



Epidemiology of General Anesthesia Practice in Japan: An Ecological Study Using Open Data from the National Database of Health Insurance Claims and Specific Health Checkups of Japan

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Abstract

As Japan does not have a population-based registry of general anesthesia cases, frequency and disposition of the population requiring general anesthesia remain unknown. We aimed to estimate the number of general anesthesia cases in Japan and to describe the demographic and regional characteristics of this population. We used data from the National Database of Health Insurance Claims and Specific Health Checkups of the Japan Open Data repository, recently developed by the Japanese government. Using the claims codes to identify general anesthesia, we calculated the number of general anesthesia episodes based on sex, age, surgical setting, and prefecture from April 2016 to March 2017 in Japan. Using the national insurance claims open database in 2016, we noted 2,427,894 general anesthesia cases annually. Additionally, we noted 19,132 general anesthesia cases in outpatient settings, representing 0.79% of overall cases. A total of 65,009 pediatric patients (< aged 5 years) underwent general anesthesia in inpatient settings (2.7% of all inpatient cases). The estimated number of super-elderly patients (≥ 85 years) who underwent general anesthesia in an inpatient setting was 169,044 (7.0% of all inpatient cases). There was substantial regional variation of general anesthesia cases per anesthesiologist in Japan. This is the first study to investigate the epidemiology of general anesthesia practice in Japan. Our novel use of a national claims database allowed us to accurately estimate the annual number of general anesthesia cases in Japan and may provide valuable medical and economic information for medical research, healthcare delivery, and governmental policy.

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Introduction

Although the number of surgical procedures has increased over recent decades both in Japan and worldwide, an accurate estimate of the number of inpatient and outpatient surgeries requiring general anesthesia has not been quantified or reported. As Japan does not have a population-based registry for general anesthesia cases, the frequency of anesthesia use nationwide remains unknown. The Health Service Bureau, Ministry of Health, Labour and Welfare (MHLW) conducts a "Static Survey of Medical Institutions" every 3 years to determine the current status of medical services in every institution (hospitals and clinics) [1]. In the most recent survey by MHLW 226,928 general anesthesia cases were noted in September 2014 in 3,484 hospitals (with ≥ 20 beds), and 7,870 were noted in 785 clinics (with <20 beds), suggesting approximately 2.8 million general anesthesia episodes in 2014 overall ($234,798 \times 12$ months = 2,817,576/year) [2]. However, the Static Survey reported only the sum of the questionnaires from each medical facility and just one period was surveyed (during September). Such limitations illustrate the difficulty of accurately estimating the annual number of general anesthesia episodes. In addition, the epidemiology of general anesthesia (e.g., age distribution, surgical setting, and regional distribution) was not recorded in this survey. Therefore, the Japanese Society of Anesthesiologists and the MHLW did not capture the current status of general anesthesia practice in Japan. It is evidently important to accurately estimate the number of general anesthesia episodes in Japan and to describe the epidemiology of the population in question, since such data can provide valuable information for medical research, healthcare delivery, and governmental policy. For example, the rate of general anesthesia use in pediatrics is important for medical research related to this sub-population's exposure to anesthetic agents. This is particularly urgent given that the United States (US) Food and Drug Administration (FDA) has

Table 1: General anesthesia case based on the NDB Open Data in 2016.

Age category (years)	Male				Female			
	Outpatient Non-high-risk	High-risk	Inpatient Non-high-risk	High-risk	Outpatient Non-high-risk	High-risk	Inpatient Non-high-risk	High-risk
0-4	1,028	-	35,661	4,063	817	-	21,826	3,459
5-9	686	-	31,834	483	625	-	20,916	390
10-14	444	-	30,118	482	250	-	17,898	305
15-19	251	-	37,792	757	210	-	22,345	399
20-24	251	-	23,840	708	150	-	20,876	566
25-29	320	-	20,916	846	239	-	29,631	859
30-34	340	-	24,164	1,195	550	-	43,864	1,230
35-39	454	-	29,903	1,840	710	-	54,345	1,758
40-44	557	-	40,493	3,141	815	-	73,458	2,711
45-49	634	-	44,938	4,196	677	-	80,935	3,203
50-54	629	-	48,189	5,089	646	-	66,547	3,424
55-59	669	11	60,646	6,910	595	-	68,479	4,180
60-64	795	22	84,913	10,298	620	-	85,925	6,604
65-69	922	28	136,554	19,308	889	-	129,913	12,457
70-74	681	34	119,459	19,680	751	-	118,711	14,294
75-79	445	27	107,616	21,762	516	-	122,365	18,514
80-84	221	21	71,511	17,616	285	-	99,835	20,575
85-89	68	-	31,342	9,018	101	-	59,603	15,573
≥ 90	22	-	8,907	2,926	30	-	31,764	9,911
Total	9,417	NA	988,796	130,318	9,476	NA	1,169,236	120,412

General anesthesia claims are classified as either "high-risk anesthesia" or "non-high-risk" according to the patient's associated risk with a given pre-operative existing condition.

- denotes that cell counts <10 were not available.

NA: Not Available; NDB: National Data Base of Health Insurance Claims and Specific Health Checkups of Japan

recently warned that repeated or prolonged exposure to anesthetics before the age of 3 years "may affect the development of children's brains" [3]. Therefore, we introduced a novel claims-based approach to describe the epidemiology of general anesthesia practice in Japan using the National Database of Health Insurance Claims and Specific Health Checkups of Japan (NDB) Open Data Japan, recently developed by the Japanese government. Unless otherwise indicated, public data in this study were obtained from the MHLW, wherein data are publicly available on the MHLW web site.

Materials and Methods

In 2009, the MHLW was responsible for operating the NDB, which collects information on almost all ($\geq 95\%$) health insurance claims issued under the universal health insurance coverage program in Japan [4]. The database records nationwide health insurance claims every month, as well as specific health checkup data every year, resulting in one of the most comprehensive national healthcare databases in the world [5]. The MHLW compiled accumulating health insurance claims and health checkup data every year, and published The NDB Open Data Japan first in 2014; now the third edition in the series is freely available on the website [6]. The NDB Open Data Japan provides health statistics based on outpatients; inpatients; Diagnosis, Procedure, and Combination (DPC) inpatients; prescriptions; and dental treatments and the specific health checkup data. The third NDB Open Data Japan summarized seven statistics as follows: statistics on medical treatments, dental treatments, dental diseases, drugs, and special treatment materials, results of specific health checkups

and questionnaires, and answers of specific health checkups. We therefore obtained a sample from the third NDB Open Data recorded from April 2016 until March 2017. Drawing upon this nationally representative data, we extracted the following information: sex, age category (by 5-year age groups), the type of anesthetic administered, anesthetic claims related to the preoperative existing conditions (See Table S1 in the Supplementary Material for a detailed description of the anesthetic claims), surgical setting (inpatient or outpatient), and prefecture. The primary outcome was an estimate of the number of general anesthesia cases in inpatient and outpatient settings in Japan. The receipt of general anesthesia was identified using the claim records based on the common general anesthesia code, "general anesthesia under closed-circuit system 5," according to the medical fee schedule defined by the MHLW (See Table S2 in the Supplementary Material for a detailed description of general anesthesia code). In addition, general anesthesia claims were classified as either "high-risk anesthesia" or "non-high-risk" according to the patient's associated risk with a given preoperative existing condition (e.g., "high risk general anesthesia" involved an added additional medical fee; see Table S1). In addition, we performed nationwide ecological analyses of 47 prefectures in Japan and described the prefectural distribution of general anesthesia cases per board certified anesthesiologists. The numbers of board-certified anesthesiologists and registered anesthesiologists were based on a statistics survey in 2016 [7]. Owing to the anonymous nature of the NDB Open Data, fewer than 10 cases per each category were described as "not available" [5]. As this study was based on tertiary analyses of publicly available data, sourced from all hospitals and

clinics in Japan, it was exempt from ethics review board approval. All calculations of recorded data were performed using a spreadsheet in the Excel 2010 software (Microsoft Co., Tokyo, Japan).

Results and Discussion

Between April 2016 and March 2017, there were an estimated 2,427,894 general anesthesia cases. Additionally, we estimated that there were 19,132 general anesthesia cases in outpatient settings, which was 0.79% of overall cases. The distribution of inpatient and outpatient general anesthesia episodes by age is shown in Figure 1 and 2, respectively. The age group with the highest case load was 65 to 69 years among the non-high-risk patients (inpatient setting) and 0 to 4 years among the non-high-risk patients (outpatient setting). Table 1 shows that an estimated 65,009 pediatric patients (<aged 5 years) underwent general anesthesia in inpatient settings (2.7% of all inpatient cases). The number of super-elderly patients (≥ 85 years) who underwent general anesthesia in an inpatient setting was estimated to be 169,044 (7.0% of all inpatient cases). The total numbers of outpatient surgery patients who underwent non-high-risk and high-risk general anesthesia were 18,893 and 239, respectively (Table 1). However, detailed numbers were partially unavailable owing to the small number of cases and the anonymity policy of the NDB Open Data Japan [5]. The median number of general anesthesia cases per board certified anesthesiologists by prefecture was 338 (range: 237 to 525). The regional distribution is shown in Figure 3 and Table S3 in the Supplementary Material for a detailed description of prefectural variation of general anesthesia cases. This is the first study to investigate annual general anesthesia statistics in Japan. The use of general anesthesia in the national healthcare system has not been well described. Our novel approach, using a claims-based methodology, could help establish basic national statistics on its use, stratified by age, throughout Japan. The advantages of using the NDB Open Data Japan, including its practical and inexpensive nature, have recently been recognized in obstetrics research to estimate annual cesarean section rates [8]. Both epidemiological research and existing triennial data are reliable reflections of the true specific demographics in Japan [8,9]. In the present study, we estimated that the annual number of children <5 years of age who underwent general anesthesia in an inpatient setting was 65,009, which is approximately 1.0% of the pediatric population (6.24 million) in Japan [10]. This estimation was much lower than earlier reports from Western countries. A previous population based birth cohort study from Canada estimated that approximately 1 in 7 (14.9%) children underwent general anesthesia before age 3 [11]. Another study from the US estimated that 4.9% of children aged less than 1 year and 6.0% of children aged between 1 and 4 years received general anesthesia during outpatient surgical procedures [12]. Additionally, we estimated that the number of general anesthesia cases in outpatient settings was 0.79% of all cases, which suggests that ambulatory surgery is not as common in Japan than in other developed countries [13-15]. An earlier study in the US demonstrated that approximately 60% to 70% of all surgical procedures were handled in an outpatient setting [15]. The reasons for these discrepancies between Japan and Western countries remain unknown and are difficult to explain. Social differences and variation in health insurance systems may contribute to the lower general anesthesia rate regarding pediatric and ambulatory general anesthesia in Japan, compared with other developed countries. Our study showed that there was substantial geographical variation in anesthesiologists' workload. The prefectural distribution map (Figure 3) shows the wide variation in the burden of anesthesiologists by the prefecture.

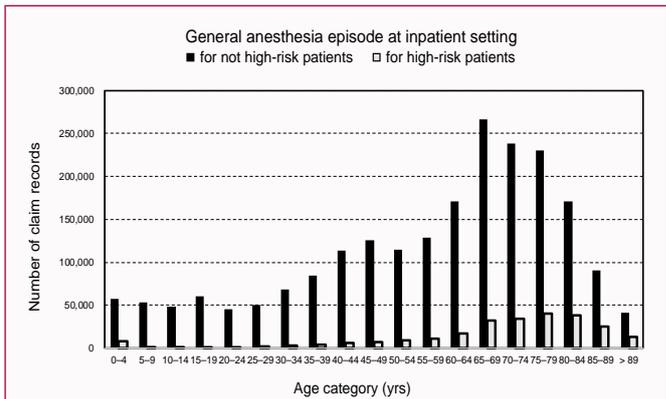


Figure 1: The distribution of general anesthesia episodes in an inpatient setting by age category. High-risk anesthesia was categorized according to the patient's risk of preoperative existing conditions and any additional claims (Table S1).

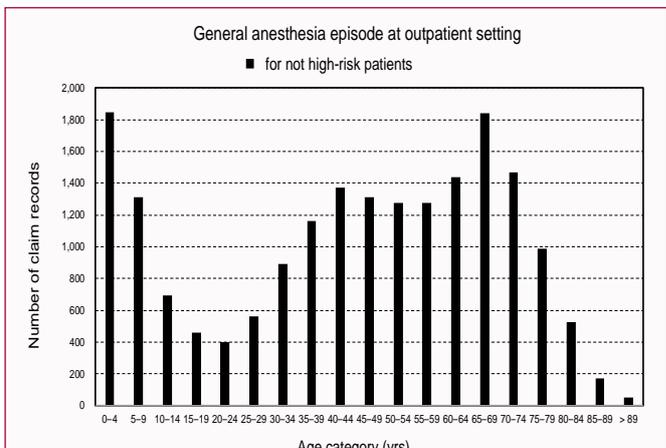


Figure 2: The distribution of general anesthesia episodes in an outpatient setting by age category.

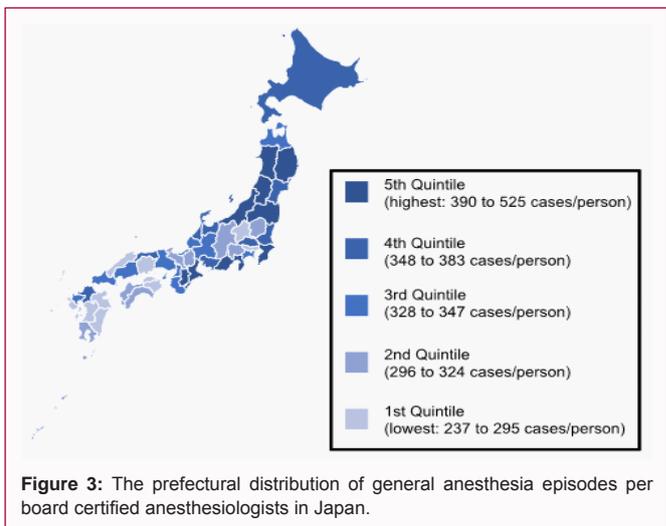


Figure 3: The prefectural distribution of general anesthesia episodes per board certified anesthesiologists in Japan.

This visualization provides important information to understand the current practice of general anesthesia, and to provide healthcare uniformity all over Japan [16]. This study used the governmental open data, which were methodologically robust and clinically relevant for use as baseline data in terms of general anesthesia practice in Japan. The present study has certain limitations. First, the NDB administrative

database is the one of the largest claims databases in the world and it enables accurate estimation of the number of general anesthesia cases on a national scale [5]. However, since their estimates were affected by miscoding or misclassification of claim records regarding the type of anesthesia, our results may have underestimated the actual numbers. In addition, social welfare-entitled patients who underwent general anesthesia were excluded. The total population on social welfare (i.e., patients who received public assistance) numbered 2.17 million in Japan in 2015 [17]. The overall effect of excluding these patients is unknown, but this exclusion may partially explain the discrepancy between the governmental survey (2.8 million) and our own results (2.4 million). The validity of our approach to estimate the general anesthesia episodes using the claims data should be evaluated in future research. Using a validated method, we could evaluate the change of general anesthesia practice over a period of several years, focusing on the changes in clinical practice or national health policies. Second, epidemiology of other anesthetic methods frequently administered in clinical practice, including regional anesthesia or sedation, remains unclear and warrants further study. Ideally, all anesthesiologist-related anesthetics should be recorded to provide comprehensive data for improving the overall working environment. Finally, NDB Open Data Japan provides only the claim records for de-identified patients and this anonymity precludes an accurate determination of the number of patients undergoing multiple general anesthesia episodes.

Conclusion

This is the first Japanese population-based study addressing the epidemiology of general anesthesia. Our analysis, drawing from the Japanese National Data from 2016, showed that the annual number of general anesthesia cases was approximately 2.4 million. The present study also highlights the wide variation and burden of working anesthesiologists in Japan. This claims-based methodology can provide baseline data for the utilization of general anesthesia in Japan. This data will yield valuable information not only for medical research, but also for healthcare delivery, the national healthcare insurance system, and governmental policy.

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