan.[43] In response to this trend, the Japanese government in 2016 introduced a policy goal to reduce the use of antibiotics by two-thirds by 2020. In pursuit

Table 2 Healthcare spending of low-value care for 33 healthcare services in the fiscal year 2019

Low-value services	Narrower definition		Broader definition	
	Total healthcare spending,* JPY (millions)	% of overall healthcare spending	Total healthcare spending,* JPY (millions)	% of overall healthcare spending
Antibiotics prescription for common cold[50]	196.0	0.01	253.3	0.01
Serum T3 level testing for hypothyroidism[9]	209.6	0.01	209.6	0.01
Pregabalin prescription for back pain[51 52]	605.0	0.02	3473.6	0.14
Spinal injection for low back pain[9]	1733.8	0.07	1760.2	0.07
Oral betamimetics prescription[53]	61.3	0.002	61.3	0.002
Preoperative pulmonary function testing[9]	119.0	0.01	119.2	0.01
Preoperative echocardiogram[9]	252.7	0.01	253.8	0.01
Bone mineral density testing at frequent intervals[9 10]	84.0	0.003	431.0	0.02
Hypercoagulability testing for patients with deep vein thrombosis[9 10]	21.8	0.001	23.4	0.001
Intravenous betamimetics for inhibiting preterm labour, >48 hours[54]	101.9	0.004	101.9	0.004
Preoperative stress testing or stress testing for stable coronary disease[9 10]	49.8	0.002	930.5	0.04
Preoperative breast MRI[55]	46.5	0.002	49.9	0.002
Intravenous sivelestat for acute respiratory disease syndrome[56 57]	52.0	0.002	52.0	0.002
Traction therapy for back pain or neck pain[58–60]	0.4	<0.001	0.5	<0.001
Spinal fusion for lumber stenosis[11 61]	1038.2	0.04	1184.6	0.05
Endoscopy for dyspepsia for people <55 years or colonoscopy for constipation in people <50 years[11]	40.6	0.002	41.2	0.002
PTH testing for patients with stages 1–3 chronic kidney disease[9]	1.9	<0.001	2.0	<0.001
Electroencephalography for headache[9]	6.4	<0.001	19.7	0.001
1,25-dihydroxyvitamin D testing in the absence of hypercalcemia or decreased kidney function[9]	2.2	<0.001	2.2	<0.001
Vertebroplasty for osteoporotic vertebral fractures[9 11]	459.3	0.02	525.8	0.02
Inferior vena cava (IVC) filters for the prevention of pulmonary embolism[9]	118.6	0.01	118.6	0.01
Endotoxin apheresis for sepsis[62 63]	297.1	0.01	297.1	0.01
Artificial liver support for acute liver failure[64]	10.8	<0.001	10.8	<0.001
PAC in the ICU[9]	5.9	<0.001	5.9	<0.001
Arthroscopic surgery for knee osteoarthritis[9 11]	68.5	0.003	288.0	0.01
Renal angioplasty[9 11]	89.9	0.004	89.9	0.004
PCI with angioplasty or stent placement for stable coronary disease[9]	26.7	0.001	2454.5	0.10
Intravenous anti-herpes drugs for sudden sensorineural hearing loss[65]	0.1	<0.001	0.3	<0.001
Surgery for vesicoureteral reflux[11]	8.1	<0.001	8.1	<0.001
Tricyclic antidepressants prescription for children without other psychological disorders[66]	0	0	0.1	<0.001
Carotid endarterectomy in asymptomatic patients[9 11]	0	0	92.1	0.004
Nasolacrimal probe in infants[11]	0	0	0	0
Electroconvulsive therapy in children[11]	0	0	0	0
Total	5708.3	0.23	12 861.3	0.51

*The healthcare spending was calculated based on a fee-for-service method. Healthcare spending on services was multiplied by 20 to approximate the healthcare spending for the entire patient population from 5% samples.
ICU, intensive care unit; JPY, Japanese yen (110 JPY=1US$ and 140 JPY=1 British pound); PAC, pulmonary artery catheterisation; PCI, percutaneous coronary intervention; PTH, parathyroid hormone; T3, triiodothyronine.

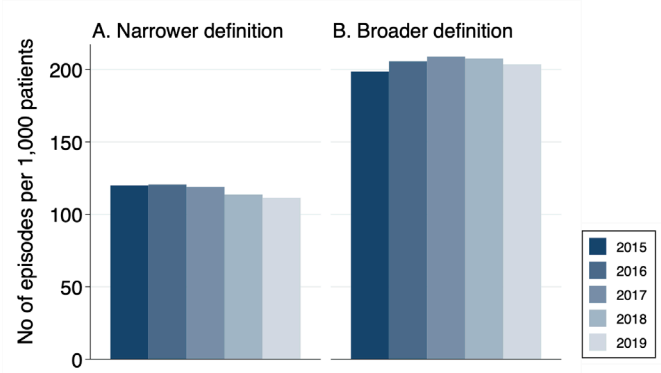

Figure 1 Total number of low-value episodes per 1000 patients: fiscal year 2015–2019. Among the 33 identified low-value services, we evaluated the aggregated number of 31 low-value services that were measurable throughout the period, except for bone mineral testing (measurable from FY2017) and breast MRI (measurable from FY2016).

of this goal, Japan has successfully promoted the education of physicians, the financial incentive for not prescribing antibiotics to children and public awareness campaigns using posters.[44] In a similar vein to a previous study that showed how the trend of antibiotics prescribing was influenced by this nationwide policy,[45] our findings suggest the possibility that bolstering and combining such supply-side and demand-side interventions may work to reduce low-value care. However, our finding contrasts with studies in the USA that showed recent stable or increasing trends in inappropriate antibiotic prescribing,[38 46] meaning that further investigations are needed to understand how and why the effect

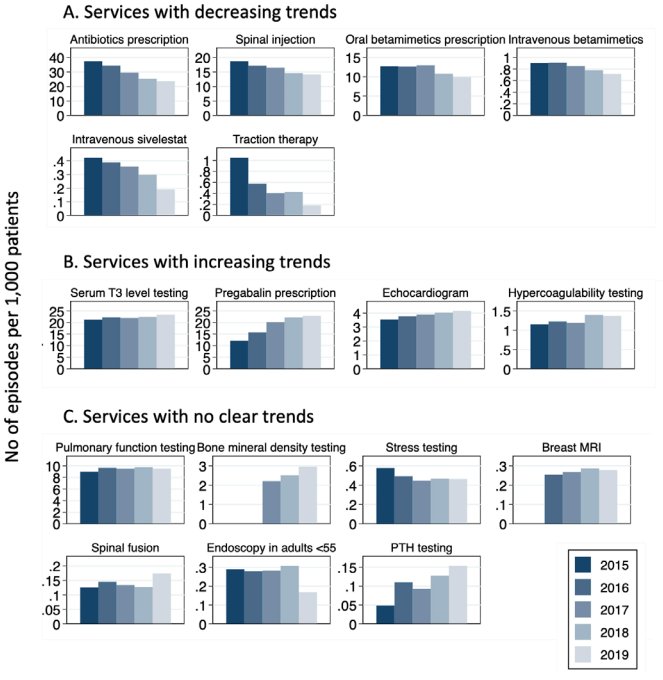

Figure 2 Number of low-value episodes per 1000 patients for 17 common low-value services: fiscal year 2015–2019. We focused on 17 healthcare services, with most episodes involving low-value care (narrower definition) in the fiscal year 2019. PTH, parathyroid hormone; T3, triiodothyronine.

of global initiatives to reduce low-value care may differ by country.

Patient characteristics such as age, gender and Charlson's score were associated with the risk of receiving low-value care. For example, in the case of antibiotics for the common cold, physicians may be more defensive to patients who have more complications and, as a result, may be more likely to prescribe unnecessary antibiotics. Akin to a previous study in Canada, however, the associations with age and Charlson's score were inconsistent across services. We also found that the probability of receiving low-value care differed depending on hospital characteristics. The inconsistent direction of association with hospital size across services suggests the importance of measurement and reporting of specific low-value services at the hospital level.[47] The variations in low-value care frequencies across healthcare organisations were similarly reported in previous studies in the USA.[8 47 48] Our study extends those findings by suggesting that provider-level drivers influence the overuse of individual low-value care even in the Japanese health insurance system strictly regulated by the government. Do to the lack of data, other provider-level characteristics including hospital ownership, location and teaching status, were not assessed in the current study. Further studies are needed to evaluate structural hospital characteristics associated with the provision of low-value care. For example, private hospitals, which account for approximately 80% of total hospitals in Japan,[49] may have stronger incentives to provide profitable health services, including low-value services.

Our study has several limitations. First, although we investigated as many as 33 measures of low-value care, identified based on solid clinical evidence, we did not consider other possible inappropriate care. For example, we could not capture services beyond the coverage of the Japanese health insurance system. Further research investigating more kinds of evidence-based low-value care will help to improve the understanding of low-value care provision in Japan. In addition, we did not capture downstream effects caused by inappropriate care, such as healthcare spending on adverse events and complications associated with low-value care. Despite these limitations, our estimates suggest that low-value services in Japan are substantial. Second, as with any direct low-value care measurement studies, our estimates were limited by using claims data. The claims data can precisely capture whether procedures are provided but do not include detailed clinical information of the sort that is often required to determine the appropriateness of the procedures, which is in contrast to medical record data. In selecting low-value care recommendations, we emphasised specificity with which overuse could be identified to address this uncertainty. We also reported the narrower and broader definitions with different sensitivity and specificity, following the methods used in previous studies.[7] Despite these limitations, claims-based measurement of low-value care could be performed at less cost than medical record data and is helpful for continuous monitoring and payment policy. Validation of claims-based measurement of low-value care using medical records as a gold standard would be

Table 3 Association between patient characteristics and probability of receiving low-value care (narrower definition) for adults aged ≥18 in the fiscal year (FY) 2019

	Adjusted OR (95% CI)				
	At least one of the 33 low-value services	Antibiotics prescription for the common cold	Serum T3 level testing for hypothyroidism	Spinal injection for low back pain	Spinal fusion for lumbar stenosis
Patients' age (every 10 years)	0.90*** (0.90 to 0.91)	0.75*** (0.74 to 0.76)	1.03** (1.01 to 1.06)	1.30*** (1.26 to 1.34)	1.43*** (1.28 to 1.61)
Patients' sex (reference: male)					
Female	1.37*** (1.32 to 1.41)	1.02 (0.96 to 1.08)	1.74*** (1.60 to 1.88)	1.06 (0.95 to 1.19)	1.04 (0.62 to 1.73)
Charlson's comorbidity score (reference: 0–1)					
2–4	1.51*** (1.45 to 1.57)	1.49*** (1.38 to 1.60)	2.73*** (2.50 to 2.98)	0.68*** (0.59 to 0.79)	0.54 (0.27 to 1.08)
5+	2.45*** (2.29 to 2.63)	2.61*** (2.31 to 2.96)	6.04*** (5.35 to 6.82)	0.96 (0.74 to 1.26)	0.59 (0.14 to 2.42)
Size of treating hospital (reference: small)					
Medium	0.82*** (0.78 to 0.86)	0.60*** (0.55 to 0.64)	1.16 (0.99 to 1.35)	0.45*** (0.39 to 0.51)	1.10 (0.43 to 2.84)
Large	0.73*** (0.69 to 0.77)	0.37*** (0.34 to 0.41)	1.53*** (1.31 to 1.78)	0.31*** (0.26 to 0.37)	1.53 (0.58 to 4.01)

The size of the treating hospital was categorised according to the number of beds as follows: small (<200 beds), medium (200–499 beds) and large (≥500 beds). After excluding 10945 patients (3.6%) who had missing data on comorbidities, we analysed 292275 adult patients seeking care at an analytic acute care hospital, including outpatient and/or inpatient services, at least once in FY2019 (note that the same individual might be double-counted if he or she visited a different hospital). We regressed the indicator of receiving at least one of the 33 low-value services in FY2019 on the patient characteristics (age, sex and Charlson's comorbidity score at the first visit of FY2019) and treating hospital size by using logistic regression with Huber-White robust standard errors. We similarly calculated the OR for receiving each of the four selected low-value services at least once in the year in the same manner. Antibiotics prescription for common cold and T3 level testing for hypothyroidism are the two services with most episodes involving low-value care (narrower definition), and spinal injection for low back pain and spinal fusion for lumbar stenosis are the two services accounting for the greatest healthcare spending in FY2019.
**P<0.01, ***p<0.001.
T3, triiodothyronine.

needed to elucidate the relative strengths and weaknesses of claims-based measurement. Finally, while the patient population covered acute care hospitals, it did not examine other medical facilities, such as outpatient clinics, non-acute care hospitals and nursing homes. Patients treated in these facilities may have different patterns in receiving low-value care and thus warrant further investigation.

CONCLUSION

Our claims-based measurement of low-value care revealed that a substantial number of patients were receiving low-value care in Japan. The overall trend in low-value care use remained similar or declined only slightly over time, despite increasing awareness of waste of healthcare spending in Japan. Identifying and measuring low-value care is an essential step in reducing it, and it is hoped that close collaboration with clinicians and policymakers will improve the indicators of low-value care developed in this study or add new ones.

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