

Anesthesia services in Taiwan: A nationwide population-based study

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Abstract

Background: This study was conducted to provide an overview of anesthesia services in Taiwan from 2001 to 2010.

Methods: A retrospective population-based analysis was performed using data from Taiwan's National Health Insurance Research Database for the period 2001 to 2010. The results were stratified by patient sex, patient age, anesthesia type, and hospital setting. Categorical data are presented as totals and percentages. Linear regression was performed to analyze the anesthesia trends.

Results: The annual use of anesthesia increased continually from 964,440 instances in 2001 to 1,073,160 in 2010, totaling 10,076,600 cases with a total cost of 25.4 billion USD. The overwhelming majority (83.9%) of anesthesia cases was for anesthesia in an inpatient setting; general anesthesia accounted for 73.8% of anesthesia cases, and female patients outnumbered male patients (52.4% vs 47.6%). The average number of anesthesia cases was 44.2 per thousand of the population annually, but this percentage was much higher in elderly people (100.9 cases per thousand people annually). The annual number of anesthesia cases per thousand of the population increased from 104.4 in 2001 to 113.0 in 2010 in the oldest group (>80 years). By contrast, a considerable decline in use of anesthesia was discovered over the study period among those aged younger than 18 years.

Conclusion: The use of anesthesia services in Taiwan has increased over the years. The relationships of age with anesthesia volume and cost were found to follow an inverse U-shaped pattern. Elderly people used anesthesia services more frequently. The planning of geriatric anesthesia services deserves attention, especially in continually aging societies such as Taiwan.

Keywords: Aging; Anesthesia; Attention; Retrospective studies; Taiwan

1. INTRODUCTION

Health care systems worldwide are facing problems, including a low birth rate, extended life expectancy, aging population, and continuously increasing health care expenditure. Statistics from the Ministry of the Interior indicate that the birth rate in Taiwan declined from 1.17% in 2001 to 0.72% in 2010.¹ The Taiwanese population is also living longer, with the average life expectancy rising from 76.75 years in 2001 to 79.18 years in 2010. Therefore, the population of Taiwan is aging, similar to that in numerous western countries. The elderly population (>65 years) comprised 8.81% of the population in 2001, and this percentage rose to 10.74% by 2010 and 15.28% by 2019.² Taiwan is already an "aged" society. Given the current rate of increase in life expectancy, the Taiwan National Development Council has projected that Taiwan will become a "super-aged"

society by 2025, meaning that people aged 65 years or older will comprise more than 20% of the population of Taiwan. Similar predictions have been made for most European countries, Canada, and Japan.^{3,4} This rapid growth in the number of senior citizens indicates that health care demands will also continue to rise. According to statistics released by the National Health Insurance Administration (NHIA) of the Ministry of Health and Welfare in Taiwan, the average health care expenditure per person per year rose from 523 to 768 USD during 2001 to 2010. During this period, medical costs for people aged 65 years or older rose from an average of 1706 to 2423 USD. Reimbursing these medical costs accounted for 33.8% of all medical expenses related to senior citizens; this cost was 3 times higher than the average medical expenditure in Taiwan.⁵

The improvements in anesthesia safety in Taiwan have facilitated the use of surgery in older patients and patients with complex conditions. To our knowledge, this study is the first attempt to quantify the frequency and cost of surgery-associated anesthesia services by employing the data of patients insured in Taiwan's National Health Insurance (NHI) System. The National Health Insurance Research Database (NHIRD) consists of data from Taiwan's mandatory health care system. The population of Taiwan averaged 22 814 421 from 2001 to 2010. Nearly 100% of Taiwan's population is enrolled in the NHI,⁶ and the database contains claims data for reimbursements to all NHI beneficiaries. It thus covers anesthesia performed in Taiwan. Despite this unique source of data, few studies have researched overall anesthesia usage and costs in Taiwan.

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The goal of this study was to provide an overview of anesthesia services in Taiwan from 2001 to 2010. The rate of use, cost, frequency per thousand people, and trends in anesthetics and anesthesia costs were analyzed in patient subgroups of different sexes, ages, anesthesia types, and settings.

2. METHODS

Ethical approval (2011-05-015 IC) for the research protocol used in this Longitudinal Health Insurance Database analysis was obtained and written informed consent was waived by the Institution of Review Board of Taipei Veterans General Hospital.

2.1. Study design and data collection

Taiwan's NHI program was first implemented in 1995 and now covers almost 100% of the Taiwan population. This study used data from NHIRD provided by Taiwan National Health Research Institutes. The NHIRD is one of the largest and most comprehensive population-based data registries of medical facilities contracted with the NHIA. To obtain a suitable amount of data for analysis, 1 in 500 outpatient claims and 1 in 20 inpatient claims were extracted from the NHIRD datasets by using annual systematic sampling. The Longitudinal Health Insurance Database offers a unique source of reliable data and was used to estimate the overall demand for anesthesia in Taiwan as well as the distribution, frequency, and trends.

The records of all patients receiving anesthesia between January 2001 and December 2010 were analyzed. Anesthesia cases were identified using anesthesia procedure codes (96004C, 96005C, 96007C, 96011C, 96013C, 96017C, and 96020C). Anesthesia costs were identified from anesthesia reimbursement codes (96003C-96008C, 96011C-96023B, 96025B, and 96026B) and calculated as 1 point in 1 New Taiwan Dollar (NTD) on the basis of the health insurance reimbursement system. The exchange rate was approximately NTD 30 to USD 1 at the time of the study.

The following estimates were computed for this period:

1. Distribution, frequency, and tendency of anesthesia service utilization: the number of times anesthesia was performed in 10 years.
2. Distribution, frequency, and tendency of anesthesia resources: the cost of anesthesia over 10 years.
3. Variables: patient sex, patient age, setting, and anesthesia type.

Patient age was stratified into 5 groups: <18, 18 to 39, 40 to 64, 65 to 79, and >80 years; patients of these ages were categorized as nonelderly (<65 years) and elderly (≥65 years). Claims for anesthesia procedures performed from January 1, 2001 to December 31, 2010 were classified into 2 types: (1) general anesthesia, including intravenous and inhalational anesthesia; and (2) regional anesthesia, including epidural anesthesia, spinal anesthesia, caudal block, and brachial plexus block. Settings were classified as either inpatient or outpatient. The anesthesia services provided for each sex, age, anesthetic type, and setting subgroup were divided by the total number of anesthesia cases to obtain the distribution.

2.2. Statistical analysis

Categorical data are presented as totals and percentages. Linear regression analysis was applied to analyze the trends in anesthesia cases and associated costs from 2001 to 2010. All statistical analyses were performed using SPSS statistics software, version 18.0.

3. RESULTS

Anesthesia was performed in 10 076 600 cases between 2001 and 2010 in Taiwan, and it cost a total of USD 2 540 134 660. Of these cases, 8 454 600 (83.9%) were performed in an inpatient setting, whereas 1 622 000 (16.1%) were performed in an outpatient setting; 781 800 (77.5%) were performed on nonelderly patients, whereas 2 264 800 (22.5%) were performed on elderly patients; 4 794 700 (47.6%) were performed on men, and 5 281 900 (52.4%) were performed on women; and finally, general anesthesia was performed in 7 436 720 (73.8%) cases, whereas regional anesthesia was performed in 2 639 880 (26.2%) cases. The number of cases receiving general anesthesia and regional anesthesia stratified by age were as follows: <18 years, 850 500 (11.4%) and 37 800 (1.4%), respectively; 18 to 39 years, 2 130 940 (28.7%) and 1 124 580 (42.6%), respectively; 40 to 64 years, 2 878 740 (38.7%) and 789 240 (29.9%), respectively; 65 to 79 years, 1 243 280 (16.7%) and 517 520 (19.6%), respectively; and ≥80 years, 333 260 (4.5%) and 170 740 (6.5%), respectively (Table 1).

The NHIRD indicates that the total cost of anesthesia from 2001 to 2010 was USD 2 540 134 660. Of this total, USD 2 364 803 043 (93.1.8%) was spent on inpatient cases, with only USD 175 331 617 (6.9%) spent on outpatient cases. Costs for anesthesia in male patients totaled USD 1 382 558 888 (54.4%), those for female patients were USD 1 157 575 772 (45.6%). In terms of patient age subgroups, 75.3% of the total (USD 1 913 139 496) was spent on patients less than 65 years, whereas 24.7% (USD 394 264 088) was spent on patients greater than 65 years. The total cost of general anesthesia was USD 2 229 771 212 (87.8%), and that of regional anesthesia was USD 310 363 448 (12.2%). The cost of general anesthesia in female and male patients was USD 1 000 649 827 (44.9%) and USD 1 229 121 385 (55.1%), respectively, whereas that of regional anesthesia in female and male patients was USD 156 925 945 USD (50.6%) and USD 153 437 503 (49.4%), respectively (Table 2).

The overall frequency of anesthesia services was 44.2 cases per thousand of the population, with a 7.6% increase from 43.0 in 2001 to 46.3 in 2010. The overall frequency was 38.0 cases per thousand among nonelderly patients and 100.9 cases per thousand among elderly patients. Overall, the frequency of anesthesia increased with age, from 17.2 cases per thousand among children (<18 years) to 40.0 cases per thousand among patients between 18 and 39 years, 50.4 cases per thousand among patients between 40 and 64 years, 98.6 cases per thousand among patients between 65 and 79 years, and finally 110.1 cases per thousand among patients aged over 80 years. The cost per thousand increased with patient age, with USD 4598.6 per thousand among children (<18 years), USD 8191.3 per thousand among adults aged 18 to 39 years, USD 13 874.3 among patients aged 40 to 64 years, USD 28 012.6 per thousand among patients aged 65 to 79 years and USD 27 676.4 per thousand among patients aged over 80 years (Table 3).

The overall increase in anesthesia cases from 2001 to 2010 was 11.3%. Regarding the rate of increase in anesthesia cases for different age subgroups from 2001 to 2010, the number of anesthesia cases decreased by 32.6% and 11.1% among patients aged less than 18 years and 18 to 39 years, respectively. However, the number of anesthesia cases increased among those aged 40 to 64, 65 to 79, and over 80 years by 36.7%, 19.7%, and 100%, respectively. In terms of anesthesia type, the overall use of general anesthesia increased 22.6% considerably, whereas the use of regional anesthesia decreased by 15.0% during the decade studied (Table 1).

Overall, the cost of anesthesia rose by 15.9% from 2001 to 2010. The cost for nonelderly patients increased by 10.6%, and

Table 1
Distribution of anesthesia cases

	No. of Anesthetics			Growth Rate 2001–2010	Anesthetic Type	
	Total (%)	2001	2010		General (%)	Regional (%)
All	10 076 600 (100)	964 440	1 073 160	11.3	7 436 720 (100)	2 639 880 (100)
Gender						
Male	4 794 700 (47.6)	462 500	505 600	9.3	3 567 280 (48.0)	1 227 420 (46.5)
Female	5 281 900 (52.4)	501 940	567 560	13.1	3 869 440 (52.0)	1 412 460 (53.5)
Age						
<65	7 811 800 (77.5)	770 180	813 200	5.6	5 860 180 (78.8)	1 951 620 (73.9)
<18	888 300 (8.8)	106 180	71 540	−32.6	850 500 (11.4)	37 800 (1.4)
18–39	3 255 520 (32.3)	346 840	308 240	−11.1	2 130 940 (28.7)	1 124 580 (42.6)
40–64	3 667 980 (36.4)	317 160	433 420	36.7	2 878 740 (38.7)	789 240 (29.9)
≥65	2 264 800 (22.5)	194 260	259 960	33.8	1 576 540 (21.2)	688 260 (26.1)
65–79	1 760 800 (17.5)	160 080	191 600	19.7	1 243 280 (16.7)	517 520 (19.6)
>80	504 000 (5.0)	34 180	68 360	100	333 260 (4.5)	170 740 (6.5)
Setting						
Outpatient	1 622 000 (16.1)	165 500	172 000	3.9	1 522 000 (20.5)	100 000 (3.8)
Inpatient	8 454 600 (83.9)	798 940	901 160	12.8	5 914 720 (79.5)	2 539 880 (96.2)
Anesthetic type						
General	7 436 720 (73.8)	673 480	825 860	22.6		
Regional	2 639 880 (26.2)	290 960	247 300	−15.0		

Table 2
Distribution of anesthesia costs

	Expenditures			Growth Rate 2001–2010	Anesthetic Type	
	Total (%)	2001	2010		General (%)	Regional (%)
All	2 540 134 660 (100)	236 770 491	274 400 000	15.9	2 229 771 212 (100)	310 363 448 (100)
Gender						
Male	1 382 558 888 (54.4)	129 382 144	146 772 211	13.4	1 229 121 385 (55.1)	153 437 503 (49.4)
Female	1 157 575 772 (45.6)	107 388 347	127 627 789	18.8	1 000 649 827 (44.9)	156 925 945 (50.6)
Age						
<65	1 913 139 496 (75.3)	182 960 777	202 337 731	10.6	1 691 934 015 (75.9)	221 205 481 (71.3)
<18	237 027 496 (9.3)	27 955 975	19 097 640	−31.7	233 012 831 (10.5)	4 014 665 (1.3)
18–39	667 064 827 (26.3)	69 968 224	65 433 345	−6.5	546 986 991 (24.5)	120 077 836 (38.7)
40–64	1 009 047 173 (39.7)	85 036 577	117 806 746	38.5	911 934 193 (40.9)	97 112 980 (31.3)
≥65	626 995 164 (24.7)	53 809 715	72 062 269	33.9	537 837 197 (24.1)	89 157 967 (28.7)
65–79	500 284 619 (19.7)	45 445 315	55 085 104	21.2	432 404 787 (19.4)	67 879 833 (21.9)
>80	126 710 545 (5.0)	8 364 399	16 977 165	103	105 432 410 (4.7)	21 278 135 (6.9)
Setting						
Outpatient	175 331 617 (6.9)	18 233 317	17 330 517	−5.0	168 579 867 (7.6)	6 751 750 (2.2)
Inpatient	2 364 803 043 (93.1)	218 537 175	257 069 483	17.6	2 061 191 345 (92.4)	303 611 698 (97.8)
Anesthetic type						
General	2 229 771 212 (87.8)	201 408 632	247 033 049	22.7		
Regional	310 363 448 (12.2)	35 361 859	27 366 951	−22.6		

the cost for elderly patients increased by 33.9%. For patients between 40 and 64 years, costs rose 38.5% from 2001 to 2010, whereas for those between 65 and 79 years, they rose only 21.2%. For those over 80 years, the increase was highest, with the costs found to increase 103% from 2001 to 2010. The cost for patients aged less than 18 years fell by 31.7% from 2001 to 2010, and the cost for patients aged 18 to 39 years fell by 6.5% (Table 2).

The relationships of age with anesthesia volume and cost were found to follow an inverse U-shaped pattern. The consumption percentage of anesthesia volume was 8.8%, 32.3%, 36.4%, 17.5%, and 5% in age groups of <18, 18 to 39, 40 to 64, 65 to 79, and ≥80 years, respectively, and the distribution of costs among these age groups was 9.3%, 26.3%, 39.7%, 19.7%, and 5%, respectively (Tables 1 and 2). By assessing

trends in anesthesia cases and costs, we revealed positive trends in the number of anesthesia cases ($R^2 = 0.946, 0.844, \text{ and } 0.962$; $p < 0.01$) and costs ($R^2 = 0.961, 0.971, \text{ and } 0.94$; $p < 0.01$) for 3 age groups: patients aged 40 to 64, 65 to 79, and over 80 years, respectively. Furthermore, we discovered negative trends in the number of anesthesia cases ($R^2 = 0.969, p < 0.01$) and anesthesia cost ($R^2 = 0.896, p < 0.01$) among patients aged less than 18 years.

4. DISCUSSION

To our knowledge, this study was the first to quantify the use and cost of anesthesia services on the basis of the nationally representative sample of patients insured by Taiwan's NHI system. Our study revealed that anesthesia was performed in

Table 3
Annual anesthesia cases and costs per thousand persons

	All (2001–2010)	2001	2010	Growth Rate (%)
Case/1000 persons				
Total	44.2	43.0	46.3	7.6
<65	38.0	37.7	39.3	4.3
<18	17.2	18.8	15.6	-17.0
19–39	40.0	41.3	38.9	-6.0
40–64	50.4	49.7	53.2	7.0
≥65	100.9	98.4	104.5	6.1
65–79	98.6	97.3	101.8	4.6
≥80	110.1	104.4	113.0	8.2
Cost/1000 persons (USD)				
Total	11 133.9	10 567.5	11 846.9	12.1
<65	9300.3	8954.5	9787.0	9.3
<18	4598.6	4937.0	4155.5	-15.8
19–39	8191.3	8338.3	8250.4	-1.1
40–64	13 874.3	13 331.7	14 459.2	8.5
≥65	27 944.0	27 268.1	28 965.2	6.2
65–79	28 012.6	27 609.4	29 254.8	6.0
≥80	27 676.4	25 552.2	28 063.8	9.8

10 076 600 cases in Taiwan from 2001 to 2010. Among these cases, 77.5% represented nonelderly patients, whereas 22.5% represented elderly patients. In more than 80% of cases, anesthesia was performed in an inpatient setting, and inpatient anesthesia accounted for more than 90% of the total cost of anesthesia in this period. A study conducted in the United States indicated that approximately 60% to 70% of all surgical procedures were practiced in an outpatient setting.⁷ The Taiwan NHI reimbursement system (prefer day pay) could be the reason for this discrepancy between Taiwan and a western country.

Furthermore, we determined that the frequency of anesthesia increased with age; elderly patients (>65 years) received anesthesia most frequently, especially patients aged over 80 years. Furthermore, Taiwan was found to have a lower per-population frequency of anesthesia use (46.3 cases per thousand of the population) than the United States (153 cases per thousand of the population) and United Kingdom (100 cases per thousand of the population) in 2010,⁸ partly because out-of-pocket anesthesia (that for cosmetic surgery and endoscopies) was not covered by the NHI in Taiwan,⁹ and minor ear, nose, and throat and ophthalmology surgery was performed under topical anesthesia.

Most diseases are more common among geriatric patients because of declines in the functional capacity of the cardiovascular system, lungs, renal system, and joints, which lead to multiple comorbidities¹⁰ and hospitalization.¹¹ Therefore, elderly patients require more surgery. The increases may also be attributed to the increased general demand for anesthesia. In Taiwan, we determined that elderly people underwent anesthetic procedures nearly 3 times more frequently than patients less than 18 years. In France, Dadure et al¹² reported an increase in the rate of anesthesia among elderly patients and a decrease among young patients.

The cost of care is much higher for elderly patients than younger patients. Elderly surgical patients are prone to postoperative complications, functional decline, and loss of independence. Furthermore, elderly patients require a different level of care during the preoperative period than do nonelderly patients.^{13,14} Many studies have determined that age is a major factor affecting postoperative medical service utilization.^{15,16} Because of the risks associated with anesthesia and surgery, longer hospitalization, and postoperative complications, the average medical cost is higher in older adults. A study involving patients with glioblastoma demonstrated that the average

medical cost was 38% higher in the older adult group (≥70 years) than in the younger group. Furthermore, the medical cost for older adults with complications was 2.1 times higher than that of older adults without complications; the rate of complications was 2.9 times higher than in younger patients.¹⁷ However, the increases in anesthesia cases and costs may also have been due to easy and free access to all health care facilities in Taiwan without the need for a referral.^{18,19}

Women were more likely to receive anesthetic procedures than men in the period studied, with these sexes accounting for 52.4% and 47.6% of the total cases, respectively. Similarly, Dadure et al¹² indicated that in France, 58% and 42% of all anesthesia procedures were performed in women and men, respectively. However, the cost of anesthesia in men was almost 1.2 times higher than that in women. A study conducted in the United Kingdom reported that men sought medical help at a later stage of illness,²⁰ which could partially explain the additional anesthesia costs incurred.

General anesthesia was the most frequently performed anesthesia procedure in Taiwan, accounting for 73.5% of cases; this may have been because of the payment differentials adopted by the NHIA in Taiwan for different anesthesia techniques. The 2-hour spinal anesthesia fee is USD 50, and the fee for general anesthesia with intubation is USD 128.²¹ Taiwan anesthesiologists prefer general anesthesia because of the higher reimbursement. The rapidly aging population in the United States has led to an increase in the use of general anesthesia.²² Furthermore, the type of anesthesia used also depends on the person's preferences. Shevde and Panagopoulos²³ demonstrated that 69% of patients prefer general anesthesia over regional anesthesia, whereas another study reported this percentage to be 49.3%.²⁴

Upward trends in anesthesia cases were observed for several age groups between 2001 and 2010. The use of anesthesia services for elderly patients increased by 33.8% over the period of this study, whereas the cost of anesthesia services for this age group increased by 33.9%. We also determined that the increase in anesthesia costs for patients aged over 80 years displayed a notable increase of 100%, contrasting with a 32.6% decrease for patients less than 18 years. The negative trend in demand for anesthesia services for patients less than 18 years is related to the low birth rate in Taiwan. These findings indicate substantial growth in the use and costs of anesthesia in older patients, especially those over 80 years. Elderly people use more NHI resources in all medical service settings compared with all other age groups.²⁵

Naughton and Feneck²⁶ reported that an aging population results in more surgeries, greater use of anesthesia services, and higher associated medical expenditures. The aging population in Taiwan may also increase the demand for geriatric anesthesia services. Similar trends were observed in Europe, with the proportion of the elderly surgical population undergoing anesthesia increasing significantly.¹⁴ This topic warrants further investigation.

Furthermore, performing anesthesia in elderly people may considerably increase the workload of anesthesiologists than doing so in other age groups. Elderly patients require more complicated anesthetic care, including more preoperative evaluations and perianesthetic monitoring. Therefore, anesthesiology departments must emphasize geriatric anesthesia during residency training and education to compensate for the increase in the number of geriatric patients.

The use of the NHIRD implies limitations regarding the accuracy of the results of this study. The analysis was based solely on NHI claims data and thus did not include patients who paid out of pocket, which is sometimes done when anesthesia and sedation are used in cosmetic surgery or endoscopy. Therefore, our results do not cover these various nonreimbursed uses of anesthesia.

In conclusion, age was found to have inverse U-shaped relationships with anesthesia volume and cost. The decreased number of anesthesia procedures in younger patients was related to the low birth rate, but overall, the demand for anesthesia services exhibited an upward trend. The anesthesia costs for patients aged 80 years and older increased by 100% from 2001 to 2010 in Taiwan, whereas the cost decreased moderately among patients aged younger than 39 years. Anesthetic procedures for men cost more than those for women during this decade. Taiwan's NHI reimbursement system may enable general anesthesia to be performed more frequently than in other payment systems. Elderly patients received anesthesia almost 3 times more frequently than patients aged less than 18 years and incurred much higher associated costs. In an aged population such as in Taiwan, anesthesia services for geriatric patients may become a critical health-related issue.

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REFERENCES

1. Ministry of the Interior, Department of Household Registration. R.O.C. (Taiwan). Available at <http://ris.gov.tw/>. Accessed May 8, 2020.
2. Ministry of the Interior, Department of Statistics. Available at <http://www.moi.gov.tw/>. Accessed May 5, 2020.
3. National Development Council. Available at <https://www.ndc.gov.tw/>. Accessed May 5, 2020.
4. World Health Organization. The World Health Report 1998: Life in the 21st Century-A Vision for All. Geneva: World Health Organization; 1998.
5. National Health Insurance Administration, Ministry of Health and Welfare. Available at <http://www.nhi.gov.tw/>. Accessed March 15, 2020.
6. Lu JF, Hsiao WC. Does universal health insurance make health care unaffordable? Lessons from Taiwan. *Health Aff (Millwood)* 2003;22:77-88.
7. Benarroch-Gampel J, Sheffield KM, Duncan CB, Brown KM, Han Y, Townsend CM Jr, et al. Preoperative laboratory testing in patients undergoing elective, low-risk ambulatory surgery. *Ann Surg* 2012;256:518-28.
8. IFNA/International Federation of Nurse Anesthetists. Available at <http://www.ifna-int.org/ifna/news.php>. Accessed 5 May 2020.
9. Wang JO, Li CY, Kao S, Yeh TC, Arens JF, Ho ST. Factors associated with Taiwan anesthesiologists' intention to leave anesthesia practice. *J Formos Med Assoc* 2015;114:509-16.
10. Wolff JL, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. *Arch Intern Med* 2002;162:2269-76.
11. Gijzen R, Hoeymans N, Schellevis FG, Ruwaard D, Satariano WA, van den Bos GA. Causes and consequences of comorbidity: a review. *J Clin Epidemiol* 2001;54:661-74.
12. Dadure C, Marie A, Seguret F, Capdevila X. One year of anaesthesia in France: a comprehensive survey based on the national medical information (PMSI) database. Part 1: in-hospital patients. *Anaesth Crit Care Pain Med* 2015;34:191-7.
13. Cook DJ, Rooke GA. Priorities in perioperative geriatrics. *Anesth Analg* 2003;96:1823-36.
14. Klopfenstein CE, Herrmann FR, Michel JP, Clergue F, Forster A. The influence of an aging surgical population on the anesthesia workload: a ten-year survey. *Anesth Analg* 1998;86:1165-70.
15. McKissack HM, Viner GC, Jha AJ, Wilson JT, Anderson MC, McGwin G Jr, et al. Comparison of risk factors for postoperative complications across age groups in patients undergoing ORIF of the ankle. *Injury* 2019;50:2116-22.
16. Thorsen K, Søreide JA, Søreide K. Long-term mortality in patients operated for perforated peptic ulcer: factors limiting longevity are dominated by older age, comorbidity burden and severe postoperative complications. *World J Surg* 2017;41:410-8.
17. Sherrod BA, Gamboa NT, Wilkerson C, Wilde H, Azab MA, Karsy M, et al. Effect of patient age on glioblastoma perioperative treatment costs: a value driven outcome database analysis. *J Neurooncol* 2019;143:465-73.
18. Cheng SH, Chiang TL. The effect of universal health insurance on health care utilization in Taiwan. Results from a natural experiment. *JAMA* 1997;278:89-93.
19. Cheng TM. Taiwan's new national health insurance program: genesis and experience so far. *Health Aff (Millwood)* 2003;22:61-76.
20. Banks I. No man's land: men, illness, and the NHS. *BMJ* 2001;323:1058-60.
21. National Health Insurance Administration, Ministry of Health and Welfare. Available at <http://www.nhi.gov.tw/webdata/>. Accessed May 4, 2020.
22. Forman SA. Molecular approaches to improving general anesthetics. *Anesthesiol Clin* 2010;28:761-71.
23. Shevde K, Panagopoulos G. A survey of 800 patients' knowledge, attitudes, and concerns regarding anesthesia. *Anesth Analg* 1991;73:190-8.
24. Matthey PW, Finegan BA, Finucane BT. The public's fears about and perceptions of regional anesthesia. *Reg Anesth Pain Med* 2004;29:96-101.
25. Shao CC, Chang CP, Chou LF, Chen TJ, Hwang SJ. The ecology of medical care in Taiwan. *J Chin Med Assoc* 2011;74:408-12.
26. Naughton C, Feneck RO. The impact of age on 6-month survival in patients with cardiovascular risk factors undergoing elective non-cardiac surgery. *Int J Clin Pract* 2007;61:768-76.